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QUANTIFIERS AND VARIABLES: INSIGHTS FROM SIGN LANGUAGE (ASL AND LSF)[1]

ABSTRACT: In standard logical systems, quantifiers and variables are essential to express complex relations among objects. Natural language has expressions that have an analogous function: some noun phrases play the role of quantifiers (e.g. *every man*), and some pronouns play the role of variables (e.g. *him*, as in *Every man likes people who admire him*). Since the 1980's, there has been a vibrant debate in linguistics about the way in which pronouns come to depend on their antecedents. According to one view, natural language is governed by a 'dynamic' logic which allows for dependencies that are far more flexible than those of standard (classical) logic. According to a competing view, the treatment of variables in classical logic does not have to be fundamentally revised to be applied to natural language. While the debate centers around the nature of the formal links that connect pronouns to their antecedents, these links are not overtly expressed in spoken language, and the debate has remained open. In sign language, by contrast, the connection between pronouns and their antecedents is often made explicit by pointing. We argue that data from French and American Sign Language provide crucial evidence for the dynamic approach over one of its main classical competitors; and we explore further sign language data that can help choose among competing dynamic analyses.

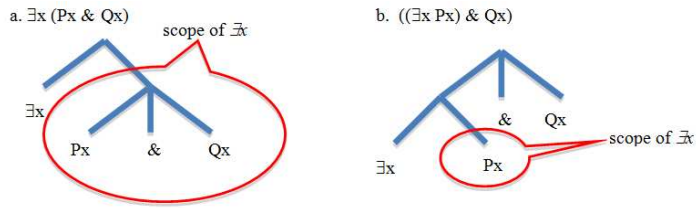
Since the advent of formal linguistics, it has become standard to consider natural language as a formal system with a specifiable syntax and semantics (Chomsky 1957, 1965; Montague 1974). One can then ask what *logic* underlies the computation of meaning. It is uncontroversial that English has resources to express counterparts of the quantifiers and variables of standard ('Predicate') logic: *everything* and *something* can, as a first approximation, play the roles of the universal and existential quantifiers ($\forall$ and $\exists$), and some pronouns play the role of variables (e.g. *him*, as in *Every man likes people who admire him*) (e.g. Quine 1987; Heim & Kratzer 1998[2]). It is uncontroversial that standard logic (First-Order Logic) needs to be enriched to deal with natural language quantifiers: minimally, generalized and restricted quantifiers must be added to it; and the logic might have to be higher-order.

But there are two competing views on the further additions that are needed to handle pronouns. According to 'dynamic semantics', natural language allows for anaphoric dependencies that are far more flexible than in standard logical systems. According to a competing view (henceforth 'classical semantics'), the standard treatment of variables does not have to be radically revised to be applied to natural language, but noun phrases and pronouns correspond less directly to quantifiers and variables than the dynamic view posits. The debate centers around the formal link that exists between pronouns and their antecedents. This link is not overtly realized in spoken language, but it often is in sign languages. We show that in some crucial cases American and French Sign Language (ASL and LSF) display precisely the links that are postulated by the dynamic approach; we then use this observation to help decide among sub-varieties of the dynamic approach.

1. QUANTIFIERS AND VARIABLES IN NATURAL LANGUAGE

An important discovery of formal syntax was that the formal notion of scope in Predicate Logic also plays an important role in several natural language phenomena (Gamut 1991; Heim & Kratzer 1998).

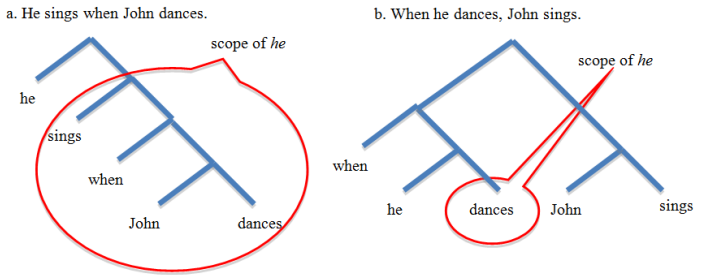
(1) Scope in Predicate Logic
Qx is in the scope of the quantifier $\exists x$ in a. but not in b. (we omit parentheses from the trees).



The *scope* of a quantifier is the sub-tree that sits next to that quantifier in the hierarchical structure of the formula. Thus in (1)a, but not in (1)b, *Qx* is in the scope of ∃*x*. A consequence of the standard semantics for Predicate Logic is that *Qx* can be dependent on ∃*x* in the first case but not in the second: (1)a means that *something is both P and Q*, while (1)b means that *something is P, and x is Q*.

