

“More is up” for domain restriction in ASL*

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Abstract This paper serves as an in depth investigation of a pattern in American Sign Language (ASL) whereby pronouns, verbs, and quantifiers can be produced progressively higher or lower in signing space to signal multiple levels of widening and narrowing, respectively, of their contextual domains. We argue that this is done through pronominal arguments of verbs and quantifiers which signals set-superset relationships using gradient means, providing new evidence that bears on (a) the nature of quantifier domain restriction and (b) the nature of verbal directionality/("agreement") in sign languages. We also discuss our findings in terms of the relationship between gesture and language by considering the grammatical functions of the phenomenon in sign languages as compared to gesture and prosody accompanying spoken language.

Keywords: domain restriction, quantification, sign languages, clitics, agreement

1 Introduction

All languages provide an array of constraints that allow referents to be tracked across a discourse, although the choice of which are instantiated in particular languages may vary. For example, some languages use grammatical gender to keep track of possible antecedents for pronouns or the sometimes omitted arguments of verbs, while others use noun classes related to semantic properties like animacy, size, etc. Some languages mark definiteness on noun phrases, yet others mark specificity, and others mark neither. In addition to some of these methods, sign languages are known to make use of a modality-specific means of tracking discourse referents using three dimensional space in which, broadly speaking, noun phrases signed in the same location in space (sharing a referential "locus") co-refer (1).

* We warmly thank signers who consulted with us on this project; the UConn Sign Language Reading and Discussion Group, the Yale Semantics Reading Group, audiences at NELS, LSA, and the University of Chicago, and Emily Carrigan, Allison Durkin, Jeremy Kuhn, Zoltán Szabó, and Matthijs Westera for helpful discussion; and Allison Durkin, Jamie Conti, Uiko Yano, and Kazumi Matsuoka for stimulating discussion and collaborations on related work in other linguistic systems, Lisa Matthewson and three anonymous reviewers, and Liz Coppock for tremendously helpful feedback and suggestions. This research was funded by the UConn IGERT: Innovation Grant and NSF GRF DGE-1247393 to DG and a Yale Cognitive Science program grant to KD.

- (1) JOHN-a LIKE BOB-b. IX-a SMART.
 'John likes Bob. He (John/*Bob) is smart.'

In (1) and throughout this paper, $-a$ is used to indicate that the sign was produced in arbitrary locus $-a$, while $-b$ signals another arbitrary locus; as the translation indicates, these constrain coreference. Sign language loci have featured prominently in discussions in semantics since Lillo-Martin et al. (1990) argued that they are an overt instantiation of semantic indices. Subsequent work within formal semantics has followed related to their dynamic properties (Schlenker 2011), iconic properties (Schlenker et al. 2013), and whether an analysis as indices accounts for all of their properties (Kuhn 2015), but all generally agree that sign language loci allow for distinctions to be made due to the mode of the language that are not made (overtly) in spoken languages.

In this paper, we focus on another distinction that sign languages seem to make that spoken languages do not make in the same way, related to the restriction of quantifier domains. To illustrate this distinction, consider the following context: A group of several friends watch a movie together about one of their favorite kinds of fantastical characters: vampires. The next morning, one of these friends is recounting the evening to someone else and reports, "Last night I watched a movie with my friends about vampires. Afterwards I went to bed and I dreamt that everyone became vampires." In saying this in English, the speaker could mean (among other possible interpretations) that they dreamt that everyone who was watching the movie became vampires (2a), or also she could just as easily mean that she dreamt that everyone in the entire world became vampires (a reasonable possibility in a horror movie scenario) (2b).

- (2) Last night I watched a movie with my friends about vampires. Afterwards I went to bed and I dreamt that **everyone** became vampires.
- a. Everyone in that story (your friends/the people in the context) became vampires.
 - b. Everyone in the entire world became vampires.

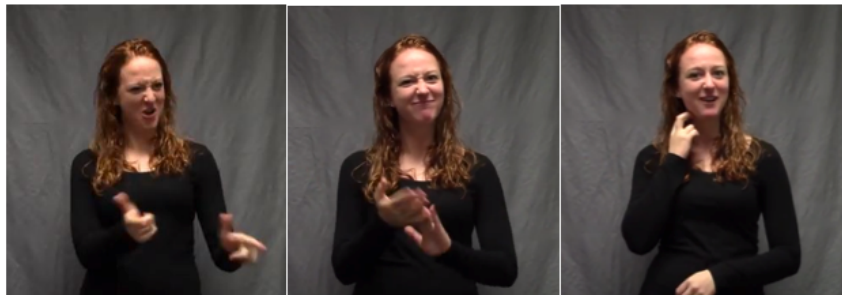
In an example like (2) in English, the listener is tasked with figuring out who exactly the speaker meant to include by "everyone." Note that both (2a)-(2b) involve universal quantification, so we can't attribute any difference in interpretation here to the force of the quantifier. Rather, the difference seems to lie in the restriction of the universal quantifier: is everyone restricted to people in the story already mentioned or to everyone in the world? Usually this resolution happens seamlessly: sometimes later information cues the listener in to how many people should be considered, sometimes it doesn't matter, and sometimes it's clear in context who speakers intend.

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In an example like (2), though, without any further elaboration on the domain of the quantifiers, the listener must make use of their substantial pragmatic capacities.

In ASL, in contrast with English above, a distinction between the intended interpretations (2a) and (2b) of the sentence in (2) is naturally made in the linguistic form of the quantifier itself. Consider (3) below in ASL, signed in the same context as (2). The signer can sign ALL lower or higher in space (as shown in the accompanying photo), and this reflects a difference in meaning such that when signed lower (at a neutral height) it only quantifies over the smaller domain of friends who watched the movie (3a) and when signed higher it quantifies over a much wider domain, most naturally in this case everyone in the world (3b).

- (3) Context: Signer has just said, "Last night I watched a movie with my friends about vampires. Afterwards I went to bed and I dreamt that..."



a. ALL-low BECOME VAMPIRE

‘All of my friends became vampires’
#‘All of the people in the world became vampires’



b. ALL-high BECOME VAMPIRE

‘All of the people in the world became vampires’
#‘All of my friends became vampires’

In recent years, sign languages have been argued to make overt certain aspects of linguistic structure, especially semantic structure, that are covert in spoken languages

(Lillo-Martin et al. 1990, Wilbur 2003, Zucchi 2004, Quer 2005, Wilbur 2008, Schlenker 2011, Caponigro & Davidson 2011, Quer 2012, Kuhn & Aristodemo 2017). This distinction in expression of quantificational domains in (3) above, then, raises questions about both the structure of the ASL case and also how it might shed light on the nature of domain restriction in language generally, a topic long of interest to those working at the syntactic/semantic/pragmatic interface. In the following two sections, then, we'll review analyses of quantifier domain restriction (1.1) and then structures of quantified noun phrases cross-linguistically (1.2), in order to determine if this is a case of something overt in sign languages that is covert in spoken languages, or perhaps whether this follows already established patterns seen across languages but instantiated in a new way in sign languages.

