Functional reference in American Sign Language

Jeremy Kuhn
Institut Jean Nicod, CNRS, Ecole Normal Supérieure

April 30, 2016

Abstract

A large body of work on spoken language has shown that natural language is able to construct and manipulate functions. Motivating examples encompass a variety of compositionally challenging phenomena, including dependent indefinites and adjectives like *same* and *different*. Intuitively, what unifies these phenomena is the fact that one constituent in the sentence is *dependent* on another. In this paper, I will be discussing these patterns in American Sign Language (ASL). Strikingly, I will show that what is conceptually unified in spoken language is visibly unified in sign language, through a **spatial representation of dependency**. In ASL, plurals are indexed over areas of space; I show that both dependent indefinites and the adjectives SAME and DIFFERENT are obligatorily signed over the same area of space as their licensor. I show that an analysis in terms of functional discourse referents explains both the licensing conditions of these constructions and their resulting interpretations.

1 Overview

A foundational question in formal semantics is the question: "What kinds of ontological objects can natural language make reference to?" Philosophers and semanticists have approached this question from a variety of perspectives, converging on a fairly unified answer: with pronouns, quantification, and various other means, there is an assortment of primitive objects that language can manipulate; these include at least individuals, times, and possible worlds (or perhaps events or situations). For example, in a sentence like 'no man is an island,' the truth-conditions require quantification over individuals; individuals can also be the value of a pronoun: *he*, *she*, or *it*. In a sentence like 'whenever it rains, it pours,' the truth-conditions require quantification over times or worlds; these objects also make up the values of pronouns like *then*.

Language can also manipulate and refer to higher-order objects, constructed from these semantic primitives. Perhaps the simplest example of a higher-order object is the case of plurals. Plurals are built up out of primitive objects—they are defined as sums of individuals or events. Yet, plural objects also behave as an autonomous semantic unit: they can be picked out with

the pronoun *they* and can be quantified over in certain constructions. For example, the sentence 'no two snowflakes are alike' requires quantification over pluralities (pairs) of snowflakes (for more on plural quantification, see discussion of 'covers' in Schwarzschild 1996).

In this paper, I will focus on a particular higher-order object—the case of functions. Specifically, I am going to be looking at functional reference as it appears in American Sign Language. In general, I will argue that sign language provides a unique window into the question of reference, because it often represents objects overtly with the use of space. In particular, I will argue that the use of space provides new evidence in favor of recent theories of dependency in natural language in which functions can be built 'on the fly' through the logical correspondence of two plural arguments (e.g. Dynamic Plural Logic of van den Berg 1996, and related frameworks).

A large body of work on spoken language has shown that natural language is able to construct and manipulate functions. The motivating examples encompass a wide range of compositionally challenging phenomena; these include functional questions (Groenendijk and Stokhof 1984, Chierchia 1993), dependent indefinites (Brasoveanu and Farkas 2011, Henderson 2014), and 'internal' readings of adjectives like *same* and *different* (Brasoveanu 2011, Bumford 2015). Intuitively, what unifies these phenomena is the fact that one constituent in the sentence is *dependent* on another. Essentially, a function is a way of systematically relating one set of objects to another, of keeping track of correspondences.

This paper presents the new finding that functional reference in ASL can be overtly realized. In ASL, plurals may be indicated in a variety of ways over areas of space. Here, I will show that two functionally associated plurals may be indexed over spatially associated areas of space. The result is that a range of disparate phenomena, all related to the abstract notion of functions, are overtly unified in a very intuitive phonological way in ASL.

Examples (1)–(3) provide a taste of the core data discussed in this paper. In each sentence, the plural DP ALL BOY, 'all the boys,' is indexed over an area of space on the right-hand side of the signer (the locus a). Later in the sentence, the numeral or adjective moves in an arc movement over the same area of space. The resulting interpretation in each case is the same: the DP modified by the numeral or adjective must be dependent on the DP that introduced the locus.

(1) ALL-a BOY READ ONE-arc-a BOOK.
'All the boys read one book *each*.'

(2) ALL-a BOY READ SAME-arc-a BOOK.
'All the boys read the same book *as each other*.'

(3) ALL-a BOY READ DIFFERENT-arc-a BOOK.
'All the boys read different books *from each other*.'

In natural language, covert structure often results in ambiguity. As a result, if more structure is overt, there is less ambiguity. In ASL, since spatial association allows dependency to be overt, the empirical result will be to disambiguating sentences that are ambiguous in spoken language. Specifically, sign language will provide new insight into sentences where a dependent constituent has multiple possible licensors, a configuration that has been relevant to recent

debates about the link between a dependent constituent and its licensor (Bumford and Barker 2013). The sign language data provides a new unique piece to the puzzle: through the use of space, a dependent term is able to overtly specify its licensor.

For example, in (4), the boys are established over locus a on the right, and the girls are established over locus b, on the left. The numeral ONE moves in space over locus b, thus disambiguating that the books depend on the girls.

(4) ALL-a BOY GIVE ALL-b GIRL ONE-arc-b BOOK.

'All the boys gave all the girls one book *per girl*.'

These facts require a system powerful enough to formally represent dependency relations in a way accessible to the compositional semantics.

2 Functions in spoken language

As with most cases of reference, perhaps the clearest case of functional reference comes in the form of a pronoun—in this case, in the form of a paycheck pronoun (Karttunen 1969, Jacobson 2000, a.o.). Sentence (5) provides an example:

(5) Every 5 year old boy loves his mother. Every 10 year old boy hates her.

$\langle e, e \rangle$ e

In this pair of sentences, the important pronoun is the word *her*. Of note, we observe that it can't be an individual variable, either bound or free, because, while it co-varies with the noun phrase 'every 10 year old boy,' it doesn't *denote* that boy; rather, it denotes his mother. A standard story (Cooper 1979, Engdahl 1986) is that the meaning of the pronoun comes with two variables: a functional variable retrieved from context (here, 'his mother'), and a bound individual variable, plugged into the function.

Sentence (6) provides a slightly more complex example (called 'quantificational subordination' by Heim 1990 and Brasoveanu 2006), which will be relevant for us here.

(6) Each boy saw a girl. No boy waved to her.

a. $f_{\langle e,e \rangle} = \lambda x$. the girl that x saw

In this sentence, again the pronoun *her* denotes a function, with a meaning as in (6a). However, in this case, there is no single constituent (such as 'his mother' in the previous sentence) from which the functional meaning can be retrieved. Such examples have been discussed by van den Berg 1996, Nouwen 2003, and Braoveanu 2006, among others. The basic analysis is that, somehow, a functional antecedent is *constructed* through the interaction of the distributive operator, here 'each boy', and the indefinite, here 'a girl'.

But it turns out that it's not just pronouns where functional reference rears its head. Beyond pronouns, there are many cases where functions are necessary to get the correct truth conditions.

These examples, which we'll see in a second, include: (a) functional questions, (b) functional indefinites, and (c) the 'internal' readings of certain adjectives, like *same* and *different*. I'll quickly go through these in spoken language, before turning to the relevant examples in sign language.

The first case is functional questions (including the sub-case of pair-list questions), as discussed by Groenendijk and Stokhof 1984 and Chierchia 1993, among others. The examples of note are question-answer pairs like the ones in (7).

(7) a. **Q:** Which woman does every man love?
A: His mother.

b. **Q:** Which woman does every man love?
A: John – Mary, Bill – Susan, Stephen – Alice.
'What is the function f from men to women such that each man x loves $f(x)$?'

Of note here, the given answers do not denote individuals—they're functions relating one individual to another. On the standard assumption that the meaning of a question is closely related to the meaning of its answers, this means that the questions in (7) have a functional meaning, which are felicitous with functional answer. In (7a), it is the *mother-of* function; in (7b) it is an arbitrary correspondence.

The second case of functional reference involves sentences with an indefinite (Hintikka 1986, Kratzer 1998b Schwarz 2001, Winter 2001, Solomon 2011). An example is given in (8).

(8) a. No boy talks to a certain relative of his about girls. (Namely, his mother.)
'There is a certain function f from boys to relatives such that no boy x talks to $f(x)$ about girls.'

b. If everyone improves in a certain area, then nobody will fail.
'There is a certain function f from students to areas such that, if every student x improves in $f(x)$, then nobody will fail.'

(from Schlenker 2006)

The reading brought out by the continuation in (8a) ("Namely, his mother") requires reference to functional types, as in the gloss below the sentence. Notably, there's no way the arrange the first-order quantifiers *no* and $\exists$ to get this meaning: you actually need to be able to quantify over functions. Sentence (8b), from Schlenker 2006, gives a related, but slightly more complex example; the relevant reading here is one in which the speaker has in mind a certain arbitrary correspondence between students and areas. As in (8a), there is no way to get these truth conditions by only rearranging first-order quantifiers *if*, $\forall$, and $\exists$. Solomon 2011 highlights the connection between the functional indefinite in (8b) and the pair-list question in (7b).

The final examples of functional reference involve *same* and *different*. In this example and in subsequent ones, I will be focusing on the 'internal' reading of these adjectives, which compares the individuals of a plural or distributive licensor. That is, the internal reading of (9a) doesn't mean that the boys read the same book as some other person (like, Mary), but instead, that they read the same book as each other.