After some experimentation with different formal definitions, it was found in theoretical syntax that the very same notion (called 'c-command' in syntax) plays a critical role in several linguistic phenomena. An example is given in (2)a, where the proper name *John* cannot refer to the same individual as the pronoun *he* because it is within its scope; by contrast, *John can* refer to the same individual as the pronoun *his* in (2)b because it is not within its scope (e.g. Reinhart 1976; Chomsky 1981/1993; Lasnik 1989).

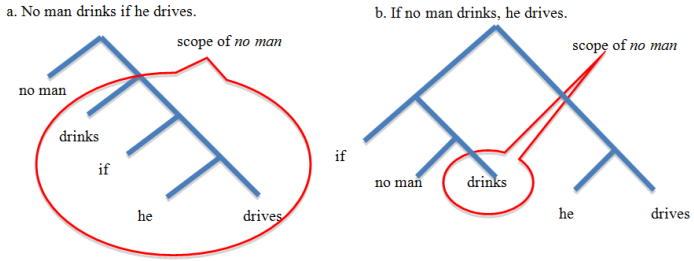
(2) Scope in English I
A proper name *cannot* be in the scope of an expression that refers to the same person (*Condition C*)



One could expect that a pronoun, just like a variable, can only be dependent on a quantifier if it is within its scope. In some cases, this

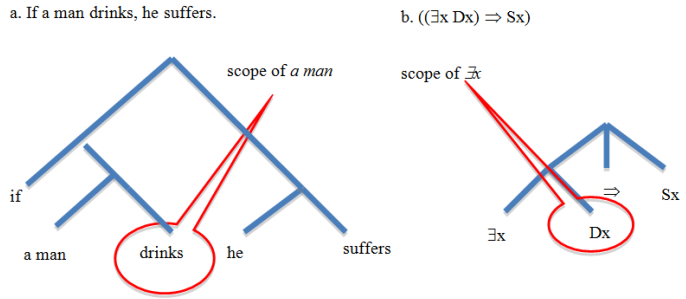
assumption appears to be correct. *No man drinks if he drives* has a meaning akin to *no man x is such that x drinks if x drives*, and *he*—the counterpart of the variable *x*—does appear in the scope of *no man*, as shown in (3)a. By contrast, *If no man drinks, he drives* does not allow the pronoun to be dependent on *no man* because *he* is not in the scope of *no man*, as shown in (3)b (to be felicitous, *he* would have to refer to some salient individual) (e.g. May 1985, Fox 2003).

(3) Scope in English II
A pronoun must be in the scope of [= 'c-commanded by'] a quantifier it depends on.



When *no man* is replaced with *a man*, however, the facts change. *If a man drinks, he suffers* is naturally interpreted as: *If a man drinks, that man suffers*; the pronoun is dependent on the quantifier although it is not within its scope, as shown in (4)a. By contrast, the logic formula shown in (4)b does not allow *Sx* to be dependent on the quantifier. The difference is particularly striking because (4)b would be expected to be a close analogue of (4)a if *Dx* is interpreted as *x drinks* and *Sx* as *x suffers* (taking ∃*x* to quantify over men, the formula *((∃x Dx) ⇒ Sx)* could (wrongly) be expected to have the same meaning as the English sentence: *If a man drinks, he suffers*) (Geach 1962; Evans 1980).

(4) Scope in English vs. Predicate Logic
A pronoun can depend on an existential quantifier without being in its scope in English, but not in Predicate Logic.



Because Geach originally discussed examples such as (5)a-b to show that a pronoun may depend on a quantifier without being in its scope, pronouns that have this property are called 'donkey pronouns' in the literature.

(5) a. Every farmer who owns a donkey beats it.
b. If a farmer owns a donkey, he beats it.

2. THE DEBATE: DYNAMIC SEMANTICS VS. CLASSICAL SEMANTICS

There have been two reactions to the problem of 'donkey pronouns'.

1. Dynamic Semantics: One view is that the logic underlying natural language is just different from standard logic. An entire movement, called 'dynamic semantics', has developed new rules that make it possible for a variable or a pronoun to depend on an existential quantifier or an indefinite without being in its scope (this may be done by treating indefinites themselves as variables, as in Kamp 2003 and Heim 1982; or by allowing existential quantifiers to bind outside of their syntactic scope, as in Groenendijk & Stokhof 1991).