1.1 On the problem of quantifier domain restriction

Stanley & Gendler Szabó (2000) compare and contrast what they categorize as pragmatic, syntactic, and semantic approaches to quantifier domain restriction, a categorization that we find also useful and so will review briefly. One type of solution to the problem of contextual domain restriction is for the pragmatics to take the full burden (Bach 1997). Under a pragmatic solution to (2) above, the semantics is as it appears on the surface, a statement of universal quantification over all individuals in the universe. What looks like contextual domain restriction comes about via pragmatic reasoning based on the unlikelihood that a speaker would want to quantify over, or even know anything about, everyone in the world. Because the literal interpretation is often unlikely to be intended by the speaker, the listener must adjust their interpretation of the quantifier's domain to a more restricted group in what is essentially a kind of quantity based conversational implicature. In other words, English speakers are constantly juggling both a basic semantic and enriched pragmatic meaning to these sentences (perhaps in a way that ASL signers need not). We purposely picked an "ambiguous" example for (2) that could be just as reasonable in a widened or restricted context, but many real life examples such as "Everyone came to the party" are clearly unlikely statements to hold of everyone in the entire universe, so it seems reasonable at first blush that a pragmatic story could restrict the contextual domain in such situations.

As often happens, a purely pragmatic story runs into some difficulty with more complex examples of contextual domain restriction. Consider (4): "everyone" who transforms into vampires must still be contextually restricted, since it could just be the relevant "everyone"/your friends, or everyone in the whole world. However, the relevant group can also vary with the first quantifier "usually", so that perhaps a different group of friends is turning into vampires each time, if they were the people you watched the movie with.

- (4) Last night I watched a movie with my friends about vampires. Usually when I do this, I dream that everyone becomes vampires.

These kinds of examples suggest instead that there must be a place in the linguistic representation of the sentence with the universal quantifier that contains information about the contextually supplied domain, which itself can participate in a binding relationship with the higher quantifier "usually". One possible solution then would be a type of syntactic ellipsis, such that there is an explicit domain in the structure, unpronounced in most cases in English (5) but potentially overt in ASL.

- (5) a. Everyone [~~I watched a movie with~~] becomes vampires.
b. Everyone [~~in the world~~] becomes vampires.

The problem with a full syntactic analysis of domain restriction is that what is elided is radically underdetermined. For example, one could arrive at the right interpretation for (5) with many other options for the elided clause: "everyone who was there during the movie", "everyone who enjoyed the movie with me", "everyone I sent an invitation to that day", etc. Unlike true ellipsis, there should be a linguistic antecedent to be copied/reconstructed at the ellipsis site, which makes a purely syntactic analysis of quantifier domain restriction difficult to maintain.

A third type of solution to quantifier domain restriction is semantic (Von Stechow 1994, Stanley & Gendler Szabó 2000). For example, in their instantiation of such a system, Stanley & Gendler Szabó propose that an open context variable *C* consisting of all of the individuals in the relevant context exists as part of the restrictor of a quantifier. As illustrated in (6) and perhaps even more clearly in (7) with a separate complement, under their analysis the variable combines with the restrictor of the quantifier (e.g. women in (7)) first. This variable acts as just another modifier, intersecting the restrictor (e.g. people, or women) with the context to return only those in the relevant context. This provides the interpretation that all women (in (7)) or all people (in (6)) in the relevant context turned into vampires. As needed, this context could be just the local context of the speaker's friends, or the wider context of the whole world, or something else, but under this account *C* is an open variable that gets its content via pragmatics.

- (6) (Everyone (*C*)) transformed into vampires.
'Every contextually relevant individual transformed into a vampire'
- (7) Every ((*C*) woman) transformed into vampires.
'Every contextually relevant woman transformed into a vampire'

This sets up an interesting question: is the use of height that we see in ASL a case of an overt variable of the sort proposed in semantic accounts of contextual domain restriction? Or is it more comparable to ellided material of the sort discussed in syntactic analyses? It's also possible that other languages might have more similar structures to ASL even in their surface forms than English does, so in the next section we focus briefly on the structure of quantified noun phrases cross-linguistically.

1.2 Variation in the structure of quantified noun phrases

English already displays some variation in the structure for quantified noun phrases. It allows at least two options displayed in (8): a quantifier followed by a partitive phrase (8a) or a quantifier followed by a bare noun (8b)-(8c). (A nonstandard but common variant includes both the partitive and bare noun, which we note but will not discuss further in this paper (8d) since we are not aware of existing research sources on the semantics of this variant, although we would be excited to see more work on this variation elsewhere.)

- (8) a. All of {them/the women} are intelligent. Q(of DP)
 b. All {*them/women} are intelligent. Q(NP)
 c. Every {*her/woman} is intelligent. Q(NP)
 d. %All (of) them women are intelligent. Q (of) DP NP

When the quantified noun phrase in English contains a partitive (e.g. "All of the women" or "All of them" in (8a)), the definite DP within the partitive (e.g. "the women"/ "them") serves as the domain of the quantifier. In these cases, quantifier domain restriction can occur by whatever process assigns definite noun phrases their referents in discourse more generally. For example, if a pronoun (e.g. "them") is used, the usual heuristics for pronoun reference could refer to people (more specifically, women) in the immediate context, or the group that the speaker points to while saying "them", or any other group as long as the process of pronoun resolution picks out that specific group; for "the women", we know that use of a definite article requires a single already salient group of women in the context. In other words, because resolving reference for DPs is already known to require complex heuristics that include a significant pragmatic component, the linguist interested in modeling quantifier domain restriction can offload the work of pragmatic restriction to this definite argument of the partitive.

In contrast to the partitive case, for the QNP case with a bare NP there is no (overt) determiner and in fact a pronoun is ungrammatical outside of the partitive (8b)-(8c). These examples have posed a more significant puzzle for quantifier domain restriction because there are no components that otherwise engage a process

of pragmatic restriction (like the definite determiner or pronouns). Nevertheless, although potentially differing in how they resolve domain restriction, both types of quantified noun phrases in English share an important property: the complement of the quantifier appears to be a property of type $\langle e, t \rangle$, as in both "of the women" and "women". It is a well known generalization that quantifiers take arguments of type $\langle e, t \rangle$ (again, either a partitive or a bare noun) before combining with clausal predicate, one which has been proposed as a fundamental property of natural language quantification (Barwise & Cooper 1981).

Additional surface patterns arise in other languages. One example described in Jelinek (1995) and Matthewson (2001) comes from St'át'imcets (Salish), in which a quantifier followed by a bare noun is ungrammatical (9a). Rather than a partitive, St'át'imcets instead uses a quantified noun phrases that consists of both a quantifier and a determiner phrase, and nothing else (9b) (both examples from Matthewson 2001, p. 150).

- (9) a. *lélex tákem smelhmúlhats Q(NP)
 intelligent all woman(PL)
 'All women are intelligent'
- b. lélex tákem i=smelhmúlhats=a Q(Det(NP))
 intelligent all DET.PL=woman(PL)=EXIS
 'All (of the) women are intelligent'

Matthewson highlighted this pattern to argue that the semantic type of the complement of the quantifier in St'át'imcets is type e instead of $\langle e, t \rangle$, providing a potential counter example to Barwise & Cooper (1981).

Another type of pattern is present in Basque, as reported in Etxeberria (2012) and Etxeberria & Giannakidou (2014) and seen in (10) (Etxeberria 2012, p. 252). In Basque, a determiner is also required, like Salish, but instead of appearing after the quantifier, this determiner appears on the quantifier itself.

- (10) a. Ume guzti-ak goiz iritsi ziren. (DetQ)(NP)
 child all-D.PL.ABS early arrive AUX.PL
 'All of the children arrived early.'
- b. * Ume-ak guzti goiz iritsi ziren.
 child-D.PL.ABS all early arrive AUX.PL
 'All of the children arrived early.'