(9) a. Every boy read the same book.
'The function from boys to the book they read is a constant function.'
b. Every boy read a different book.
'The function from boys to the book they read is an injective function.'

Bumford 2014 argues that there are deep connections between internal readings of adjectives and functional readings of indefinites. Without getting into the details of this account, however, observe that the only way to state the truth conditions for the sentences in (9) is by making reference to the boy-book correspondences. This means that a paraphrase in terms of functions, as given above, is very natural way to state the truth conditions. In general, all compositional accounts of *same* and *different* are forced to include mechanisms which fill a similar role (see, e.g. Barker 2007).

In this paper, I will show that American Sign Language in fact uses space in a similar way for each of these phenomena. I will focus in particular on the case of 'dependent indefinites' and the adjectives *same* and *different*. Ultimately, I will argue that the use of space allows functional dependencies to be made overt.

3 The use of space in American Sign Language

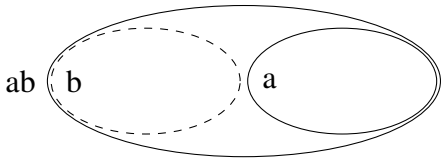
In American Sign Language, space can be used with semantic effect. Most famously, individuals can be indexed at points in space, or 'loci;' the use of loci can then serve to disambiguate pronominal antecedents (Lillo-Martin and Klima 1990, *i.a.*). For example, if a signer is talking about some individual, Mike, who's not in the conversation, the signer can index him at a location in space; he or she can then refer back to him later with a pronoun that literally points to the location where Mike was established. Sentence (10) presents a simple example in which spatial indexing can disambiguate a singular pronoun with two possible antecedents. Notationally, lower-case letters a and b indicate distinct points in the horizontal plane.

(10) JOHN-a TELL BILL-b IX-{a / b} WILL WIN. (from Kuhn 2015a)
'John$_i$ told Bill$_j$ that he$_{\{i/j\}}$ would win.

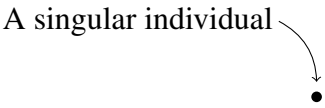
Plural individuals are associated with areas of space. Areas of space can be established in a variety of ways—e.g., by reduplicating a noun over an area of space, by accompanying a noun with a plural pronoun, IX-arc, that moves over the area, or by inflecting a quantifier, such as ALL or EACH, over the area. Here, I use '-arc' for inflection of a sign across an area of space.

(11) a. singular individual b. plural individual

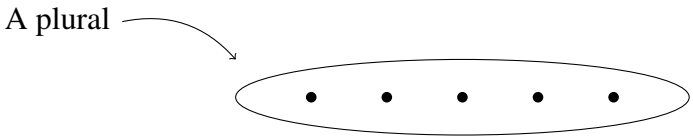
One final point about plurals is relevant to talk about now, since (a) it will be relevant for the argumentation later, and (b) it gives a taste of the increased expressive power that is allowed with the use of space. The basic observation, discussed in depth in Schlenker et al. 2013, is that geometric properties of the *form* of a plural in sign language map onto mereological properties of the *denotation* of the plural. What this means in practice is that when you indicate one plural within the area of another plural, then you infer that the first is a subset of the second. The construction also makes various antecedents available for later plural pronouns. As with spoken language, it introduces a discourse referent for each of the two plurals indicated (the superset and subset). Unlike spoken language, though, it also makes available the complement set; by moving a plural pronoun over (roughly) the difference between the two areas, a discourse referent denoting the complement set—the subset minus the superset—can be retrieved. This discourse referent emerges by virtue of the iconic interaction of the other two plurals. Here, I use notation 'ab' to indicate a plural locus that includes both locus a and locus b.



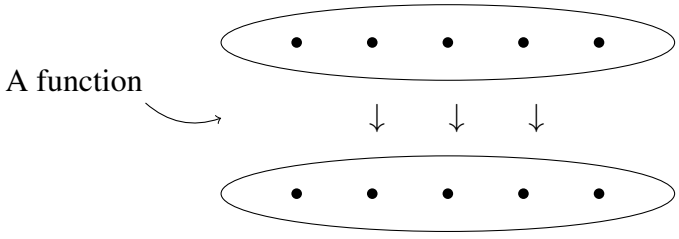
At this point, we have a rather intuitive *graphical* representation of these semantic objects. Singular individuals are represented as points in space.



Plural individuals, we've just seen, can be *areas* of space—that is, sets of points.



If that's the case, then what would we expect a *function* to look like? Well, a function is a relation between two plurals—it's a map from one plural to another. You could represent it graphically like this:



Here, I will argue that this picture that I've just sketched should be taken quite literally, and that it is actually very close to way that space can be used to indicate functional reference in American Sign Language. Specifically, functional reference can be established in ASL by indexing two plurals over spatially associated—often co-located—area of space. One of these plurals provides the input of the function; the other plural provides the output of the function.

(12)
$$\begin{array}{ccccc} i_1 & & i_2 & & i_n \\ \downarrow & & \downarrow & \cdots & \downarrow \\ o_1 & & o_2 & & o_n \end{array}$$

This spatial representation of functions then allows dependencies to be overtly realized.

The following three examples show this in practice. In (13), the numeral ONE, quantifying over students, moves in space over an area that is previously associated with professors. The resulting interpretation is that one student *per professor* will be nominated.

(13) EACH-EACH-a PROFESSOR NOMINATE ONE-arc-a STUDENT.
'Each professor nominated one student.'

In (14), the adjective SAME, modifying BOOK, moves over the same area of space that was indicated by the quantifier phrase ALL BOY. The resulting interpretation is that the book that each boy read is the same as the book that the other boys read. The sameness is distributed over the boys.

(14) ALL-a BOY READ SAME-arc-a BOOK.
'All the boys read the same book.'

Finally, in (15), the adjective DIFFERENT, modifying BOOK, moves over the same area of space that was indicated by the plural IX-arc-a BOY. The resulting interpretation is that each boy gave the girl a different book from the other boys.

(15) IX-arc-a BOY DIFFERENT-arc-a BOOK a-GIVE-alt-b THAT-b GIRL.
'All the boys gave that girl a different book.'

The following two sections explore each of these constructions in more depth.

4 Dependent indefinites

4.1 Dependent indefinites in spoken language

In English, the following sentence is ambiguous:

(16) All the boys lifted a table. ✓distributive ✓collective

The sentence can be interpreted distributively, with each boy lifting his own table, or it can be interpreted collectively, with the group of boys working together to lift a single table.

In some languages, the indefinite can be morphologically altered, often through reduplication, with the semantic result that the indefinite must depend on the other operator, with a mandatorily distributive reading. Some languages that have these so-called **dependent indefinites**[1] include Hungarian (Farkas 1997, 2001), Romanian (Farkas 2002), Telugu (Balusu 2006), Korean (Choe 1987, Gil 1993), Russian (Pereltsvaig 2008, Yanovich 2005), and Kaqchikel Mayan (Henderson 2014).

Example (17) gives a Telugu sentence with the reduplicated numeral *renDu renDu*, 'two two.' Here, the semantic effect of reduplicating the numeral is the generation of a mandatorily distributive reading—there must be twice as many monkey-sightings as there are kids (parallel to the English translation). In fact, Balusu 2006 reports that the sentence requires there to be variation in the monkeys that were seen by each kid; the sentence cannot be used if the two monkeys seen by each kid happened to be the same. (Note that this differs from the English translation, which admits cases of accidental identity.)

(17) **Telugu** (Balusu 2006)

pilla-lu renDu-renDu kootu-lu-ni cuus-ee-ru.
kids two-two monkey-Pl-Acc see-Past-3PPL
'The kids saw two monkeys each.'

We can state this constraint as the following **variation condition**: dependent indefinites must introduce a non-constant functional discourse referent into the discourse context. That is, in (17), there must be a non-constant function from the kids to the monkeys they saw; the monkeys must vary with respect to the boys.

This can be made precise with an informal but explicit algorithm, illustrated in (18). For a given situation, we make a table listing all the kids and the monkeys they saw; every row of the table contains a kid-monkey pair that was involved in a seeing event. We then divide up the rows of the table with respect to the kids, and compare the sets of monkeys seen by each kid. What it means for the function to be non-constant is that these sets are not all identical.

The table in (18) shows one possible verifying situation for the Telugu sentence in (17). Here, the sets of monkeys are not all the same, so there is a non-constant function from kids to monkeys, and the sentence is felicitous.

[1]The term 'dependent numeral' has also been used somewhat interchangeably to describe the same phenomenon. In some languages, modifying the number 'one' has a slightly different effect than modifying any other number; in these cases, 'dependent indefinites' is sometimes used to refer to the former and 'dependent numeral' to the latter. In ASL, I have observed no differences between the two, so I will use the terms interchangeably.