2. Classical Semantics: The opposing view is that no new logic is needed for natural language because the assimilation of pronouns (e.g. *he* in (4)a) to variables (e.g. *x* in (4)b) is incorrect. On this view, the

pronoun should be analyzed as a concealed description such as *the man*, or *the man who drinks* (e.g. Evans 1980; Heim 1990; Elbourne 2005); analyses that make this assumption are called 'E-type theories'. In some E-type theories, the pronoun is literally taken to come with an elided noun: *he* = *he* ~~*man*~~, where *man* is unpronounced and *he* is a version of *the* (this identity is morphologically realized in German, where *der* means both *the* and *he*) (Elbourne 2005). In other E-type theories, the pronoun is taken to have a richer semantic content, with for instance *he* = *the man who drinks* (e.g. Heim 1990). We henceforth restrict attention to the former analysis (Elbourne's), which is one of most elegant and articulated E-type theories currently on the market (see Schlenker (to appear) for a discussion of other E-type theories in the present context).

Each analysis involves some refinements.

– The *dynamic analysis* develops rules of semantic interpretation that allow *he* in (4)a to depend on *a man* without being in its scope (the same methods can be applied to formal logic, leading to a 'dynamic' interpretation of (4)b in which *Sx* depends on the quantifier ∃*x*). This formal connection is taken to be represented in language through unpronounced variables similar to those of logic. Thus the sentence *If* [*a man*]$_x$ *drinks, he*$_x$ *suffers* is taken to include a variable *x* that encodes the dependency of *he* on *a man*.

– The classical analysis (= E-type theory) must address two challenges. (i) First, it must explain which man the pronoun *he* (analyzed as meaning *the man*) refers to in (4)a—for there is certainly more than one man in the world. The standard solution is to take the word *if* to make reference to cases or 'situations' that are small enough to contain just one man. *If a man drinks, he suffers* is thus analyzed as: *In every situation s in which a man drinks, the man* <u>*in s*</u> *suffers*, with one man per situation (explicit reference to 'cases' is made when *if* is replaced with the nearly equivalent expression *in case*). (ii) Second, the classical analysis must explain what kind of formal link connects *he* to *a man* in (4)a. While the thrust of the approach is that this link is not directly interpreted (or else the analysis would be granting the main point of the dynamic solution), there appears to be some formal connection between the pronoun and its antecedent, which forces the latter to be a noun phrase. The reason for this conclusion is that when one keeps the

meaning of the *if*-clause constant, it can be shown that the presence of a noun phrase is crucial to license the pronoun. For instance, *John is married* and *John has a wife* are usually synonymous; but although (6)a is grammatical, (6)b is not—it seems that the pronoun is missing a noun phrase as its antecedent.

(6) a. If John had a wife, he would be kind to her.

b. #If John were married, he would be kind to her.

This is known as the problem of the 'formal link' between the pronoun and its antecedent (Heim 1990). While different E-type theories give different solutions to this problem, we will follow here Elbourne's elegant analysis (Elbourne 2005): the desired data can be derived if *her* is represented as *the ~~wife~~*, with ellipsis of *wife*, which must be recovered through a syntactic operation; ellipsis resolution can in effect establish the desired formal link between *her* and its antecedent.

Each analysis comes in several varieties—and some versions from opposite camps might even converge (Dekker 2004). The empirical debate has centered around sentences such as (7)a ('bishop sentences'), which are characterized by the fact that two NP antecedents with symmetric semantic roles are present in the *if*-clause.

(7) a. If a bishop meets a bishop, he blesses him.

b. If [a bishop]$_x$ meets [a bishop]$_y$, he$_x$ blesses him$_y$.

c. If [a bishop] meets [a bishop], he ~~bishop~~ blesses him ~~bishop~~.

c'. If [a bishop] meets [a bishop], he ~~bishop#1~~ blesses him ~~bishop#2~~.

(7)a is crucial because the cases referred to by the *if*-clause include two bishops that play symmetric roles (if a bishop x meets a bishop y, it is also true that a bishop y meets a bishop x). The *dynamic analysis* in (7)b has no difficulty here because each noun phrase introduces a separate variable; this allows each pronoun to depend on a different quantifier because he_x and him_y carry different variables (we could also have he_y/him_x, but not he_x/him_x or he_y/him_y: the pronouns must carry different variables to refer to different bishops, or else the sentence would be understood as involving self-blessings—and in addition a reflexive would be needed). The *classical analysis* must first postulate

that the two bishops mentioned in the antecedent of (7)a are in principle distinguishable by some descriptions. This is not quite trivial: if bishop b meets bishop b', by virtue of the (symmetric) meaning of *meet*, it is also the case that bishop b' meets bishop b. Without fine-grained situations, this can cause difficulties for E-type theories. For Elbourne's theory, the potential problem is that the two pronouns found in the consequent clause both stand for the description *the bishop*—which means that some additional measures are needed to allow these pronouns to refer to different individuals. Importantly, analyses that posit a richer descriptive content for the pronouns also encounter difficulties: if *he* is analyzed as *the bishop that meets a bishop*, and *him* as *the bishop that a bishop meets*, we still have a symmetry problem, because here too the two descriptions should be synonymous (by virtue of the symmetry of *meet*).