The authors argue further that in Basque, the Determiner and the Quantifier form a constituent, which takes the subsequent NP as its complement. Under their analysis, Basque illustrates a different structure than English for quantified noun phrases but

the quantificational generalization suggested based on English can remain essentially intact given that the complement of this (complex) quantifier is still of type $\langle e, t \rangle$.

In the following table, we summarize structural variation for quantified noun phrases in English, St'át'imcets, and Basque.

Schema for quantified NPs in spoken languages cross-linguistically	
<i>English:</i>	
'All of the women are intelligent'	Q(of DetP)
'All women are intelligent'	Q(NP)
<i>St'át'imcets (Matthewson 2001):</i>	
léxlex tákem i=smelhmúlhats=a	Q(DetNP)
intelligent all DET.PL=woman(PL)=EXIS	
'All (of the) women are intelligent'	
<i>Basque (Etxeberria 2012):</i>	
Ume guzti-ak goiz iritsi ziren.	(DetQ)(NP)
child all-D.PL.ABS early arrive AUX.PL	
'All of the children arrived early.'	

We can ask, then, whether the change in form on the quantifier in ASL seems to have parallels in other languages, especially whether the use of height corresponds to a *DetNP* or a *Det*, or whether the use of height is rather like an overt instantiation of a covert domain variable, or something different altogether.

1.3 Overview

In what follows, we will argue that the case of domain restriction is yet another way that the ASL loci system allows for disambiguating discourse referents, in this case plural pronouns that are the restrictor of these quantifiers. In doing so, we will draw a straight line from earlier observations on loci in sign language pronouns, through a new discussion of the use of the same loci in directional (“agreeing”) verbs, and finally to the restrictor of these quantifiers through what we argue is a partitive construction in which the higher/lower locus is a pronominal argument. In some ways, then, we will not be proposing a radically new structure: the quantified noun phrases in (3) is essentially a quantifier and a pronominal argument (“all of them”, a Q(of DetP)), but the pronoun shows a distinction regarding domain size that is not seen in spoken language as far as we know.

In Section 2 will review important structural properties of ASL loci and show that the same use of height is present in the pronominal system. Section 3 will illustrate the same use of height in verbs in ASL, and lay out arguments in favor of

our analysis of this use of height in verbs as coming through incorporated pronouns. Section 4 will then focus on quantifiers, extending the argument from verbs to argue that the domain restriction is also achieved through a pronominal argument akin to a partitive construction. Section 5 will formalize these observations. Section 6 will discuss this use of height for representing domain sizes found in other sign languages beyond ASL, and Section 7 concludes.

1.4 A brief note on methodology

As we mentioned at the outset, the focus of our work in this paper is on American Sign Language (ASL), the language of the Deaf and Hard-of-Hearing communities of the United States and parts of Canada. Our data and images are based primarily on in depth consultations with two Deaf, native signers (one male, one female, both exposed to ASL from birth from Deaf signing parents). Additional supporting data and images are from two Deaf adults (one male, one female) who were each exposed to ASL before age 2. Our methodology consisted of three parts: first, participants chatted informally with the authors (one of whom, DG, is a hearing native signer) while being videorecorded about topics designed to elicit the use of height that we discuss below. Second, we made notes of the examples that were elicited, and asked participants to produce sentences with and without changes to them in front of the camera, or in other words to "play around" with how small changes in the targeted forms affected grammaticality. Third, example sentences deemed most natural by participants were recorded in "clean" versions in isolation to the camera, which are the ones that appear in figures here.

2 Height for signaling domain in pronouns in ASL

2.1 Background: Noun phrases and loci in ASL

In ASL, as in many other sign languages, a point of the index finger (IX) functions as a singular pronoun, unmarked for gender (11a). Most full noun phrases (i.e. not pronouns) in ASL are bare noun phrases containing no articles (11b), although it has been argued that IX can sometimes be used as a definite article like "the" in ASL (MacLaughlin 1997) when it is pronominal as in (11c); others have argued that ASL is an NP language in the typology argued for by Bošković (2005), concluding therefore that all noun phrases in ASL are bare noun phrases, and such uses of IX are modifiers of some sort (Koulidobrova 2012) or demonstratives (Koulidobrova & Lillo-Martin 2016). More recently Barberà (2012a, 2012b) has suggested that the pronominal IX in examples like (11c) marks specificity, not definiteness, at least in Catalan Sign Language but also possibly extending to ASL.

- (11) a. MARY LOVE IX .
 "Mary loves her/him/it."
 b. MARY LOVE WOMAN.
 "Mary loves a/the woman/women"
 c. MARY LOVE [IX WOMAN]
 "Mary loves the/that/SPEC woman"

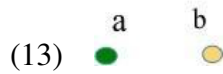
For our purposes it will not be directly relevant how we analyze prenominal IX , since we will focus instead on uses of the indexical point IX instead where it appears on its own as a full NP (a pronoun) as in the singular form in (11a) and the plural form in (12). Example (12) illustrates a common sentence structure in ASL: base word order is subject-verb-object, but instead of appearing in its argument position, the subject FRIENDS has been topicalized, and the pronominal IX -arc_a appears in its argument position. Dropped arguments are also grammatical in ASL under the right discourse conditions, so the subject or object could also be omitted entirely. The plural form IX-arc_a traces out an arc or circle to outline a 2-dimensional circular area in front of the signer. The area traced out by IX-arc in (12) is noted as a, since the space chosen (the plural "locus") is for our purposes arbitrary but must be distinguished from any others.



- (12) **FRIENDS,** **IX-arc(PL)_a** **REALLY** **SMART**
 '(My) friends, they (are) really smart.'

As we noted at the outset, discourse referents in ASL can be tracked through a system of spatial co-occurrence using these "spatial loci." As an example, consider (13). The signer signs the name JOHN in one location (the locus "a") in signing space. Unless otherwise specified, this location is at a "neutral" signing height (approximately mid-torso) and either to the signer's right or left. They can then sign another name BOB at a different location at neutral signing height, usually the opposite side (left if right) from the first name (here, locus "b"). The establishment of these names in space then allows a pronoun in the next sentence IX to unambiguously refer to one of these referents depending on which location it points to (if a, then John is the referent; if b, it is Bob). We include (13b) to show that association of

discourse referents with locations in space is optional, although it is frequently used if the continuing discourse will be making reference to their contents.



- a. JOHN-a LIKE BOB-b. IX-a SMART. *singular with locus*
'John likes Bob. He (John) is smart.'
- b. JOHN LIKE BOB. *singular, no locus*
'John likes Bob.'

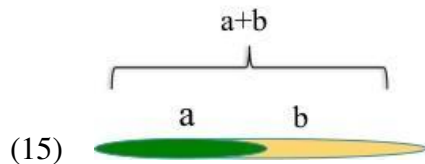
Importantly for the rest of the discussion in this paper, all of these same locus properties are seen with plural discourse referents as well. Like the singular the use of loci, associating plural noun phrases with loci is optional but frequently used when the contents will be referred to again in subsequent discourse (14).



- a. MANY STUDENT IX-arc-a LIKE TEACHER IX-arc-b.
IX-arc-a SMART. *plural with locus*
'Many students like the/their teachers. They (the students) are smart.'
- b. MANY STUDENT LIKE TEACHER. *plural, no locus*
'Many student(s) like the/their teacher(s).'