(18)

kids	monkeys	
k_1	m_1	Monkeys seen by k_1 = $\{m_1, m_2\}$
k_1	m_2	
k_2	m_1	Monkeys seen by k_2 = $\{m_1, m_2\}$
k_2	m_2	
k_3	m_2	Monkeys seen by k_3 = $\{m_2, m_3\}$
k_3	m_3	

We can compare this situation to what happens on a collective reading of the sentence: on this logical form, the only situations verifying the sentence would be ones where a single pair of monkeys was seen by the group of kids. No situation could satisfy the variation condition, so the logical form would be ruled out.

This algorithm, though informal, is intended to evoke the formalism of Dynamic Plural Logic; see Henderson 2014 and Kuhn 2015b for explicit accounts of dependent indefinites within Dynamic Plural Logic. In its current form, however, it should be noted that the generalization faces certain limitations. First, while the algorithm that I have given tells us how to determine if a given situation satisfies the variation condition, it gives no guidance about how to arrive at a set of situations for a particular sentence with a dependent indefinite. Above, I implicitly assumed that the semantic contribution of dependent indefinite, aside from the variation condition, is otherwise identical to that of a plain indefinite. This will work as a rough approximation, but will not extend to cases with SAME and DIFFERENT.

Second, the algorithm that I've described here only looks at sentence-level truth conditions of the output form, so it's not able to see whether the variation condition has been satisfied at a lower level in the derivation. For instance, the Hungarian sentence in (19) provides an example where a dependent indefinite is licensed by a plural that scopes below sentential negation. The truth conditions of the sentence as a whole mean that a single table was lifted by all the boys. Nevertheless, the sentence is felicitous, because the variation condition is satisfied at the level just below the negation.

(19) **Hungarian** (p.c Dániel Szeredi)

A gyerekek nem egy-egy asztalt emeltek fel; kzsen egyet
The kids not one-one table lift.PAST.3PL pfx; together one.ACC
emeltek fel.
lift.PAST.3PL pfx
'The kids didn't lift one table each; they lifted one together.'

Kuhn 2015b provides a formal analysis that makes both of these points explicit. In a nutshell, Kuhn 2015b argues that dependent indefinites require a functional discourse referent to be dynamically accessible at a given point in the (dynamic) evaluation of a sentence. Without going into details here, I take this functional discourse referent to be exactly the function that can be retrieved in cases of quantificational subordination in English, as seen in examples like (6), repeated here in (20).

(20) Each boy saw a girl. No boy waved to her.
   a. $f_{\langle e,e\rangle} = \lambda x$. the girl that x saw

Anticipating the ASL data, I hypothesize that arc-movement in ASL is available only if quantificational subordination is licit in English. That is, the inflection of ONE in (21) will only be possible in environments where an analogous indefinite in English generates a functional antecedent that can be retrieved by a pronoun, as in (22).

(21) ALL-a BOY READ ONE-arc-a BOOK.
   'All the boys read one book.'

(22) All the boys read a book, and all of them liked it.

One final point should be flagged for later: at this point, the reader may wonder whether the variation condition is truly a semantic entailment, or if it could be a pragmatic inference, arising from competition with another form. I will return to this question in §6.2; I will ultimately be amenable to the idea that there is some pragmatic reasoning involved; however, I will argue that a competition-based analysis is insufficient to capture the full range of data, so we will still need the general analysis that I develop here.

4.2 Dependent indefinites in ASL

In American Sign Language, the uninflected form of a numeral (ONE, TWO, etc.) is signed by holding a hand in place; in this form, ASL indefinites generate ambiguities just like English indefinites. In ASL, though, numerals may additionally move in space over an area associated with another plural. This plural inflection may be applied to any numeral that doesn't specify a movement on the uninflected form (i.e. the numbers 1 to 9). The semantic effect of this plural inflection is the same as that of dependent indefinites in other languages: only a distributive reading is possible for the sentences.

To illustrate the semantic effect, consider the ASL paradigm in (23). Recall that the English gloss (repeated from (16)) is ambiguous between a distributive and collective reading. In ASL, the readings available depend on the inflection of the numeral. In (23a), ONE is signed neutrally, with no plural inflection; like its English counterpart, the resulting sentence is ambiguous, with a possible preference for the collective reading. In (23b), on the other hand, ONE moves over the area of space associated with the boys; the resulting sentence is unambiguous, only permitting the distributive interpretation.

(23)
a.	ALL-a BOY LIFT ONE TABLE.	✓distributive	✓collective
b.	ALL-a BOY LIFT ONE-arc TABLE.	✓distributive	* collective

'All the boys lifted one table.'

Kimmelman 2015 reports an analogous finding in Russian Sign Language: in RSL, numerals may be reduplicated over an area of space, with a distributive interpretation. Thus, the RSL sentence in (24) means that each man bought one beer.

(24) **RSL** (Kimmelman 2015)[2]
top
MAN IX BUY BEER ONE-arc.
'The men bought one beer each.'

Thus, the behavior of inflected numerals in both the ASL and RSL fits perfectly into a pattern that is familiar from spoken language. Additionally, though, there is the added role of space: numerals with plural inflection must move over an area associated with another plural in the sentence.

The remainder of the section will proceed as follows. First, I will confirm that numerals with plural inflection must move over the area of their licensor. I will show that this area concurrently indexes both plurals. I will then present facts about the licensing of dependent indefinites in ASL; these will fall out nicely from the variation condition proposed in §4.1. Finally, putting the licensing facts together with the spatial properties, I will turn to cases with multiple possible licensors. The result will be that ASL is able to disambiguate readings where spoken language cannot. In Section 5, I will repeat the same process for SAME and DIFFERENT.

4.3 Two plurals, one locus

First, I will argue that the plural motion of a numeral plays a double role: it establishes the locus of the NP that it attaches to (e.g. the tables in (23)), but it also agrees with the locus of another plural in the sentence (e.g. the boys in (23)). A correlate of this claim is the fact that two plurals may end up simultaneously located over the same area of space. As it turns out, Kuhn 2015a argues that in general non-coreferential NPs may share a single locus, especially when motivated by pragmatic association. Under the current claim, dependent indefinites would comprise a new piece of evidence in favor of the generalization in Kuhn 2015a.

Empirically, if two NPs are co-located, then pointing to their locus should be able to retrieve either NP. The examples in (25) and (26) provide evidence that this is indeed the case in constructions with dependent indefinites. Here, both sentences start out the same way, with the motion of ONE indexed over the same locus as motion of EACH. The two sentences differ, though, in their continuation: in (25), the anaphoric, plural sign IX-arc-a is combined with an NP that indicates that the space indexes the professors. In (26), the same anaphoric sign occurs, but it's identified as indexing the students.

(25) EACH-a PROFESSOR SAID ONE-arc-a STUDENT WILL RECEIVE A. IX-arc-a PROFESSOR WILL HAPPY.
'Each professor said one student (per professor) will receive an A. The professors will be happy.'

(26) EACH-a PROFESSOR SAID ONE-arc-a STUDENT WILL RECEIVE A. IX-arc-a STUDENT WILL HAPPY.

[2]Kimmelman glosses the dependent numeral as $\text{ONE}_{\text{distr}}$; I have adjusted notation here to match my own. The translation is also my own, based on Kimmelman's description.

'Each professor said one student (per professor) will receive an A. The students who got an A will be happy.'

The interpretation of the first sentence is that the professors will be happy; the interpretation of the second is that the students who receive an A will be happy. These examples show that ONE-arc is able to establish the locus of the NP it attaches to over the same locus as a plural NP earlier in the sentence.

Nevertheless, the skeptical reader might wonder whether the sign IX-arc-a in (26) is truly indexing the students, or whether it could still be indexing the professors, interpreted possessively as 'their students.'[3] As it turns out, conclusive evidence against this counter-analysis comes from examples with complement set anaphora. In particular, we observe that the NP attached to ONE-arc may feed complement set anaphora, as for any ASL plural with structural iconicity, just as we saw before. Sentence (27) gives an example. Here, the students are indexed over a large area of space (locus ab), then a dependent numeral, dependent on EACH STUDENT, is indexed over a subset of that area (locus a). By pointing to the superset area, the subset area, or the complement set area, a subsequent sentence can be interpreted in one of three ways: either all the students will be happy, the students who get a B will be happy, or—the complement set anaphora reading—the students who *don't* get a B will be happy.

(27) STUDENT IX-arc-ab, EACH-a PROFESSOR SAID ONE-arc-a STUDENT WILL RECEIVE B.

a. IX-arc-ab STUDENT WILL HAPPY.
'All the students will be happy.'

b. IX-arc-a STUDENT WILL HAPPY.
'The students *who get a B* will be happy.'

c. IX-arc-b STUDENT WILL HAPPY.
'The students *who don't get a B* will be happy.'

The only way that the complement set could come into existence is if ONE-arc-a has established the set of students at locus a. Thus, a dependent indefinite establishes the locus of the NP that it attaches to.

The flip side of the coin, though, is that a dependent indefinite must also be spatially associated with the locus of the plural that is dependent on. Examples (28) and (29) provide a minimal pair that illustrate this fact. In (28), the quantifier EACH moves over area a (the ipsilateral side of the signer); the dependent indefinite ONE-arc moves over the same area, resulting in a grammatical sentence, entailing that the choice of student depends on the professor. In contrast, in (29), the dependent indefinite moves over area b (the contralateral side of the signer). The sentence receives a degraded judgement, and, to the extent that it's grammatical, a different meaning, where the students are inferred to depend on some other contextually salient plurality.