Elbourne's conclusion is that situations/cases must be so fine-grained that a case <x, y, meet> in which x meets y is different from a case <y, x, meet> in which y meets x.[3] Interestingly, Elbourne also notes that for structurally different examples this distinction just cannot be made; he argues in particular that (8) is ungrammatical because the two antecedents are so symmetric that they cannot be distinguished at all (Elbourne 2005).

(8) ∗If a bishop and a bishop meet, he blesses him.

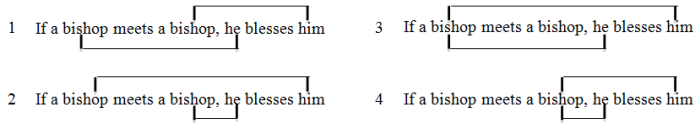
In (7)a, by contrast, the symmetry is somehow broken, but to obtain the right meaning the pronouns must still be endowed with some additional material—perhaps provided by the context—to pick out different bishops in a given case <bishop$_1$, bishop$_2$, meet>. (7)c is thus insufficient because it does not specify *which* bishop each pronoun refers to; in (7)c', the pronouns are enriched with the (stipulated) symbols #1 vs. #2, which are intended to pick out the 'first' or the 'second' bishop in <bishop1, bishop2, meet>. Importantly, this additional material is probably not provided by the antecedents, which play symmetric roles; if it is real, it must be provided by some other, non-linguistic (e.g. contextual) mechanism.

In this version of the debate, we obtain different predictions about the formal connection between the pronouns and their antecedents in (7)a. According to the *dynamic analysis*, the pronouns can be linked to

any noun phrase, as long as they have different antecedents. According to (Elbourne's version of) the *classical analysis*, the formal connection is not by itself interpreted: its only function is to indicate where the elided noun phrase is to be found; thus as long as each pronoun has some antecedent, the sentence should be fine *on the intended reading* (which does not involve any 'self-blessings')—even if the two pronouns happen to have the same antecedent (if so, the examples under consideration are in this respect analogous to *When two bishops meet, the one ~~bishop~~ blesses the other ~~bishop~~*, where the two elided occurrences of ~~*bishop*~~ have the same antecedent, but the two descriptions still denote different individuals).[4] The predictions are represented in (9) by linking the pronouns to their possible antecedents.

(9) Possible formal links according to Dynamic vs. Classical Analyses

Dynamic Analysis: only patterns 1 and 2 should be possible (different antecedents are necessary)
Classical Analysis: all patterns 1, 2, 3 and 4 should be possible (any antecedents are fine)



In spoken languages, the formal connection between a pronoun and its antecedent is not morphologically realized. As a result, arguments for or against dynamic and E-type approaches have been indirect, and the debate between these two approaches has remained largely open.

3. DONKEY PRONOUNS IN SIGN LANGUAGE: ASL AND LSF

In sign languages, pronouns are usually realized by pointing, and their connection to their antecedent can be made fully explicit. This makes sign language an ideal testing ground to revisit the debate between dynamic and classical approaches to donkey pronouns.

3.1. Pronouns in sign language

In American Sign Language (ASL) and in French Sign Language (LSF), the relation between a pronoun and its antecedent is usually mediated by *loci*, which are positions in signing space that are associated with nominal elements (e.g. Sandler & Lillo-Martin 2006, Neidle et al. 2000). A pronoun that depends on a noun phrase will thus point towards (or 'index') the locus that was introduced by that noun phrase. We see in (10) examples of locus assignment to proper names and indefinites in ASL (American Sign Language).