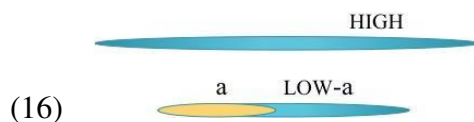
Schlenker et al. (2013) discuss a further property of plural loci in particular, which is that they follow what they call an "iconic geometry." By this, they mean that the spatial relationship (specifically: the set/subset relationship) of the arc/circles in 2 dimensional space in the default locus plane should correspond to the same relationship of their referents. So, if a signer establishes a plural locus for a plural referent (for example, a group of students), and then later wants to establish a plural locus for a subset of this group, that second locus should spatially take up a subset of the space of the first locus. Similarly, if one establishes a locus for a group and later wants to establish a locus for a superset of this group, the new locus should be a superset of the space of the first locus (15a). Furthermore, they note that the enforced geometry of the locus system provides access to discourse referents that are otherwise more difficult to find in non-spatial languages, most notably complement set anaphora: in (15) the signer can assign the large group of students to a large locus (a+b) and assign a subset of that set to a subset locus (a), and then by the

enforced mapping can simply point to the remainder of the large locus (b) to refer to the complement (boys) of the smaller set within the large set. Schlenker et al. note that a rough translation with the same meaning is ungrammatical in English, since the only available discourse referents for they in such a translation are the large set and the smaller set (15b).



- a. STUDENT IX-arc-a+b SMART.
GIRL IX-arc-a HAPPY.
IX-arc-b NOT HAPPY.
'The students are all smart. The girls (a subset of the students) are happy, but the rest (the boys) are not happy.'
- b. #The students are smart.
The girls are happy.
They (intended: boys) are not happy.

To this discussion we add a further observation, briefly made in previous work (Davidson & Gagne 2014), that these plural loci need not always be established overtly to make use of the same system including its iconic geometric properties. They can instead make use of "default" interpretations for whole planes in space (which we contrast with the overtly marked arcs by using blue colors in the figure accompanying (16)). For example, a signer can establish a locus "a" for a group of students at a neutral ("low") height. This can be followed with an arc that traces out the remainder of the neutral signing space ("Low minus a"), as if the whole low plane were the relevant superset, and is interpreted as everyone else in the current context besides the students (16a), without any prior establishment of the larger referent for the whole lower plain. If instead that same "whole plane" arc was made at a higher height, the interpretation is that the referent is of a much larger group, a superset of both the small original locus and also of the lower set (16b).



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- a. STUDENT IX-arc-a SMART. IX-arc-low-a NOT. *implicit loci*
'The students, they are smart. The rest are not.'
- b. STUDENT IX-arc-a SMART. IX-arc-high NOT.
'The students, they are smart. Generally, everyone else is not.'

Put another way, neutral/low signing space seems to represent the entirety/whole universe for the contextually relevant/restricted default context; a higher space seems to allow reference to a superset of this set, when the signer wants to signal a larger domain than was already being considered.

One important fact about this use of height is that it is not binary, despite implications that might be drawn from our “high/low” notation. For example, consider (17): the context is contrived such that the signer unexpectedly finds herself and her family at a nudist colony. In such a context, she can use the lower/neutral height to set up a locus for her family as in any discourse, and then a mid-level height to pick out a super set which is all of the people at the nudist colony, and finally a further higher level to pick out all of the people in the world (a superset of the nudist colony). Note that we used a nudist colony example in particular because wearing clothes is something that can be widely said to hold in general of people in the world, although a small group (e.g. the nudist colony) may be an exception to contrast with at the mid-level height (similar, the family contrasts with the nudist colony), and so in each case can be the referent for the third person plural pronoun (which allows for rare exceptions).

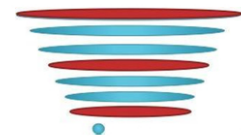
- (17) Context: Discussing an accidental family visit to a nudist colony. (The family is a subset of people at the nudist colony, who are in turn a subset of people in the world.)
- a. POSS-1 FAMILY IX -arc-neutral WEAR CLOTHES .
'My family, they all wear clothes.'
 - b. IX -arc-mid NOT WEAR CLOTHES .
'They all (at the nudist colony) don't wear clothes.'
 - c. IX -arc-high WEAR CLOTHES .
'They all (people generally) wear clothes.'



a. IX-arc-low

b. IX-arc-mid

c. IX-arc-high



If the signer only wanted to contrast two groups, she could use two levels, with the lower of these spaces for the local nudist colony instead of her family as in (18). The contrast between (17) and (18) also illustrates that these heights are only conveying relative, not absolute, contextual restriction.

- (18) Context: Discussing an accidental family visit to a nudist colony. (The family is a subset of people at the nudist colony, who are in turn a subset of people in the world.)
- a. IX -arc-neutral NOT WEAR CLOTHES . 'They all (at the nudist colony) don't wear clothes.'
 - b. IX -arc-high WEAR CLOTHES . 'They all (people generally) wear clothes.'

We see, then, that the pronominal expression IX -arc has a use of height that involves information about set size, and we will argue that this is in fact the same use of height that we see in the quantifier domain restriction example that we started with in (3). How to account for this aspect of meaning in a pronoun is not entirely straightforward, however. As we alluded to earlier, there is some debate concerning the syntactic/semantic status of the indexical point and its plural marked form IX-arc. MacLaughlin (1997) argued that it can function pronominally as a definite determiner, while Koulidobrova & Lillo-Martin (2016) argue that it is always a demonstrative pronoun, and Irani (2016) has proposed that it is a strong definite article similar to that found in German (Schwarz 2009), presumably at least its pronominal form. Some of the difficulty in applying diagnostics of these different hypotheses from spoken languages to the case of IX in sign languages is that when one points, one necessarily points to something, either something present in the context (a deictic use) or, at least in sign languages, to an abstract locus (an anaphoric use), so it is difficult to disentangle the role of the locus from the role of the morpheme (although both Koulidobrova and Lillo-Martin and Irani attempt to do this by including examples of IX signed with a "neutral" locus - not just neutral in height but also in horizontal location). To make matters even more complicated, by pointing IX also assigns discourse referents to loci, so at least in this use it doesn't impose a familiarity requirement.

While each of these analyses capture important aspects of the semantics of IX, none seems to capture all of its uses that introduce referents, refer back anaphorically, refer deictically, and participate in binding relationships. In each case, though, there is at least some evidence that we want to analyze IX or noun phrases containing IX as introducing an individual, and so for now we suggest that IX is at least determinate in the sense of Coppock & Beaver (2015). The puzzle, then, is to understand how this expression of type *e* changes meaning when signed at different heights. We can focus on pronouns, since not all type *e* expressions combine with quantifiers: in (19),

contrast the use of a topicalized COMMITTEE with its use as the complement of a quantifier, which is impossible. It can only be interpreted as a plural (since number isn't marked on nouns in ASL).

- (19) a. COMMITTEE, NO WOMEN
"On the committee there were no women"
- b. *NO COMMITTEE ORDER SUSHI
"None of the [people on the] committee ordered sushi"
- c. NO COMMITTEE ORDER SUSHI
"No committees ordered sushi"

3 Verbs and height in ASL

In the previous section, we discussed a new use of height for plural pronouns in sign languages that reflects a set/superset relationship. In this section, we extend this observation to loci in certain classes of verbs in sign languages, which ultimately we will extend to quantifiers as well, the focus of our original example involving disambiguation of quantifier domains.