[3]In general, possessive structures are constructed with the possessive pronoun POSS, but Chen Pichler & Hochgesang 2009 report that the personal pronoun IX may sometimes appears with a possessive meaning, such as with kinship terms and body part possession, though they remain agnostic about whether IX is actually acting as a true possessive in these structures.

(28) EACH-a PROFESSOR SAID ONE-arc-a STUDENT WILL RECEIVE B.
'Each professor said that one student will receive a B.'

(29) ?? EACH-a PROFESSOR SAID ONE-arc-b STUDENT WILL RECEIVE B.
'Each professor said that one student *from each contextually salient group* will receive a B.'

Thus, we observe that dependent indefinites *require* spatial association with their licensor.[4]

4.4 Licensing

In this section, we address what can serve as the licensor for a dependent indefinite. The generalizations are as follows: bare plurals can license dependent indefinites; distributive quantifiers like ALL and EACH can license dependent indefinites. Singular individuals cannot license dependent indefinites. Finally, the quantifier NONE cannot license dependent indefinites. These generalizations are exemplified in (30a)–(30d).

(30) a. BOYS IX-arc-a READ ONE-arc-a BOOK. plural
'The boys read one book each.'

b. ALL-a BOYS READ ONE-arc-a BOOK. all
'All the boys read one book (each).'

c. * BOYS IX-arc-a, NONE READ ONE-arc-a BOOK.[5] none

d. * JOHN-a READ ONE-arc-a BOOK singular

We can understand these generalizations in light of the variation condition described in §4.1. Turning first to plural and distributive operators, the explanation is clear: in both cases, a plurality of boys are introduced by the licensor; the scenario on which they each read their own book is one which may introduce a non-constant function and satisfy the variation condition. The case of a singular subject is also straightforward: if only one boy read a book, then there is only one book involved, so the variation condition can never be satisfied.[6]

[4]Must these two plurals be co-located, or can they be separated if they remain spatially associated in some way? Preliminary results suggest that spatial association may be sufficient, but only in certain spatial configurations. As we have seen in (29), separation along the x-axis from right to left does not allow a dependent interpretation. Separation along the y-axis, with the dependent indefinite indexed *above* its licensor is also not possible. However, separation along the z-axis may be possible: a dependent indefinite may be established *in front of* its licensor and still retain a dependent interpretation. Pronouns can then point to either location to unambiguously pick out the input or the output of the function. However, since the use of the z-axis in ASL has not been explored in depth, I remain cautious in interpreting this result.

[5]As a control, the same sentence with no inflection on the indefinite is grammatical, with the meaning that no boys read any books.

(31) BOY IX-arc, NONE IX-arc READ ONE BOOK.
'None of the boys read a book.'

Perhaps most surprising is the fact that ONE-arc is not grammatical under the quantifier NONE, even though (a) NONE quantifies over a dynamically accessible plurality of boys and (b) there is a quantifier that can take scope over the dependent indefinite. As it turns out, though, this fact can also be explained through the requirement of a non-constant functional discourse referent.

The situation can be understood by considering the truth conditions for a sentence where a (plain) indefinite scopes under a universal quantifier compared to those for a sentence where an indefinite scopes under *none*. Intuitively, if every boy read a book, then there is a correspondence between the boys and the books they read. In contrast, if no boy read a book, there is no such mapping from boys to books. Purely mechanically, if we follow the algorithm described in §4.1 and construct a table for a situation that verifies the sentence 'none of the boys read a book,' we will end up with an empty table, since there are no boy-book pairs in the reading relationship.

Finally, in §4.1, I claimed that arc-movement is only licensed in ASL in those contexts where functions are dynamically accessible to quantificational subordination in English. This prediction is borne out in the contrast between *all* and *no* in (32).

(32) a. Each student read a book. They each liked it. ($\forall > \exists$)

b. * No student read a book. They each liked it. (None $> \exists$)

Thus, dependent indefinites are licensed exactly by those operators that are able to introduce a non-constant function into the discourse context.

4.5 Multiple licensors

Finally, we turn to cases where the use of space in ASL is able to disambiguate sentences in ways not possible for spoken language.

Because the motion of the numeral must be spatially associated with the licensor—i.e the input of the function—we can specify *what the numeral is dependent on*. The critical cases will be those in which a sentence has two potential licensors. Sentences (33) and (34) give examples from Hungarian and Albanian.[7]

(33) **Hungarian** (p.c. Dániel Szeredi; three speakers)

A fiúk két-két könyvet adtak a lányoknak.
The boys two-two book give.3Pl the girls
'The boys gave the girls two books each.'

[6]One puzzle is the fact that dependent indefinites can be licensed by operators that distribute down to atomic individuals, like EACH in (25). The puzzle here is that there is no way to satisfy the variation condition if the dependent indefinite only has access to a single individual. This puzzle forms the crux of a large amount of theoretical work (see, e.g., Henderson 2014), and is a central concern of Kuhn 2015b. Essentially, the solution is to allow the variation condition to take scope outside of the distributive operator in order to see the full set of individuals. We set this aside for now.

[7]Thanks to Daniel Szeredi and Bujar Rushiti for extremely thorough and insightful discussion on these sentences and others.

(34) **Albanian** (p.c. Bujar Rushiti)

Djemtë u dhanë vajzave nga dy libra.
boys 3Pl.Dat gave girls DIST two books
'The boys gave the girls two books each.'

In Hungarian, dependent indefinites require licensing by a plural or distributive operator, but there is no morphological marking that specifies what this licensor is. Thus, sentence (33), with two potential licensors, *két-két*, 'two-two,' could in principle depend on either the boys or the girls. This is borne out: the sentence in (33) may be true in a scenario in which the boys collectively gave one book to each of the girls, and also in a scenario in which the girls collectively received one book from each of the boys. The example in (34) provides an analogous example in Albanian: the dependent indefinite *nga dy*, 'DIST two,' may be licensed by either plural: the sentence is true in exactly the same scenarios as the Hungarian example. (The two are also true in the third scenario where each boy gave each girl two books.)

In contrast, in ASL, the two licensors can be located over two different areas of space. The numeral then can agree with either area, with the result of disambiguating the meaning. Sentence (35) provides an example.

(35) ALL-a BOY-a GIVE ALL-b GIRL-b ONE-arc-b BOOK.
'All the boys gave all the girls one book (per girl).'

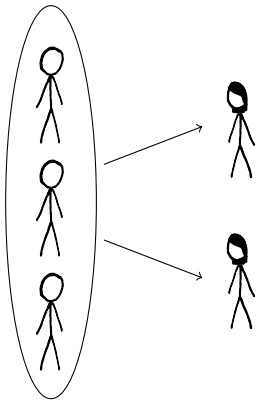
Here the boys are indexed over locus a, the girls are indexed over locus b; ONE then moves in space over locus b, where the girls were indexed. The resulting inference is that there is a (non-constant) function from girls to the books they received. To unpackage this meaning, let us focus on two specific cases, where either the boys or the girls acted collectively. Other readings are also available (e.g. the one in which each boy gave each girl a book), but the point is clearest if we set these aside for now.

First, consider a situation in which the boys collectively gave books to the girls; for example, the boys as a group gave Mary one book and gave Elizabeth one book. This situation is illustrated in (37a). In (37b), I represent this in table form, where each row represents a boy-girl-book triplet that was involved in a giving event. When we look at the sets of books given to the two girls, we see that they are different sets, so there is a non-constant function and the reading is licensed.[8]

[8]Possibly a more perspicuous way to represent this situation in a table would be with sum individuals, as in (36). Note that this produces exactly the same results.

(36)

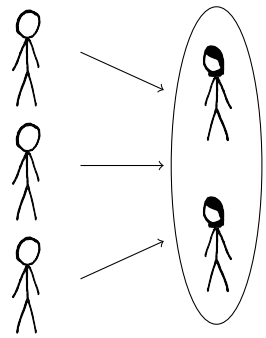
boys	girls	books	
$b_1 \oplus b_2 \oplus b_3$	g_1	o_1	Books given to $g_1 = \{o_1\}$
$b_1 \oplus b_2 \oplus b_3$	g_2	o_2	Books given to $g_2 = \{o_2\}$

(37) a. 

b.

boys	girls	books	
b_1	g_1	o_1	Books given to g_1 = $\{o_1\}$
b_1	g_2	o_2	
b_2	g_1	o_1	Books given to g_2 = $\{o_2\}$
b_2	g_2	o_2	
b_3	g_1	o_1	
b_3	g_2	o_2	

Second, consider a situation in which the girls collectively received books from the boys; for example, John gave the group of girls one book, Bill gave the group of girls one book, and Eric gave the group of girls one book. This situation is illustrated in (38a). In (38b), I represent this in table form, as above. When we look at the sets of books given to the two girls, we see that they are the same set, so the reading is *not* possible.