In the following, sign language sentences are glossed in capital letters. Nonmanual markings are omitted because they do not play a role in the present discussion (although they are definitely crucial to a proper understanding of meaning in sign language). *arc* is in both ASL and LSF a circular movement found in plural pronouns. Subscripts correspond to the establishment of positions ('loci') in signing space. In some cases, this is done by signing an expression in the relevant location—for instance $_a$*ONE* is the word 'one' signed in locus *a*. It must be emphasized, however, that there are multiple ways to establish loci—sometimes gazing at a location while producing a sign is enough; and sometimes pointing is used to establish a locus. In the former case, we use subscripts; in the latter case, we use *IX-a* to make clear that a pointing sign ('index') is associated with locus *a*. Pronouns are usually realized through pointing towards a locus, and they are also glossed as *IX-a, IX-b*, etc. Letters corresponding to loci are assigned in alphabetical order from right to left from the signer's perspective; the numbers *1* and *2* correspond to the position of the signer and to that of the addressee respectively.[5]

(10) **ASL**

a. IX-1 KNOW $_a$BUSH IX-1 KNOW $_b$OBAMA. IX-b SMART BUT IX-a NOT SMART.
'I know Bush and I know Obama. He [= Obama] is smart but he [= Bush] is not smart.' (Inf 1, 4, 179)

b. IX-1 KNOW PAST SENATOR PERSON IX-a IX-1 KNOW NOW SENATOR PERSON IX-b. IX-b SMART BUT IX-a NOT SMART.
'I know a former senator and I know a current senator. He [= the current senator] is smart but he [= the former senator] is not smart.' (Inf 1, 4, 179)

Since there appears to be an arbitrary number of possible loci, it was suggested that the latter do not merely spell out morpho-syntactic features (e.g. 1st, 2nd, 3rd person, etc.), but rather are the overt realization of indices, i.e. of variables (Lillo-Martin 1991, Sandler & Lillo-Martin 2006). Using this observation, we will use sign language data to revisit the debate about donkey anaphora, which crucially hinges on the nature of coindexation (for simplicity, we do not discuss here other uses of pointing in sign language; see Schlenker, to appear for a more detailed discussion in the context of donkey anaphora).

3.2. Bishop sentences in ASL and LSF

The patterns of indexing found in standard bishop sentences in ASL and LSF are in agreement with the predictions of dynamic analyses, and contradict the E-type analysis discussed above: we find the two patterns of indexing predicted by dynamic theories, and no other patterns (but see Schlenker (to appear) for a discussion of the more fine-grained patterns of preference among these examples). Since *MEET* in ASL involves additional complexities, we study the construction *x lives with y*, which is just as symmetric (since x lives with y if and only if y lives with x).

(11) **ASL**
WHEN $_a$SOMEONE LIVE WITH $_b$SOMEONE,
'When someone lives with someone,'

a. IX-a LOVE IX-b
'the former loves the latter.'

b. ?[6] IX-b LOVE IX-a
'the latter loves the former.'

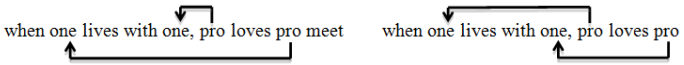
c. # IX-a LOVE IX-a

d. # IX-b LOVE IX-b

(Inf 1 i P1040962; i P1040963, i P1040972)

If we represent the results by putting an arrow between a pronoun and the antecedent whose locus it indexes, we obtain the simplified patterns in (12) and no other patterns. This confirms the predictions of the dynamic analysis outlined in (9).

(12) 'When someone lives with someone, he/she loves him/her' in ASL



The examples in which the two pronouns index the same locus ((11)c and (11)d) are odd, for two reasons: to the extent that a meaning is obtained, it is one that involves a claim of 'self-loving'; in addition, to express such a claim properly one would have to use a reflexive (*SELF*).

The same pattern holds in (13), except that now the only problem with (13)c-d is that they give rise to an implausible meaning—one that entails that in the relevant situations a Frenchman wonders who *he himself* lives with. Importantly, the prediction of the classical analysis summarized in (7) was that the two pronouns could index the same locus *while referring to different individuals*—which fails to be the case here.

(13) **ASL**
WHEN $_a$[FRENCH MAN] a,b-MEET $_b$[FRENCH MAN], 'When a Frenchman meets a Frenchman,'

a. IX-a WONDER WHO IX-b LIVE WITH.
'the former wonders who the latter lives with.'

b. ? IX-b WONDER WHO IX-a LIVE WITH.
'the latter wonders who the former lives with.'

c. # IX-a WONDER WHO IX-a LIVE WITH.
'the former wonders who the former lives with.'

d. # IX-b WONDER WHO IX-b LIVE WITH.
'the latter wonders who the latter lives with.'