3.1 Background on directional verbs in sign languages

Like other sign languages, ASL is well known for having different morphological verb classes, some which change their form depending on their subject and object (call these "directional" verbs), and some which do not (called "plain" verbs) (Padden 2016). For example, plain verbs (e.g. LIKE) do not, and cannot, change their form for subject and object (20); this contrasts with directional verbs (e.g. INFORM) which do change their form depending on their subject and object (21).

- (20) a. (IX-1) LIKE (IX -arc) 'I like them'
b. * (IX-1) LIKE -arc-a 'I like them'
- (21) a. 1-INFORM -arc-a 'I inform them(plural)'
b. 1-INFORM -a 'I inform him/her/it/then(singular)'
c. A-INFORM -1 'He/she/it/they(singular) informs me'

The forms that these directional verbs take are closely related to the locus system. In fact, the sharing of features between pronouns and loci have lead many researchers

to talk about verb directionality as verb “agreement”, and to call these “agreeing verbs” (Neidle 2000, Sandler & Lillo-Martin 2006, Lillo-Martin & Meier 2011, among many others). However, there are also differences with verb agreement as seen in spoken languages, in ways that show even closer ties between the loci system and pronouns, and directionality. For example, just as pronouns IX and IX -arc can point to arbitrary loci (e.g. *a*, *b*, etc.) in anaphoric uses, as well as pick out referents from the real world in deictic uses (22), so can directional verbs (23).

(22) IX-1 LIKE IX -Mary(to the location of Mary in the scene) ‘I like Mary’

(23) a. 1-INFORM -Mary(to the location of Mary in the scene) ‘I inform Mary’

b. Mary-INFORM-1 ‘Mary informs me’

Schlenker et al. (2013) also note that their observations about “iconic variables” apply not only to loci as used in pronouns, but also to the use of loci in directional verbs as well. Their examples (24)-(25) (in their paper, example (64) illustrates a directional verb ASK moving toward/from especially high or low locations in space for referents that are unusually high or low. (They also use this to illustrate that this iconic use of height is not reflecting an inherent property of these referents because it changes depending on their configuration in what is being described, e.g. a really tall person hanging upside down will be signed especially low, not especially high.)

(24) TREE BRANCH, SEVERAL GIANT STAND -rep.

IX -a WANT IX -1 1-ASK -a^{high/medium/low}-rep.

‘Several giants were standing on a tree branch. One of them wanted me to ask him questions.

High locus rated: 6.5/7, *Medium* locus rated 3.5/7, *Low* locus rated 1/7.

(25) TREE BRANCH, SEVERAL GIANT HANG -rep.

IX -a WANT IX -1 1-ASK -a^{high/medium/low}-rep.

‘Several giants were hanging from a tree branch. One of them wanted me to ask him questions.

High locus rated: 1/7, *Medium* locus rated 3/7, *Low* locus rated 6.7/7.

Given the incorporation of deictic uses and iconic uses, an analysis as traditionally grammatical agreement seems suspect. As outlined most clearly by Nevins (2011), there are in fact many reasons to analyze this directionality as incorporated/cliticized pronouns instead of agreement. Among several properties that he notes strongly favor a pronominal clitic analysis of loci and directional verbs, we

note a few that we find most compelling. First, while subject agreement tends to be an all/none phenomenon across verbs within a language, subject clitics can be optional, which is the case in sign languages, with the directional and plane verb classes. Sign language directionality is also more likely to mark indirect objects over direct objects (Janis 1995), which happens in clitics in spoken language, while the opposite happens in spoken language agreement. Second, directionality is found in what seem to be infinitival/non-finite clauses in sign languages (Padden 2016), unexpected for agreement. Third, the deictic uses we mentioned above are found in clitics but not agreement. Fourth, number is dissociable from person marking (Mathur 2000), as in clitics but not typically agreement.

Given syntactic evidence for directionality as cliticized pronouns, we might ask, then, whether the use of height that we reported in plural pronouns involving domain size extends to verbs, the focus of our next section.

3.2 Verbs and the use of height for signaling domain

The use of height that we reported in pronouns in the previous section is indeed found in verbs. “Plain” verbs do not modify for height in this way (26), while “directional” verbs do (27).

- (26) a. *IX-1 LIKE -arc-a ‘I like them’
b. IX-1 LIKE IX -arc-a ‘I like them’
c. *IX-1 LIKE -arc-high ‘I like everyone’
d. IX-1 LIKE IX -arc-high ‘I like everyone’

- (27) a. 1-INFORM -arc-a ‘I inform them’
b. 1-INFORM -arc-high ‘I inform everyone’

On the one hand, this is somewhat surprising given that we’re not aware of any previous descriptions of this use of height to indicate set size used in directional verbs in sign languages. On the other hand, given discussion in the past subsection about the evidence in favor of a pronominal incorporation analysis of directionality, and if plural pronouns make use of height to indicate set size, then it is perhaps unsurprising that directional verbs would look like they are using height to indicate set size.

This use of height in verbs even shows the same semantic range as the use of height in pronouns and that we will see in quantifiers, including an indiscriminate interpretation (28).

- (28) a. 1-PICK-FROM ++-arc-high
'I pick indiscriminately (I could end up with anyone)'
b. 1-PICK-FROM ++-arc-neutral
'I pick from among this specified set'

Also, just as with pronouns, although we generally simplify and use two levels for illustration, it is also possible to have more than two levels. Consider (29).

- (29) Scenario: someone is talking about a bunch of fliers they've printed to advertise for an upcoming event:
PASS-OUT -neutral CLASS, HAVE LEFT.
PASS-OUT -mid CAMPUS, STILL HAVE LEFT .
PASS-OUT -high OTHER PEOPLE MY TOWN.
"I passed out (the flyers) to my classmates, but I had some left, so I passed some out (to people) on campus, but I still had some left, so I gave them out (to whoever I found) in town."



Finally, just as loci with neutral height are known to make available their locus for later anaphora, the same is true for "high" locations/high space, even ones that are only marked through this height modification on a verb. For example, the verb PICK-FROM was used by one signer in a story about an apocalyptic event, and he later went back to the same area of space used for the domain in that verb to refer to the people who were chosen, either from a specified group (31) or generally from the population (32).

- (31) LET-YOU-KNOW WORLD WILL DESTROYED. IX -high-right(thumb) GOVERNMENT HAVE SPECIAL BOAT READY. UNDERSTAND IX -high-right **1-PICK-FROM-neutral+++** LIMITED PEOPLE WHO FILE-ON ON BOAT IX-left. UNDERSTAND **IX-ARC-right-low** RESPONSIBLE WHAT-rq. POSS-low-right CLOTHES BAGS FOOD INCLUDE BRING FILE-ON-BOAT-right-to-left. UNDERSTAND GOVERNMENT PROVIDE BOAT THAT'S-ALL.

“I’ll tell you, the world is getting destroyed but the government has a special boat- they’re ready for it- and they choose people (from a previously determined set) who can go on it. The people who are chosen are responsible for bringing their own supplies. The government is just providing the boat.”

- (32) WORLD HAPPEN DESTROYED WOW. LET-YOU-KNOW GOVERNMENT HAVE SPECIAL BOAT READY FOR.
UNDERSTAND **IX-high-right PICK-FROM-high+++** PEOPLE WHO CAN FILE-ON -left.
UNDERSTAND **IX-ARC-right-high** RESPONSIBLE WHAT -rq.
POSS -mid-right #OWN -mid-right BAGS CLOTHES FOOD INCLUDE .
GOVERNMENT PROVIDE WHAT -rq BOAT THAT’S-ALL .