(38) a. 

b.

boys	girls	books	
b_1	g_1	o_1	Books given to g_1 = $\{o_1,o_2,o_3\}$
b_1	g_2	o_1	
b_2	g_1	o_2	Books given to g_2 = $\{o_1,o_2,o_3\}$
b_2	g_2	o_2	
b_3	g_1	o_3	
b_3	g_2	o_3	

A similar example exists where ONE agrees with the boys, with the opposite interpretation: true for (38) but not for (37). It should be noted, however, that when there are two possible quantifiers that a ONE can be dependent on in the same sentence, there is a preference for the numeral to depend on the closest one. Thus, the sentence in (39), minimally different, from the one in (35), receives a slightly degraded judgment. Nevertheless, the meaning of this sentence is clear, and, if the sentence order is changed, as in (40), then the example becomes perfect.

(39) ? ALL-a BOY-a GIVE ALL-b GIRL-b ONE-arc-a BOOK.
'All the boys gave all the girls one book (per boy).'

(40) EACH-a BOY-a ONE-arc-a BOOK GIVE ALL-b GIRL-b.
'Each boy gave one book to all the girls.'

In these examples, ASL goes beyond other languages with dependent indefinites in its ability to disambiguate dependencies. In order to express this meaning, we need to make reference to functions.

5 SAME and DIFFERENT

Turning to the adjectives SAME and DIFFERENT, we see exactly the same patterns as we did for dependent indefinites. SAME and DIFFERENT may move over an area of space associated with an appropriate licensor. Just as for dependent indefinites, possible licensors include bare plurals and distributive operators, but do not include singular nouns or the quantifier NONE. When two possible licensors exist in a sentence, the movement of SAME and DIFFERENT can disambiguate the meaning of the sentence where spoken language cannot.

5.1 SAME agrees with its licensor

ASL has several words that translate roughly as 'same.' One of these words is signed with a Y handshape; this can be signed with a small, neutral motion, but it can also move in space to agree with a plural locus. Agreement specifies the things which are the same.

Figure 1: ASL SAME agreeing with two singular loci.

Sentence (41) provide a simple example that demonstrates the flexibility of this agreement. Here, the thumb points to the floor, the pinky to the ceiling, and the motion is a vertical one.

(41) CEILING AND FLOOR SAME-up/down COLOR.
'The ceiling and the floor are the same color.'

In English, the adjective *same* is known to be ambiguous between an 'external' and an 'internal' reading. For example, the sentence in (42) can be used to describe two kinds of scenarios. In a context in which it has already been mentioned that someone—say, Mary—has read a book, (42) can be used to indicate that all the boys read the same book as Mary; this is the external reading. On the second (and perhaps more prominent) reading of (42), no antecedent from context is needed; *same* compares members of the plural licensor, and the sentence entails that the boys read the same book as each other. This is the internal reading.

(42) All the boys read the same book.

a. All the boys read the same book *as someone else*. (external reading)

b. All the boys read the same book *as each other*. (internal reading)

Turning to sign language, we see that arc-movement on SAME has a semantic effect: when signed neutrally, SAME is ambiguous, akin to the English examples; when inflected to move over an area of space, SAME-arc only allows the internal reading.

(43) a. ALL-a STUDENT READ SAME-neutral BOOK. ✓internal ✓external
b. ALL-a STUDENT READ SAME-arc-a BOOK. ✓internal * external
'All the students read the same book.

As with dependent indefinites, when SAME moves in space, it must be spatially associated with the plural that licenses it. This can be seen in the ungrammaticality of sentences that have a locus mismatch. In sentence (44), of the two NPs that establish loci, only the plural one is able to license SAME-arc. Therefore, SAME-arc must occur over the locus where the boys are indexed, and not at the locus where the singular girl is indexed.

(44) a. ALL BOY-a a-GIVE-alt-b THAT GIRL-b SAME-arc-a BOOK.
'All the boys gave that girl same book.'
b. * ALL BOY-a a-GIVE-alt-b THAT GIRL-b SAME-arc-b BOOK.

In the functional terms that we have been using thus far, we can say SAME entails a constant function (here, from boys to books); when SAME moves in space, then arc-movement must agree with the input of this function.

5.2 No licensing of SAME by singulars

Turning to licensing, we observe that (the internal reading of) SAME cannot be licensed by a singular noun, as seen in the ungrammaticality of (44b) above. In fact, this is no different from English *same*. For example, we cannot interpret (45) with an internal reading, even though we can imagine what such a reading would be: 'there is a constant function from the elements of the set {John} to the books that they read.' In other words, the sentence should be equivalent to 'John read a book.'

(45) * John read the same book.
(Ungrammatical on internal reading)

In §4, I accounted for the ungrammaticality of dependent indefinites under singulars by requiring there to be a non-constant function from the individuals introduced by the licensor to the individuals introduced by the dependent noun phrase; here, however, that strategy seems doomed to fail, since the meaning of *same* is exactly that the function in question *is* constant.

As it turns out, the literature on *same* in English provides a solution. Specifically, a number of authors have observed that the adjective *same*, on both the external and internal readings, presupposes the existence of a plurality of events (Carlson 1987, Barker 2007, Hardt et al. 2012, Hardt and Mikkelson 2015). A convincing example involving an external reading of *same* comes from Hardt et al. 2012, who observe that *same* is not grammatical in (46b), in which both sentences describe a single reading event.

(46) a. I read War and Peace on my last vacation, and I read it in a single sitting.

b. * I read War and Peace on my last vacation, and I read the same book in a single sitting.

(from Hardt et al. 2012)

Barker 2007 makes a similar point for sentences with internal readings of *same*. He observes that (47) only admits the reading in which John's buying and Mary's selling are not part of the same exchange.

(47) John bought and Mary sold the same book. (from Barker 2007)

a. 'There were two events: one in which John bought the book and one in which Mary sold it.'

b. * 'There was one event in which Mary sold John a book.'

Translating this observation to the current domain, we are presented with a solution: SAME in ASL (and presumably also *same* in English) requires there to be a non-constant function from its licensor *to a set of events*. A singular noun cannot license SAME because there's only one input to the function, so there is only a single output event.

In addition to providing a solution to the singular licensing puzzle, this move also begins to unify the contribution of arc-movement in the case of dependent indefinites and the case of SAME: now both can be seen as involving non-constant functions. I discuss the implications of the move to event semantics further in §6.2, where I suggest that even the case of dependent indefinites may be better viewed as involving a function from the licensor to events.

5.3 SAME under NONE

Next, we turn to SAME under NONE. Recall that ONE-arc and other dependent indefinites in ASL are ungrammatical under NONE. On the other hand, note that *same* in English is perfectly fine under *none*, as seen in (48). It's not entirely clear, then, what to expect from the ASL data.

(48) None of the boys read the same book.

It turns out that ASL SAME reflects *both* of these patterns, in a paradigm that hinges critically on the presence or absence of arc-movement. When SAME is signed neutrally, it may be licensed by NONE, patterning with *same* in English. On the other hand, when SAME is inflected with arc-movement, it becomes ungrammatical under NONE, patterning with dependent indefinites in ASL—in other words, with the other instance of arc-movement on a noun modifier. The contrast is illustrated in (50), with (49) providing a control with ALL.

(49) THAT CLASS IX-arc, …

a. ALL STUDENT READ SAME-neutral BOOK.

b. ALL STUDENT READ SAME-arc BOOK.
'All the students read the same book.'

(50) THAT CLASS IX-arc, …

a. NONE STUDENT READ SAME-neutral BOOK.

b. * NONE STUDENT READ SAME-arc BOOK.
'No students read the same book.'

This example provides us with a clean minimal pair isolating the semantic contribution of the arc-movement. Based on the data that we have seen up to this point, I have argued that arc-movement is responsible for specifying the input of a function. Using the same insight, we can provide a sketch of what is going on in (50).

In general terms, the arc-movement in (50b) indicates the existence of a function from the boys to a plurality of reading events that all contain the same book. However, given the truth conditions of SAME under NONE (i.e. the same truth conditions as for (48)), no such plurality exists, yielding ungrammaticality.

As we try to make this more precise, however, the situation becomes a little more complex. Specifically, the sentence (50a), like its English counterpart in (48), *does* entail (in fact, presuppose) that each boy read a book—the books are just all different. The informal system that I provided in §4.1 to check the existence of a non-constant function (to events or to individuals) is based solely on the truth-conditions of a sentence; it thus breaks down in this case, satisfied by the existence of the presupposed plurality of reading events.

But in §4.1, I also introduced a second, empirically-based diagnostic to test whether a functional discourse referent was dynamically accessible: namely, the availability of quantificational subordination in English. It turns out that this test supports the hypothesis that there is no dynamically accessible function from books to boys. The examples in (51) provide a minimal pair: the first sentence in both examples are true in exactly the same set of scenarios. Nevertheless, (51a) allows quantificational subordination; (51b) does not.

(51) a. All the boys read a different book, and all of them liked it.

b. * No boys read the same book, and all of them liked it.