(Inf 1, i P1040945; i P1040946, i P1040955, i P1040968)

Similar facts hold in LSF as well:

(14) **LSF**

a. EACH-TIME IX-a $_a$STUDENT a,b-MEET IX-b $_b$STUDENT, a-GIVE-b CIGARETTE.
'Each time a student meets a student, he [= the former] gives him [= the latter] a cigarette.'

b. EACH-TIME IX-a $_a$STUDENT a,b-MEET IX-b $_b$STUDENT, IX-b b-GIVE-a CIGARETTE.
'Each time a student meets a student, he [= the latter] gives him [= the former] a cigarette.'

c. No other patterns are exemplified.
(Inf F, 3, 35)

In sum, our results provide support for the dynamic approach: only the patterns 1 and 2 illustrated in (9) are possible; patterns 3 and 4 are never instantiated. Importantly, the same patterns extend to ASL versions of the (deviant) English sentence in (8) (**If a bishop and bishop meet, he blesses him*), as shown in (15).

(15) **ASL**
WHEN $_a$SOMEONE AND $_b$SOMEONE LIVE TOGETHER,
'When someone and someone live together,

a. IX-a LOVE IX-b
the former loves the latter.'

b. IX-b LOVE IX-a
the latter loves the former.'

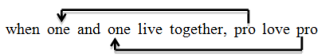
c. # IX-a LOVE IX-a

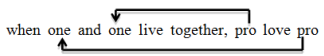
d. # IX-b LOVE IX-b

(Inf 1, i P1040966; i P1040967, i P1040973 [= scale-based judgment])

If we use the same schematic representations as in (12), we obtain for (15) the patterns in (16) and no others.

(16) 'When someone and someone live together, he/she loves him/her' in ASL





Thus the deviance of sentence (8) is not reproduced with analogous sign language sentences. There are two possible conclusions one might draw: (a) sign language pronouns are constrained by different principles than their spoken language counterparts; or (b) the deviance of the English example in (8) is due to a relatively superficial (possibly

morphological) property of the structure. The latter line is explored in Schlenker (to appear), where it is suggested that the presence of distinct loci in sign language makes it easier to break the *syntactic* symmetry between the two antecedents.

4. GOING FURTHER: DISTINGUISHING AMONG DYNAMIC APPROACHES

As we saw, noun phrases can introduce loci in signing space, and a pronoun depends on a noun phrase if it points towards its locus. These loci play the role of 'discourse referents' in dynamic approaches (Sinha 2009). According to the latter, in the discourse $[A\ man]_x$ *came.* He_x *sat down.*, the first sentence introduces a discourse referent x which denotes a man who came; the second sentence then asserts that x sat down. The close correspondence between loci and discourse referents makes it possible to use sign language to decide competing versions of the dynamic approach. We will briefly consider two debates (see Schlenker (to appear) for a more detailed discussion).

1. Are discourse referents introduced by (a) all quantifiers (van den Berg 1996, Brasoveanu 2006, Nouwen 2003) or (b) only existential ones (such as *a man*, *two men*, etc; e.g. Kamp & Reyle 1993)?[7]

2. Is the link that connects a pronoun to an existential antecedent (a) blocked by some elements, such as negation (Kamp 2003, Heim 1982, and all standard dynamic accounts), or (b) is it unconstrained, with the sole requirement that the pronoun should denote *something* (see Brasoveanu 2010)?[8]

Sign language data argue in favor of answers 1a and 2b. We consider each debate in turn.

4.1. Do all quantifiers introduce discourse referents?

(17) shows that all sorts of quantifiers—including the negative quantifier *less than five students*—can introduce a locus towards which a pronoun can point (the follow-up questions mentioned in the examples were intended to check that *IX* really had the interpretation of a

'donkey' pronoun; for instance, in (17)a we ascertained in this way that the pronoun referred to *the students that come*—rather than, for instance, to all students).

(17) **ASL**

a. IF $_a$[LESS FOUR STUDENT] a-COME PARTY, IX-arc-a WILL BORED.
Follow-up question: Who would get bored? Answer: 'all student partygoers'.
'If fewer than four students come to the party, they [= the students that come] will get bored.'
(Inf 1, i P1040994; P1040995 ; see also i, 1)

b. IF LESS $_a$[THREE FRENCH PERSON HERE] AND LESS $_b$[FIVE AMERICAN PERSON HERE], IX-arc-a WILL GREET-b IX-arc-b
'If less than three Frenchmen were here and less than five Americans were here, they [= the Frenchmen] would greet them [= the Americans].'
(Inf 1, 2, 117)

c. IF $_a$[HALF STUDENT] a-COME PARTY, IX-arc-a WILL BORED.
Follow-up question: Who would get bored? Answer: 'all student partygoers'.
'If half the students come to the party, they [= the students that come] will get bored.'
(Inf 1, i P1040994; P1040995)

d. IF $_a$[MOST STUDENT] a-COME PARTY, IX-arc-a WILL BORED.
Follow-up question: Who would get bored? Answer: 'all student partygoers'.
'If most students come to the party, they [= the students that come] will get bored.'
(Inf 1, i P1040994; P1040995)

e. IF $_a$[20 % STUDENT] IX-arc-a a-COME PARTY, IX-arc-a WILL BORED.
Follow-up question: Who would get bored? Answer: 'all student partygoers'.
'If 20% of the students come to the party, they [= the students that come] will get bored.'
(Inf 1, i P1040994; P1040995)