“The world is getting destroyed! (But) FYI, the government has a special boat- they’re ready for it- and they are choosing people (randomly, from everyone) who can go on it. The people who are chosen (a subset of everyone) are responsible for bringing their own supplies. The government just provides the boat.”



a. 1-PICK-FROM++-arc-low ... IX-arc-low



b. 1-PICK-FROM++-arc-high... IX-arc-high

We see then that directional verbs can also make use of vertical height to signal domain size of their argument. We find this especially nice evidence to add in favor of a cliticized pronoun on the verb, since we can provide a straightforward semantic analysis by simply using the same analysis given to pronouns. In fact, we are going to use the fact that pronouns and verbs that incorporate pronouns show this modification for height to argue that the height use on quantifiers is also coming from a pronoun in its restrictor, as a partitive-like construction. Before we do so, though, we will take the next section to note what kind of structures do not modify for height, even if we can give them a plausible meaning: these are precisely places where there is no cause to imagine a pronominal argument, such as other noun phrases.

3.3 Only structures that include pronominal arguments modify for height.

So far, it would be possible to argue that there is nothing special about pronouns for providing domain information in ASL: it seems that everything can change its height to signal consideration of larger or smaller sets. Perhaps, as one reader phrased an alternative hypothesis, "height signals set size more generally in ASL." This has been true so far in our discussion for quantifiers, IX itself, and directional verbs, at first a heterogeneous set which we argue is unified in allowing pronouns within their structure. However, we next discuss a case that does not allow a change in height to be interpreted as widened or restricted domains: noun phrases. As shown in (33), vertical height cannot combine with bare nouns with a felicitous domain interpretation (33a). We suspect this is not due to a phonological restriction on the noun sign itself: the word DOG is pronounced with one hand in neutral space, and can with marginal grammaticality be moved to high space to incorporate, for example, the location of a dog that might be high in terms of literal spatial location (on a roof, for example, versus a person on the ground)(33b). This latter, more iconic use of high space not only has a different interpretation, but involves different eye gaze behavior: it must be directed toward the sign DOG for the "literally high" interpretation. The iconic use contrasts with the high use of space for existential examples like SOMEONE, which do not allow eye gaze toward the high existential-why this contrasts with the universal is an open question but perhaps correlates with specificity, as in Barberà Altimira et al. (2012). All signers that we consulted indicated the complete unavailability of a widening domain interpretation for nouns like DOG with height. We find this especially interesting because there is a very plausible interpretation, namely the indiscriminate interpretation in (34), which can be expressed using the minimally different DOG SOMEONE -high 'some/any dog'.

- (33) Context: Talking about adopting a pet.
IX-1 WANT DOG -high.
- a. #'I want any/all dog(s).'
 - b. ?'I want the/a dog that is high (e.g. up on that roof).' (and only with eye gaze to DOG)
- (34) IX-1 WANT DOG SOMEONE -high.
'I want a dog (any kind of dog).'

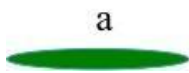
Under an analysis in which height is providing domain information via a pronoun, it should not be surprising that nouns cannot move higher for a widening interpretation, since the nouns here do not take pronouns as arguments. Verbs do take

pronouns as arguments, and they can inflect for height; nouns do not take pronouns as arguments and not surprisingly they cannot inflect for height. This indicates to us, then, that since quantifiers do allow changes in height of their form, they are also taking a pronoun as an argument, incorporating it via simultaneous morphology just like directional verbs. Thus, height is a property of pronouns that acts as arguments, and crucially height cannot appear in contexts that only allow modifiers. Given that directional verbs have been argued to involve pronoun incorporation, and that the only other categories in ASL that inflect for height are verbs and IX itself, if quantifiers take pronouns as arguments we should not be surprised that they, too, can use height in this way. We will investigate quantifiers in more depth in the next section.

4 Quantifiers and sign height in ASL

We turn finally to quantifiers, the source of our original observation that ASL disambiguates the size of the restrictor of a quantifier in a way that English does not. First, quantificational noun phrases are like other noun phrases in ASL in showing optionality of locus use: they may either be signed without using a locus (35) or they can be associated with a locus that functions as the domain of the quantifier (36) (Petronio 1995, Boster 1996, Barberà 2012a, 2012b). As with non-quantified noun phrases, the second option (let's call it a "Spatial QNP") is common in signed discourse and allows for unambiguous anaphora resolution, as in (36).

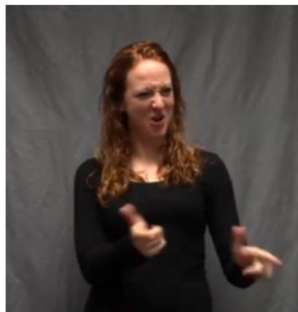
- (35) A-L-L/NONE/SOMEONE LIKE TEST
 'Everyone/No-one/someone likes tests/that test' *QNP without locus*

- (36) 
 (Context: I just mentioned that a group of my friends recently took the bar exam.)
 A-L-L -a/NONE -a/ONE -a FAIL . *Spatial QNP*
 'All/none/one of them (of the friends) failed.'
 IX -a MAD .
 'They (my friends) were mad'

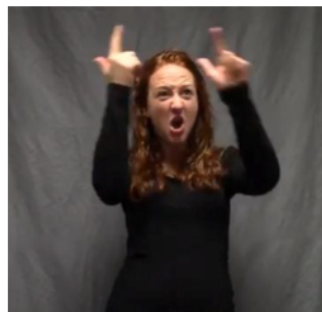
When it comes to the use of higher loci for domain restriction, recall that in Section 1 we discussed the puzzle with our example about friends watching a vampire movie ((2), repeated below as (37)). In English, the sentence "Everyone transformed into vampires" lacks a distinction that ASL makes regarding the size of the domain of

the universal quantifier: did just all of the friends turned into vampires, or everyone in the world? Is the domain for that universal quantifier more or less restricted? In ASL the same sentence ALL BECOME VAMPIRE can be signed in different ways to signal these smaller or larger domains. The only difference is in the spatial QNPs ((3), repeated below as (38)).

- (37) Last night I watched a movie with my friends about vampires. Afterwards I went to bed and I dreamt that everyone became vampires.
- a. Everyone in that story (your friends/the people in the context) became vampires
 - b. Everyone in the entire world became vampires
- (38) Context: Signer has just said, "Last night I watched a movie with my friends about vampires. Afterwards I went to bed and I dreamt that. . ."
- a. ALL -neutral BECOME VAMPIRE
'All of my friends became vampires'
 - b. ALL -high BECOME VAMPIRE
'All of the people in the world became vampires'



ALL-low
(of my friends)
(#in the world)



ALL-high
(#of my friends)
(in the world)

In (38), when ALL is signed at a lower/neutral height it is interpreted as having a different domain than when signed at a high height: in particular, the low ALL has a domain that is restricted to a set based on the context, namely whoever is in the group we have been talking about, even if that default restricted set has not yet been explicitly assigned a locus. It is as if the low/neutral height is always able to refer to the default pragmatically restricted set. (Recall that we noted the same use of the default height in (16) above with a pronoun.) When ALL is signed higher (at the level of the signer's head), it is interpreted as having a wider than default

domain, or even the widest possible. Note, importantly, that the signer's hands are not actually more spread apart or wider for the high case, so this is not merely a case of the use of space in horizontal planes for set-superset relationships, as in the "iconic geometry" discussed by Schlenker et al. (2013). The nonmanual/ facial expressions are also equally emphatic in both cases. Instead, the difference comes from her eyegaze, which is directed down (for low space) or up (for high space), and from IX-arc (directed down or up for low and high space respectively), and this is sufficient to convey a very different interpretation for the same string of words.