What the English examples show is that—at the sentence level—there is no accessible function from boys to books generated by the construction in (51b).[9] I take the ungrammaticality of arc-movement in an analogous environment as evidence that arc-movement, too, is sensitive to the presence of a functional discourse referent at the level at which the sentence is evaluated.

There are many more questions to ask about the dynamics of *none* and of *same*; I leave these open for future work.

[9]The minimal pair in (51) bears on debates between dynamic theories and E-type theories of cross-sentential anaphora (Evans 1980, Elbourne 2005). The paradigm in (51) can potentially serve as evidence in favor of dynamic semantics over an E-type theory, since the minimal situations verifying the two sentences are identical; meaning that the same set of individuals should be recoverable from each of them. Note, in particular, that replacing the pronoun in (51b) with a full definite description is perfectly grammatical.

(52) No boys read the same book, but all of them liked the book they read.

5.4 Multiple licensors

Finally, we turn to examples with multiple licensors, where SAME in ASL, like ONE-arc and other dependent indefinites, can disambiguate readings.

In English, Bumford and Barker 2013 observe that sentences with *same* are ambiguous when they appear in sentences with two potential licensors (i.e. two plural or distributive nouns). For example, sentence (53) can receive two readings, depending on whether *same* associates with the licensor *every boy* or the licensor *every girl*. Association with *every girl* produces an 'unimaginative boys' reading, where each boy bought many copies of a single book: John gave every girl the same book; Bill gave every girl the same book, and so on. Association with *every boy* produces an 'unlucky girls' reading, where each girl ends up with many copies of a single book: every boy gave Sally the same book; every boy gave Elise the same book; and so on.

(53) Every boy gave every girl the same book.

The existence of this ambiguity turns out to be of importance for existing semantic analyses of *same* and *different*. Specifically, Bumford and Barker 2013 show that Brasoveanu 2011's analysis of *different* predicts that *different* should obligatorily associate with the closest distributive operator to take scope over it. They further show, through examples with bound pronouns, that an ambiguity like the one in (53) cannot be explained as a matter of the scopal ordering of the two distributive operators. The continued existence of the ambiguity in these sentences means that the analysis in Brasoveanu 2011 undergenerates readings.[10]

In ASL, the fact that space shows overt dependencies allows the signer to disambiguate the sentence. The example in (54) should look very similar to the parallel example with dependent indefinites in (35).

(54) BOYS IX-arc-a EACH-EACH-a a-GIVE-alt-b ALL-b GIRL-b SAME-arc-b BOOK.
'Each boy gave all the girls the same book.'

Here, SAME agrees with the area over which the girls are indexed, so the sentence is interpreted unambiguously with the first reading—the unimaginative boys—where, for each boy, there is a constant function from the girls to the book that they received from that boy.

5.5 DIFFERENT

The patterns that DIFFERENT displays are essentially the same as for indefinites and SAME, so I will cover them very briefly. In ASL, DIFFERENT has two forms; the neutral form is signed

[10] It so happens that Henderson 2014's analysis of dependent indefinites makes exactly the same empirical prediction as Brasoveanu 2011's analysis of *different*, though for different reasons. Specifically, the variation condition proposed by Henderson 2014 (analogous to the one proposed here) is obligatorily evaluated at the closure of a distributive operator; this feature is necessary in order to rein in the mechanism of 'post-suppositions' that he uses for scope-taking. The data reported in (33) thus provide a potential argument against Henderson's account, although I interpret this result with caution, since I have not yet carried out all of Bumford and Barker 2013's controls on the scopal ordering of the two distributive operators.

once by separating the two hands, as in Figure 2. A plural form, DIFFERENT-arc is signed by reduplicating the motion of the singular across an area of space.

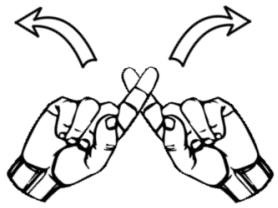


Figure 2: Uninflected DIFFERENT in ASL.

One property that distinguishes reduplicated DIFFERENT from dependent indefinites and SAME-arc is that DIFFERENT-arc may appear without a licensor, as seen in the grammaticality of (55). The resulting interpretation in such a case is that there is a plurality of items which are all (or mostly all) different kinds of things. Interestingly, this seems to be analogous to a reading of English plural *different* (e.g. 'a lot of different things'), which likewise doesn't require a licensor.

(55) JOHN-a READ DIFFERENT-arc-b BOOK. IX-arc-b INTERESTING.
'John read an assortment of different books. They were interesting.'

Nevertheless, when DIFFERENT-arc *is* signed over the area of a possible licensor, the result is to disambiguate the dependent reading. The sentences in (56) and (57) provide an example. Focusing only on readings in which the quantifiers THREE BOYS and NINE GIRLS are interpreted cumulatively, the two sentences are judged to have different meanings. For (56), where DIFFERENT-arc moves across the space where the nine girls are indexed, the sentence entails the existence of nine different books, one for each girl. In contrast, for (57), where DIFFERENT-arc moves across the space where the three boys are indexed, multiple girls could have received the same book, as long as a different set of books was chosen by each boy.

(56) [THREE BOYS]-a a-GIVE-REP-b [NINE GIRLS]-b DIFFERENT-arc-b BOOKS.
'Three boys gave nine girls books that were different *with respect to the girls.*'

(57) [THREE BOYS]-a a-GIVE-REP-b [NINE GIRLS]-b DIFFERENT-arc-a BOOKS.
'Three boys gave nine girls books that were different *with respect to the boys.*'

6 Alternative accounts: dependent indefinites

In this paper, I have sketched an analysis in which dependent indefinites are characterized by a semantic 'variation condition.' I have motivated the semantic approach with a variety of facts, including licensing conditions and the morphological similarity with SAME and DIFFERENT in

ASL. In this section, I address two alternative analyses of dependent indefinites. First, I will compare the analysis presented here to a scope-based analysis; a wide range of data will show that the latter is not viable. Second, I will discuss the role of implicature in the interpretation of dependent indefinites; I will conclude that there is a component of implicature but that it doesn't undermine the general analysis presented here.

6.1 Competing analysis: 'Dependent indefinites scope low'

In my presentation here, I characterized dependent indefinites with respect to a variation condition that checked that certain output conditions were met (namely, the presence of a non-constant functional discourse referent). Another common characterization, however, can be stated in terms of scope: a dependent indefinite must take obligatorily narrow scope with respect to a (possibly covert) distributive operator.

In this section, I consider an alternate hypothesis that directly analyzes dependent indefinites in terms of narrow scope. The hypothesis in (58) can be taken as a literal syntactic constraint (e.g., Oh 2001, 2005, Kimmelman 2015), or as a structural condition that must be met to satisfy some semantic condition (e.g., Farkas 1997, Brasoveanu & Farkas 2011).

(58) **Scope hypothesis for dependent indefinites**
Dependent indefinites must take narrow scope with respect to a distributive operator.

Henderson 2014 argues that this hypothesis can be shown to be incorrect on the grounds of pluractional paradigms from Kaqchikel Mayan. Here, using new data from both sign language and spoken language, I add three new arguments to this list.

1. In ASL, NONE does not license dependent indefinites; (some) scopal analyses predict this should be acceptable. (=overgeneration)

2. Henderson 2014: Pluractionals in Kaqchikel Mayan can be shown not to be distributive operators, but nevertheless license dependent indefinites. (=undergeneration)

3. Dependent indefinites licensed by plurals may be conjoined with an indefinite interpreted cumulatively, showing that there is no distributive operator. (=undergeneration)

4. In ASL, dependent indefinites show strong parallels with SAME and DIFFERENT. The truth conditions for these terms independently motivate mechanisms that can manipulate functional relationships. (=parsimony)

First, as we have seen, dependent indefinites in ASL are not licensed by NONE. If the only requirement to license a dependent indefinite were the need to scope under another operator, then we would incorrectly predict these sentences to be grammatical. For example, Brasoveanu and Farkas 2011 provide an analysis in which indefinites are interpreted *in situ*, and receive their apparent scope by selecting what quantifiers they can be dependent on. A dependent indefinite is defined by the condition that it cannot be independent from everything (essentially, that it

cannot take widest scope). Although no definition is provided for the quantifier *no*, the fact that a plain indefinite is able to specify its scope with respect to *no* entails that scoping below *no* should be sufficient to license a dependent indefinite. As we have seen, this is not the case, and the analysis overgenerates.

Next, we turn to three cases of undergeneration, where the scope-based analysis predicts that dependent indefinites should not be licensed in contexts where they are in fact grammatical.

Henderson 2014, discussing pluractionality in Kaqchikel Mayan, observes that a pluractional morpheme can never make a plain indefinite dependent. The contrast in (59) demonstrates this point: in Kaqchikel, the overt distributive operator *q'ij qij* ('every day') can scope over the indefinite *jun wuj* ('a book') with the meaning that there is a different book on each day. The pluractional suffix *la'* may also indicate an event recurring over time, but the book involved cannot vary over the different occasions.

(59) **Kaqchikel** (Henderson 2014)

a. Q'ij qij xukanöj jun wuj.
day day search a book
'Every day she looked for a (different) book.'

b. Xukano-la' jun wuj.
search-LA' a book
'She looked for a (particular) book many times.'