Similar facts hold in LSF:

(18) **LSF**

a. IF STUDENT $_a$IX-open-hand[9] FIVE LESS SICK FALL, IX-arc-a BORED.
'If fewer than five students fall sick, they will be bored.'
(Inf H, 17, 30; 31)

b. HERE IF PEOPLE $_a$[FRENCH THREE LESS] $_b$[AMERICAN FIVE LESS], IX-a a-GREET-b.
'If fewer than three Frenchmen were here and fewer than five Americans were here, they [= the Frenchmen] would greet them [= the Americans].'
(Inf I 16, 40; 41)

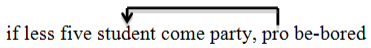
c. IF STUDENT $_a$IX-open-hand HALF SICK FALL, IX-a BORED.
'If half the students fall sick, they [= the students who are sick] will be bored.'
(Inf H, 17, 24a; 25; cf. also Inf I, 16, 43; 44)

d. IF STUDENT $_a$IX-open-hand bMOST IX-b SICK FALL, IX-arc-b BORED.
'If most of the students fall sick, they [= the students who are sick] will be bored.'
(Inf H, 17, 26; 27; cf. also Inf I, 16, 43; 44)

e. IF STUDENT $_b$IX-open-hand aGROUP IX-a 20% SICK FALL, IX-a BORED.
'If 20% of the students fall sick, they [= the students who are sick] will be bored.'
(Inf H, 17, 24c; 25; cf. also Inf I, 16, 43; 44)

If we schematically represent the patterns of antecedence as we did in our earlier discussion, we see that the same formal connection is found with all quantifiers—including the negative quantifier *less than five students*—as with indefinites:

(19) 'If less than five students come to the party, they will get bored'



This finding argues for View 1a: all quantifiers—not just indefinites—introduce discourse referents.

4.2. *Is the connection between the pronoun and an existential antecedent blocked by negation?*

(20) shows that even the quantifier *no Democrat* introduces a discourse referent (as suggested by View 1a), and furthermore that a pronoun can depend on it despite the presence of an intervening negation—as is suggested by View 2b.

(20) **ASL**

a. IX-1 THINK $_a$[SOMEONE DEMOCRAT PERSON] WILL MATCH SUPPORT HEALTH CARE BILL WITH $_b$[SOMEONE REPUBLICAN PERSON]. IX-1 THINK IX-a WILL a-GIVE-b A-LOT MONEY.
'I think that a Democrat will co-sponsor the healthcare bill with a Republican. I think he [= the Democrat] will give him [= the Republican] a lot of money.'
(Inf 1, 2, 228a; i P1040976)[10]

b. . # IX-1 THINK NO $_a$[DEMOCRAT PERSON] WILL MATCH SUPPORT HEALTH CARE BILL WITH $_b$[REPUBLICAN CL]. IX-1 THINK IX-a WILL a-GIVE-b A-LOT MONEY.
(Inf 1, 2, 228b; i, P1040976)

c. IX-1 DOUBT $_a$[NO DEMOCRAT PERSON $_a$IX-open-hand] WILL MATCH SUPPORT HEALTH CARE BILL WITH $_b$[REPUBLICAN CL]. IX-1 THINK IX-a WILL a-GIVE-b A-LOT MONEY.
(Inf 1, 2, 229 (see also 228c); i, P1040976)
'I don't think no Democrat will cosponsor the healthcare bill with a Republican. I think he [= the Democrat] will give him [= the Republican] a lot of money.'

Follow-up: Who will give money? Answer: 'the person who cosponsors' (2, 229) / 'the Democrat who cosponsors the bill'
(i, P1040976)

This pattern is summarized in simplified form in (21):

(21) a. [Unacceptable] 'I think no Democrat will co-sponsor the healthcare bill with a Republican. I think he will give him a lot of money'.

*I think no Democrat person will co-support health bill with Republican person. I think pro will give a-lot money.

b. 'I don't think that no Democrat will co-sponsor the healthcare bill with a Republican. I think he [=the Democrat] will give him [= the Republican] a lot of money'.