One of the most interesting things about this use of height is that this pattern holds not just for ALL, but also for a variety of different quantifiers. A second example illustrating this point is the negative quantifier NONE 'no one' (39).

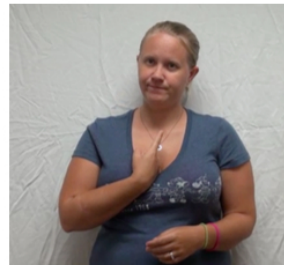
(39) Context: Discussion of whether anyone in signer's family is Deaf...

a. NONE -low ONLY-ONE

'None (of my immediate family), I'm the only one'



NONE-low



(I'm the) ONLY-ONE

'None (of my immediate family), only me'

b. NONE -high ONLY-ONE

'None, I'm the only one (not even, e.g. ancestors, distant relations)'



NONE-high



(I'm the) ONLY-ONE

'None, only me (not even, e.g. ancestors, distant relations)'

Note in (39) that even the "large" domain for high NONE is still pragmatically restricted in some sense, since here the high set "no one" can't apply to everyone in the entire world, since the signer is not the only Deaf person in the entire world. Rather, this would mean that she is the only Deaf person in her entire family, in

an unexpectedly broad sense, with more people to be included than in the default interpretation of family. Thus, it is not the case that the highest space necessarily means everyone possible, only that it is a contrastively larger domain than when signed lower. In other words, here we see explicitly that context still plays some role in pragmatic restriction even of the largest set, but the use of space allows for a set/superset distinction of default and expanded domains that isn't available in English. This is emphasized by the use of three levels, just as we saw for pronouns and in verbs in (40). In the actual production for (40) there is minimal difference between *mid* and *high* productions, but all signers consulted for this project had the intuition that they were targeting three different heights, and reported this, even when phonetic realization was close: they had the sense that the heights differ when the domains differ. The use of three levels rules out a simpler analysis of a binary distinction, such as the use of neutral height for the contextual salient domain and higher height for a single maximal or widened domain.

- (40) Scenario: lack of bananas first at store, then in town, then in whole country.
 NONE -neutral BANANAS.
 NONE -mid BANANAS .
 NONE -high BANANAS.
 "Today I went to the grocery store. There were no bananas in the store! I asked where the bananas were, and they said there were no bananas in the whole town! Then I went home and watched TV and saw that in the whole country there are no bananas!"



NONE-arc-neutral

...

NONE-arc-mid

...

NONE-arc-high

At this point, we've seen a similar use of height in a pronoun and in two different quantifiers, *ALL* and *NONE* . Recall that domain restriction in spoken languages participates in quantificational binding relationships, as in (4) above ("Usually when I do this, I dream that everyone becomes vampires."), suggesting that there is an open contextual variable as part of the syntax/semantics of the utterance, and posing problems for a simple ellipsis account for domain restriction in English. Example (41) shows a similar example in ASL with *NONE* , which can be signed either low or high. Despite this variation in size of contextual restriction (high or low),

nevertheless the adverb TYPICALLY/TEND quantifies over these contexts, such that the people in the restricted group (when NONE is signed low) may be different in each case, but still, none of them fail. We can see then that the location of these high and low domains are not just referential and bound to a particular domain, but must involve a domain variable that can be bound by quantificational adverbs.

- (41) Context: Signer is discussing the numerous tests that he gives out.
TYPICALLY NONE -low/high FAIL .
'Typically/most times none (in the group/at all) fail.'

A third quantifier to show a similar use of height is the existential quantifier SOMEONE 'someone'/'something' (42). Similar to ALL and NONE, SOMEONE is interpreted as ranging over a restricted domain when signed low, but a much wider domain when signed high.

- (42) Context: Deciding condiments to put out at a party. Host says:
- a. TYPICALLY SOMEONE -neutral LIKE MUSTARD .
'Usually there is someone who likes mustard.' (may be a different person for different parties)
 - b. TYPICALLY SOMEONE -high LIKE MUSTARD .
'Usually there is someone (in the world) who likes mustard.' (easily made true, person doesn't have to be at a party)



SOMEONE-low

SOMEONE-high

Example (42) also involves the quantificational adverb TYPICALLY scoping over the situations described with the result that the domain varies with the adverb. Here, the individual who satisfies (42a) (the "someone" who likes mustard) can vary from party to party - it doesn't have to be the same person at every party. In addition, there is another specific reading of (42a) in which SOMEONE -low is interpreted with widest scope, such that the same person at each party likes mustard. In fact,

Barberà (2012) shows that when the existential quantifier SOMEONE in Catalan Sign Language (LSC) is signed low, it can receive a specific reading, and she argues that specificity is the key notion separating the lower from higher planes. While it is true that specificity correlates with height, we argue at least for ASL that by viewing this as contextual restriction, we better capture the similarity with other quantifiers like ALL and NONE. Furthermore, if we follow the view suggested by Schwarzschild (2002) of specificity as extreme domain restriction, we predict that a low SOMEONE should be able to be interpreted as specific, which is exactly what Barberà (2012) reports for LSC and what we find to be the case for ASL.

Finally, the interpretation of height for existential quantification as also involving a wider domain helps clarify that it is not merely a strengthening of truth conditions. Since both negative and universal quantification are downward-monotonic in their first argument, in those cases if height is primarily used to strengthen an utterance, then we would expect the restrictor to be interpreted as a larger set for purposes of imposing stronger truth conditions. However, under an analysis of height as a type of intensifier, we would expect different behavior with existential quantification, where a smaller restrictor set leads to stronger truth conditions. Instead, we see that height is still used to signal a larger set size, with weaker truth conditions. We can conclude that height is contributing something about the set size itself, and not just changing the strength of the utterance.

4.1 Quantifiers that can't move for phonological reasons

So far, we have seen pronouns make use of height for set restriction, as well as verbs that incorporate pronouns, and in the last section quantifiers, too. We have suggested that the height is also incorporated via a pronoun in the case of quantifiers, looking at three different quantifiers: ALL, NONE, and SOMEONE (45a). An important additional piece of evidence to support this analysis comes from certain quantifiers that cannot be moved in space for phonological reasons. In particular, a separate set of quantifiers (EACH, MOST, FEW, ALL-B) all have phonological specifications (e.g. a specific location in their phonological form, an internal movement to the sign, or a dominant hand acting on a non-dominant hand) which make moving the quantifier in space phonologically difficult and/or relatively ill-formed. These reasons are unrelated to their meaning, seen clearly in the contrasting pair ALL/A-L-L (fingerspelling and moved in space) and ALL-B in (45) which have roughly the same lexical semantics, as far as we can tell. What is relevant for our purposes is that all of these quantifiers (EACH, MOST, FEW, ALL-B) do allow the addition of domain information via height, but do so sequentially with the quantifier followed by a pronoun IX that uses height (45b).

Domain restriction in ASL

- (43) Context: 'My family goes to the beach every year.'
- ALL -high/NONE -high/SOMEONE -high SICK .
'All/none/one (of all of the people) were sick.'
 - EACH/MOST/FEW/ALL-B IX -arc-high SICK .
'Each/most/all (of all of the people) were sick.'