Henderson takes this as evidence that pluractional inflection in Kaqchikel is not a distributive operator. Instead, he posits that it is a predicate that checks that there is a plurality of events in the denotation of the verb. Nevertheless, Henderson shows that pluractional inflection is able to license a dependent indefinite (such as *ju-jun*, lit. 'one-one') in Kaqchikel.

(60) **Kaqchikel** (Henderson 2014)

a. Xinkan-ala' **ju-jun** wuj.
search-ALA' one-one book
'I looked for a book (in each location or at each time).'

Henderson argues that this is thus a case of licensing without a distributive operator, and a counterexample to the hypothesis in (58).

A second case where dependent indefinites are licensed without a distributive operator can be seen in cases with plural licensors. In principle, plural licensors may come with a covert distributivity operator that can take scope over dependent indefinites in their complement. However, the presence of a covert distributivity operator can be ruled out if another indefinite in the verb phrase is interpreted cumulatively.

Examples (62) and (63) provide such sentences from Tamil and Hungarian, where the dependent indefinite is conjoined with a plain indefinite that is interpreted cumulatively. Whatever syntactic analysis is chosen for coordination structures (e.g. Right Node Raising, etc.), Geach 1970 shows that no new readings emerge from reconstruction of silent syntactic material.[11]

Thus, if the dependent indefinite scopes under a distributive operator, then the plain indefinite must as well, and the sentence is predicted to yield truth conditions with twice as many desserts as students. This is incorrect; if there are three students, the sentence entails that they ended up with two desserts on the table, not six.

(62) **Tamil (Chennai dialect)** (p.c. Anushree Sengupta)

Mānavarkkal thankalai kaga **oru-oru** appetizer o irenDu desserts share-panna
students themselves for one-one appetizer and two desserts share-do
order pannagu.
order did
'The students ordered one appetizer each for themselves and two desserts to share.'

(63) **Hungarian** (p.c. Dániel Szeredi)

A diákok két előételt és **egy-egy** főételt rendeltek.
The students two appetizers and one-one main dish ordered.
'The students ordered two appetizers in total, and N main dishes where N is the number of students'

Importantly, this also cannot be explained as a case of wide scope of the plain indefinite (exceptional or otherwise), since scoping an indefinite from under a distributive operator does not give rise to cumulative readings. This becomes clear if we consider a sentence with an overt distributivity operator, as in (64). Here, even if the indefinite *two appetizers* scopes above the distributive quantifier *each student*, the sentence does not generate a cumulative reading; there must still be twice as many orders as students, and the nature of an 'ordering' event means that you end up with as many dishes as orders (even if there are only two *kinds* of dish ordered).

(64) Each student ordered two appetizers for the table.

Thus, plural licensors provide a second instance of licensing without a distributive operator.

Finally, one thing that I have tried to emphasize in this paper is the overwhelming morphological similarity between dependent indefinites and the adjectives SAME and DIFFERENT. The truth conditions of *same* and *different* (in English as in ASL) are too complex to explain merely as a matter of low scope; instead, some mechanism must be introduced that allows reference to the relation between the licensor and the NP the adjective modifies. An explanation of dependent indefinites by scope alone draws allows no extensions to *same* and *different*, and thus completely misses the generalization from ASL.

[11] Geach specifically discusses examples of right-node raising; for example, the sentence in (61), from Steedman 2009, has only two meanings, not four.

(61) Everyone loves, and everyone hates, someone.

6.2 Is the variation condition an implicature?

Throughout this paper, I have developed a theory based on a variation condition that requires there to be a non-constant function from the set associated with the licensor to the set associated with the dependent indefinite. This condition was based in part on the observation that, cross-linguistically, sentences with dependent indefinites are disprefered for situations where all the members of the licensor happen to be associated with the same individual. However, we may well wonder where this inference comes from—is it is hard-wired as a semantic entailment, or is it an implicature, arising through pragmatic competition with another logical form?

Here, I provide evidence that shows that the variation condition does seem to be an implicature—but only in part. In particular, even if we introduce a pragmatic component to our system, it will not be sufficient to capture the range of data that we have seen here; most notably, we will be unable to draw a connection to the paradigms with SAME and DIFFERENT. In contrast, I will show that if we weaken the variation condition to be condition on *events*, then we can weaken the semantic entailments in an appropriate way, but still derive the results about licensing and SAME/DIFFERENT.

There are several standard tests to see if something is an implicature or an entailment. First, implicatures are cancelable: in an appropriate context, they can be denied without contradiction. Second, implicatures disappear in downward entailing environments, which flip their semantic strength with respect to that of their pragmatic competitor. In ASL, both of these tests suggest that the condition that individuals must vary is in fact an implicature.

Example (65) provides a context in which the variation of individuals is canceled. The final sentence entails that all the books were the same, but the discourse does not yield a contradiction.

(65) PROFESSOR ANNOUNCE STUDENT NEED READ ONE, TWO BOOK. HAPPEN, ALL BOY READ ONE-arc-a BOOK. REAL-BUSINESS IX-arc-a CHOOSE SAME-arc-a BOOK
'The professor announced that the students need to read one or two books. What happened was that all the boys read one book. In fact, they chose the same book.'

Example (66) provides an instance of a dependent indefinite in a downward entailing environment. The sentence is slightly degraded, with the comment that the 'if ..., then...' construction shows English influence. Nevertheless, the interpretation that is given is that the speaker will be happy if each boy reads two books, even if these happen to be the same two books.

(66) IF ALL-a BOY READ TWO-arc-a BOOKS, IX-1 WILL HAPPY
'If all the boys read two books, I will be happy.'

Could a competition-based analysis alone account for the distribution of dependent indefinites? Henderson 2014 dismisses this possibility, observing that standard theories allow implicatures to be canceled, so competition should not be strong enough to yield ungrammaticality when a dependent indefinite lacks a licensor. This out-of-hand dismissal may be a touch too fast, though, in light of recent competition-based theories for syntactic distribution. For example, Spector 2014 argues that the French '*soit... soit...*' construction comes with obligatory

exhaustification (i.e. enrichment by negating competing forms), and is licensed only if this exhaustification strengthens the meaning of the sentence.

Nevertheless, such an analysis seems untenable in the present case, for two reasons. First, theories of competition require a set of alternatives to compare to; the present case would require developing a theory of alternatives that allows not only lexical alternatives (e.g. *and* vs. *or*) to generate this set, but different scopal orderings. Perhaps more significantly, the competition-based view offers no extension to the case SAME and DIFFERENT whose truth conditions can't easily be stated in terms of competition with another form. Inspired by the morphological parallels in the ASL data, I view this as a theoretical priority.

In contrast, the mechanism developed here presents a clean way to capturing both the licensing facts and the similarity between dependent indefinites and SAME and DIFFERENT. However, because the current mechanism is built on a variation condition that is hard-wired into the semantics, we fail to predict that variation of individuals can disappear in certain cases, as above.

I'd like to suggest that we have already discovered a solution to this puzzle in our discussion about SAME: namely, the correct truth conditions can be modeled if we weaken the variation condition to hold of *events*, not *individuals*. Thus, the denotation of ONE-arc imposes the condition that there is a non-constant function from the licensor to a set of *events*, and entails that each of these events contains one individual in the relevant thematic role.[12] Additional pragmatic reasoning (perhaps through competition with the uninflected form) generates the implicature that the individuals vary as well.

This modification has a few interesting consequences, but none, I'll argue, that undermine the analysis built here. The most counterintuitive consequence is that the scopal generalization about dependent indefinites—namely, that dependent indefinites must scope below a universal quantifier—is no longer true in any form. Under the revised analysis, any distributive licensor, regardless of where it scopes, will introduce a plurality of events, so will satisfy the event-based variation condition. The reason for this arises from the condition of *thematic uniqueness* (also called the Unique Role Requirement; see Carlson 1984, Landman 2000, a.o.) which states that if two events have distinct theta roles, then they must be distinct events—for example, an event where John is the agent must be distinct from an event where Bill is the agent. What this means is that a distributive operator will *always* generate a plurality of events, because a unique event exists for each individual in the domain of the quantifier.

However, although this may be at odds with the scopal generalization, empirically, this is only allowing those truth conditions that we just established are in fact possible. More to the point, the analysis still derives the correct predictions in the places where it matters: we still successfully predict which DPs can act as licensors, and we still correctly rule out collective readings of plural licensors when relevant, as in (35), repeated below, which excludes readings on which the girls are interpreted collectively.

(67) ALL-a BOY-a GIVE ALL-b GIRL-b ONE-arc-b BOOK.
'All the boys gave all the girls one book (per girl).'

[12] By thematic uniqueness (Carlson 1984), this is a strict weakening, since $\theta(e) \neq \theta(e') \rightarrow e \neq e'$, so variation over individuals implies variation over events.

For example, a singular NP still cannot license a dependent indefinite, as it will only introduce a single event (here, thematic uniqueness has no ill-effect). For exactly the same reason, collective readings of plurals are ruled out; collective readings are exactly those where a plural NP collectively comprises a single thematic role of a single event. Finally, the same logic holds for NONE as held before: the sentence 'no student read a book,' yields no function from students to reading events, so a dependent indefinite is not licensed under NONE.