I not think no Democrat person will co-support health bill with Republican person. I think pro will give a-lot money.

c. 'I think that a Democrat will co-sponsor the healthcare bill with a Republican. I think he [=the Democrat] will give him [= the Republican] a lot of money'.

I think one Democrat person will co-support health bill with Republican person. I think pro will give a-lot money.

All approaches predict that (21)a should be unacceptable, either because *no Democrat* introduces no discourse referent at all, or because it does introduce a referent, but one that denotes an empty set—so that the pronoun's denotation is empty (as in (19), the pronoun should denote *the Democrat(s) who co-sponsor the healthcare bill with a Republican*, but by virtue of what is asserted there are no such Democrats). However, when an additional negation is added, as in (21)b, the pronoun becomes acceptable again—just as it is in the nearly-equivalent (21)c. This argues for the combination of View 1a and View 2b: *no Democrat* does introduce a discourse referent; and negation does not block the connection between the pronoun and its antecedent (in this case, it is the opposite: the negation guarantees that the discourse referent does not denote an empty set—which in turn makes the pronoun acceptable).

One can also argue in favor of View 2b on the basis of the following examples: while the negative expression *DOUBT* blocks the anaphoric connection between the pronoun and the indefinite in (22)a, adding a negation restores it, as is seen in (22)b.

(22) **ASL**

a. # IX-1 DOUBT $_a$SOMEONE WILL GO MARS. IX-a WILL FAMOUS
(Inf 1, i P1040982; i, P1040983)

b. IX-1 NOT DOUBT $_a$SOMEONE WILL GO MARS. IX-a WILL FAMOUS
(Inf 1, i P1040982; i, P1040983)
'I don't doubt that someone will go to Mars. He wil be famous.'
Follow-up: Who will be famous? Answer: 'the one who goes to Mars'.

While sentences similar to (20)c and (20)b are somewhat acceptable in English as well, the existence of a direct link between the pronoun and

the quantifier was never clearly established; thanks to the difference in modality, this link is visible in sign language.

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In sum, our main result is that sign language pronouns support the dynamic view according to which a pronoun can depend on a quantifier it is not in the scope of. Furthermore, sign language data argue in favor of some dynamic accounts over others. First, all quantifiers, rather than just indefinites, can introduce discourse referents. Second, negation per se does not disrupt the connection between a pronoun and its antecedent: the connection seems to be possible as long as the pronoun can be seen to denote something.

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Notes

[1] This is a summary, written for an inter-disciplinary audience, of the main results of Schlenker (to appear).

[2] Here and throughout, I refer to some prominent (and easily accessible) treatments without implying in any way that they are the earliest in the literature.

[3] Situations are even more fine-grained that this in Elbourne's theory, but for simplicity we disregard this point.

[4] As noted by B. Partee (p.c.), on the ellipsis analysis it is not really the *pronouns* that have an antecedent, but rather the concealed *noun phrase* they include as argument. This is the reason two pronouns could have the same NP 'antecedent' without thereby denoting the same individual.

[5] Our methodology primarily involved elicitation with two native consultants over numerous contact hours and hundreds of videos (our ASL consultant, Inf 1, was a deaf child of deaf ASL signers; our main LSF consultant, Inf F, was a hard-of-hearing child of deaf LSF signers. Videos whose number starts with i were elicited on iChat, usually to complete paradigms that had been obtained in face-to-face interaction). Data from other native LSF consultants are also mentioned. All examples were videotaped. When judgments were not trivial, we asked the consultants to watch themselves sign the sentence in a video before providing a judgment.

[6] We summarize here the judgment obtained on a 7-point scale rather than the judgment obtained in a binary task (this sentence was taken to be 'unacceptable' in the binary task, and was assessed as 5 and then 6 on the 7-point scale; see Appendix I in Schlenker (to appear) for further details).

[7] Our discussion does not attempt to be historically accurate: in early dynamic approaches, there were discussions of the 'life spans' of different discourse referents; we do not do justice to these discussions here. Still, the two lines represented in (a) and (b) offer a reasonable contemporary view of the debate.

[8] For approach (b), it should be *presupposed* that the denotation of the pronoun is

non-empty.

[9]What I transcribe as $_a$*IX-open-hand* is not a pointing sign, but a circular motion of the open hand in a particular locus (here locus *a*).

[10]Two additional remarks about (20)a.
(i) In i P1040976, Inf 1 also answered the question: 'Who will give the money?' and answered: 'the Democrat who cosponsors the bill'.
(ii) We included *THINK* in this example to obtain a complete paradigm that allowed for embedding of *no democrat* under a negative expression. But the same pattern holds with indefinites that are not embedded under an attitude verb.

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