7 Summary

In this paper, I addressed the empirical domain of functional reference and dependency, as it appears in a wide variety of phenomena in language. I showed that the properties of the sign language modality allow ASL to overtly represent dependency structures through the use of spatial association, thus allowing a more direct window into the mechanisms underlying these phenomena.

Empirically, we found compelling connections between dependent indefinites and SAME and DIFFERENT. Each of these nominal modifiers is able to move in space, agreeing with a plural or distributive licensor; this licensor serves as the input for a functional discourse referent. For both ONE and SAME, the same licensing patterns were found: arc-movement requires a licensor; licensing is possible under plurals and universal quantifiers, but ungrammatical under singulars and NONE. We drew a connection between these licensing patterns and quantificational subordination in English.

Finally, we added a new piece of data regarding cases of multiple licensors, an empirical domain that has been shown to be of theoretical importance for the semantics of dependency. In ASL, because spatial agreement allows a dependent form to overtly specify its licensor, we showed that constructions that are ambiguous in spoken language can be disambiguated in ASL with the use of space.

References

Balusu, R. (2005). Distributive reduplication in Telugu. In Davis, C., Deal, A. R., and Zabbal, Y., editors, *Proceedings of the 36th Annual Meeting of the North East Linguistic Society (NELS 36)*, pages 39–53, Amherst, MA. University of Massachusetts GLSA Publications.

Barker, C. (2007). Parasitic scope. *Linguistics and Philosophy*, 30(4):407–444.

Brasoveanu, A. (2006). *Structured Nominal and Modal Reference*. PhD thesis, Rutgers University.

Brasoveanu, A. (2011). Sentence-internal *different* as quantifier-internal anaphora. *Linguistics and Philosophy*, 34(2):93–168.

Brasoveanu, A. and Farkas, D. (2011). How indefinites choose their scope. *Linguistics and philosophy*, 34(1):1–55.

Bumford, D. and Barker, C. (2013). Association with distributivity and the problem of multiple antecedents for singular *different*. *Linguistics and Philosophy*, 36:355–369.

Carlson, G. N. (1984). Thematic roles and their role in semantic interpretation. *Linguistics*, 22(3):259–280.

Carlson, G. N. (1987). Same and different: Some consequences for syntax and semantics. *Linguistics and Philosophy*, 10(4):531–565.

Chen Pichler, D. and Hochgesang, J. A. (2008). An overview of possessives and existentials in American Sign Language. In Zeshan, U. and Perniss, P., editors, *Possessive and existential constructions in sign languages*, number 2 in Sign Language Typology, chapter 10. Ishara Press.

Chierchia, G. (1993). Questions with quantifiers. *Natural Language Semantics*, 1:181–234.

Choe, J.-W. (1987). *Anti-quantifiers and a theory of distributivity*. PhD thesis, University of Massachusetts, Amherst, MA.

Cooper, R. (1979). The interpretation of pronouns. *Syntax and semantics*, 10:61–92.

Elbourne, P. (2005). *Situations and Individuals*. Current Studies in Linguistics. MIT Press, Boston, MA.

Engdahl, E. (1986). *Constituent Questions*. Reidel, Dordrecht, Netherlands.

Evans, G. (1980). Pronouns. *Linguistic Inquiry*, 11(2):337–362.

Farkas, D. F. (1997). Dependent indefinites. In Corblin, F., Godard, D., and Marandin, J.-M., editors, *Empirical issues in formal syntax and semantics*, pages 243–268, Bern, Switzerland. Peter Lang.

Farkas, D. F. (2001). Dependent indefinites and direct scope. In Condoravdi, C. and Renardel, G., editors, *Logical perspectives on language and information*, pages 41–72. CSLI Publications, Palo Alto, CA.

Farkas, D. F. (2002). Extreme non-specificity in romanian. In Beyssade, C., editor, *Romance languages and linguistic theory 2000*, pages 127–151. John Benjamins, Amsterdam, Netherlands.

Geach, P. T. (1970). A program for syntax. *Synthese*, 22(1/2):3–17.

Gil, D. (1993). Nominal and verbal quantification. *STUF - Language Typology and Universals*, 46(4):275–317.

Groenendijk, J. and Stokhof, M. (1984). *Studies on the semantics of questions and the pragmatics of answers*. PhD thesis, University of Amsterdam, Amsterdam, Netherlands.

Hardt, D. and Mikkelsen, L. (2015). Same but different. *Linguistics and Philosophy*.

Hardt, D., Mikkelsen, L., and Ørsnes, B. (2012). Sameness, ellipsis and anaphora. In Aloni, M., Kimmelman, V., Roelofsen, F., Sassoon, G. W., Schulz, K., and Westera, M., editors, *Logic, Language and Meaning: 18th Amsterdam Colloquium*, pages 341–350, Amsterdam, Netherlands. Springer Berlin Heidelberg.

Heim, I. (1990). E-type pronouns and donkey anaphora. *Linguistics and Philosophy*, 13(2):137–178.

Henderson, R. (2014). Dependent indefinites and their post-suppositions. *Semantics and Pragmatics*, 7(6):1–58.

Hintikka, J. (1986). The semantics of *a certain*. *Linguistic Inquiry*, 17(2):331–336.

Jacobson, P. (2000). Paycheck pronouns, bach-peters sentences, and variable free semantics. *Natural Language Semantics*, 8(2):77–155.

Karttunen, L. (1969). Pronouns and variables. In et al., R. B., editor, *Papers from the Fifth Regional Meeting of the Chicago Linguistic Society*, Chicago, IL. Chicago Linguistic Society.

Kimmelman, V. (2015). Distributive quantification in russian sign language. In *Formal and Experimental Advances in Sign Language Theory*, Barcelona, Spain.

Kratzer, A. (1998). Scope or pseudoscope? are there wide scope indefinites? In Rothstein, S., editor, *Events in grammar*, pages 163–196. Kluwer Academic Publishers, Dordrecht, Netherlands.

Kuhn, J. (2015a). ASL Loci: Variables or Features? *Journal of Semantics*.

Kuhn, J. (2015b). Dependent indefinites: the view from sign language. Available at http://semanticsarchive.net/Archive/jYxMzJkN/.

Landman, F. (2000). *Events and plurality: The Jerusalem lectures*. Kluwer, Dordrecht, Netherlands.

Lillo-Martin, D. and Klima, E. (1990). Pointing out differences: ASL pronouns in syntactic theory. *Theoretical Issues in Sign Language Research*, 1:191–210.

Nouwen, R. (2003). *Plural pronominal anaphora in context: Dynamic aspects of quantification*. PhD thesis, Utrecht University, Utrecht, Netherlands.

Oh, S.-R. (2001). Distributivity in an event semantics. In Hastings, R., Jackson, B., and Zvolensky, Z., editors, *Proceedings of the 11th Semantics and Linguistic Theory Conference (SALT 11)*, pages 326–345, Ithaca, NY. Cornell University CLC Publications.

Oh, S.-R. (2006). *Plurality markers across languages*. PhD thesis, University of Massachusetts, Amherst, MA.

Pereltsvaig, A. (2008). Russian nibud'-series as markers of co-variation. In *Proceedings of the 27th West Coast Conference on Formal Linguistics (WCCFL 27)*, pages 370–378.

Schlenker, P. (2006). Scopal independence: A note on branching and wide scope readings of indefinites and disjunctions. *Journal of Semantics*, 23(3):281–314.

Schlenker, P. (2011). Donkey Anaphora: the View from Sign Language (ASL and LSF). *Linguistics and Philosophy*, 34(4):341–395.

Schlenker, P., Lamberton, J., and Santoro, M. (2013). Iconic variables. *Linguistics and Philosophy*, 36(2):91–149.

Schwarz, B. (2001). Two kinds of long-distance indefinites. In Van Rooij, R. and Stokhof, M., editors, *Proceedings of the 13th Amsterdam Colloquium*, pages 192–197, Amsterdam, Netherlands. ILLC Publications.

Solomon, M. (2011). True distributivity and the functional interpretation of indefinites. Available at http://semanticsarchive.net/Archive/zkxN2M4M/.

Spector, B. (2014). Global positive polarity items and obligatory exhaustivity. *Semantics and Pragmatics*, 7(11):1–61.

Steedman, M. (2009). Semantics in categorial grammar. In Allan, K., editor, *Concise Encyclopedia of Semantics*. Elsevier.

van den Berg, M. (1996). *Some aspects of the internal structure of discourse: the dynamics of nominal anaphora*. PhD thesis, ILLC, Universiteit van Amsterdam.

Winter, Y. (2001). *Flexibility principles in Boolean semantics: The interpretation of coordination, plurality, and scope in natural language*. MIT Press, Cambridge, MA.

Yanovich, I. (2005). Choice-functional series of indefinite pronouns and hamblin semantics. In *Proceedings of the 15th Semantics and Linguistic Theory Conference (SALT 15)*, volume 15, pages 309–326, Ithaca, NY. Cornell University CLC Publications.