ALL/A-L-L

ALL-B

Let's consider in more detail the case of FEW (44). The signer begins with the same context 'My family goes to the beach every year', without establishing any locus for either the family or the beach (both signed in neutral space). She can continue with (44a), signing FEW followed by IX -arc (one-handed in the figure) located in lower neutral space, with the interpretation that a few of the people already available in the context in a restricted sense ('my family') got sick. Alternatively, she could continue the context with (44b), signing FEW followed by IX -arc in higher space, with the interpretation that a few people from among a wider group than one might have originally guessed (e.g. not just her family, but all of the people at the beach) got sick.

- (44) Context: 'My family goes to the beach every year.'
- FEW IX -arc-low FEEL HIT SICK
'A few of them (my family) got sick. '
 - FEW IX -arc-high FEEL HIT SICK
'A few of (all) the people at the beach got sick. '



FEW IX-arc-low



FEW IX-arc-high

This use of IX in the same way following the quantifier provides further evidence, then, that spatially modified QNPs may involve a simultaneous pronunciation of quantifier and the following IX -arc pronominal. They also illustrate that the height is connected to the pronoun and not the quantifier, since in cases above when the two are separate, the pronoun is marked for height. Even in sentences with quantifiers that do allow spatial modification for height, it's dispreferred by signers to have height on a spatially modified quantifier followed by a pronoun (of any sort, high or not).

(45) Context: 'My family goes to the beach every year.'

- a. ALL -high/NONE -high/SOMEONE -high IX -arc-high SICK .
- b. ALL -high/NONE -high/SOMEONE -high IX -arc-neutral SICK .
'All/none/one (of all of the people) were sick.'



ALL/A-L-L

ALL-B

We also note at this point that despite the difference in height modifications for two classes of quantifiers in terms of pronunciation (some simultaneous with the pronoun, some sequential), there is surprising homogeneity among the quantifiers in combining with pronouns that widen and restrict domains with height. We contrast this with work on "weak quantifiers" (*some, two, many*) that have been argued to not be determiners, but rather noun phrase modifiers, argued by Etxeberria & Giannakidou (2014) to not combine with a domain variable, in contrast to "strong quantifiers" (*none, every*) that undergo contextual domain restriction. Our data from ASL suggest that all spatial QNPs can be modified for domains (46).

(46) Context: Discussing an exam.

- a. NONE -high/[EACH IX -arc-high] FAIL .
'None/each (of everyone) failed.'
- b. ONE -high/TWO -high/[MANY IX -arc-high] FAIL .
'Someone(or other), two (we're not sure who), many (we're not sure who) failed'

The ‘wide domain’ from height in these weak quantifiers often leads naturally to indiscriminate readings (“some or other, doesn’t matter who” Horn 2000). Free choice and/or indiscriminate readings are not traditionally considered domain “restriction” (in fact, they seem to be quite unrestricted, hence the highest height), but in the phenomenon we are discussing here they arise as opposite ends of the same spectrum: higher in space indicates a larger than expected domain, and lower in space is a more narrowly defined domain. Both occur through precisely the same structural configuration: the use of vertical height for placing loci that provide domain information. That is, while English uses a morphological alternation some/any for domain widening and a covert variable for domain restriction, spatial QNPs in ASL use the same process for both, whether simultaneous or sequential.

5 Modeling the use of height for domain size

So far, we have seen the use of height for marking set size in pronouns, directional verbs, and quantifiers. We argued that the use of height in verbs and in quantifiers falls out from this use of height in pronouns, since they include pronominal arguments (in the case of verbs as basic arguments, in the case of quantifiers as partitive-like restrictor clauses). These contrasted with the use of height on noun phrases which did not have any reason for us to suspect that they include a pronoun inside and do not allow this type of modification for height. However, we still have not discussed precisely how this use of height contributes domain information in quantified noun phrases and verbs via these pronouns, which is what we focus on in the present section.

5.1 Height via presupposition

To begin, we remind ourselves that the meaning of referential pronouns is highly contextually dependent in spoken language. The English examples in (47) display an array of ways that pronouns are resolved. For example, in (47a) the pronoun *they* is easily understood to be the man and the woman who are being watched, even though this hasn’t been made explicit in preceding discourse. Sentence (47b) has various interpretations in which either *they* could refer to a number of other things (e.g. attendees at a meeting waiting for the man and woman), but in context is most easily resolved to the couple in view. In (47c), masculine gender marking on the subject pronoun resolves the referent of the pronoun to the man, not the woman. In (47d), one can simultaneously point to the man while pronouncing *he* in order to make sure that the listener is picking out the intended reference. What we see is that pronouns are known to be highly dependent on context for their reference while also

marking features that help distinguish from among possible referents (e.g. gender marking, deixis/pointing).

- (47) Context: Two friends are sitting inside, looking outside through a window, where they watch a man and woman who appear to be lost.
- a. **They** must be from out of town.
 - b. Do you think **they** know where **they** are?
 - c. **He** looks very lost.
 - d. **He (pointing to the man)** should watch out.

In ASL, pronouns are unmarked for gender; nevertheless, they have been analyzed as encoding features for similar purposes of pronoun disambiguation. It has long been known that while pronouns can use an arbitrary locus system, they can also make use of a gestural system such that pointing with IX or IX -arc to a present singular or plural (respectively) individual picks out whoever has been pointing to (discussed earlier in section 2). In other words, IX has both anaphoric and deictic uses, and in either case reference resolution depends on a number of pragmatic factors. More recently in their work on iconic variables that we discussed above, Schlenker et al. (2013) discuss the case of iconic height even in anaphoric uses of IX, in which IX can be used to point to high or low abstract loci to indicate actually high or low referents, such as people up on a house or tall basketball players (high)(48) or people low on the ground or short people (low) (see (49), taken as example (26) from Schlenker et al. 2013). This same use of height can also be used to indicate an honorific hierarchy, in which honorable entities (e.g. gods, bosses) are placed high in space and inferiors (e.g. subordinates at a job) are placed low in space (48-49).

- (48) Actual height:
 POSS-1 YOUNG BROTHER WANT IX-1 REST. IX-1 UNDERSTAND IX -a-high.
 'My younger brother wants me to rest. I understand him.'
Interlocutor infers: the speaker's younger brother is tall.
 (This is unlikely to receive honorific reading because the brother is younger.)

- (49) Honorific height:
 POSS-1 BROTHER WANT IX-1 REST. IX-1 UNDERSTAND IX -a-high.
 'My brother wants me to rest. I understand him.'
Interlocutor infers: the speaker's brother is older and/or more venerable.
 (This can also receive the "tall" reading, but the point is that it need not be actual height)

In their semantic implementation, Schlenker et al. analogize both uses of height to gender marking in English by incorporating this information via a presupposition, since in contexts such as the scope of negation (50)-(51) and in the antecedent of conditionals, both gender marking (English) and iconic and honorable height (ASL) are still interpreted as attached to the pronoun- they project through presuppositional "holes".

(50) I don't understand him.

Inference: the person referred to is male.

(51) a. Negation with actual height:

POSS-1 YOUNG BROTHER WANT IX-1 REST. IX-1 NOT UNDERSTAND IX -a-high.

'My younger brother wants me to rest. I don't understand him.'

Interlocutor infers: the speaker's younger brother is tall.

(Unlikely to receive honorific reading because the brother is younger)

b. Negation with honorific height:

POSS-1 BROTHER WANT IX-1 REST. IX-1 NOT UNDERSTAND IX -a-high.

'My brother wants me to rest. I don't understand him.'

Interlocutor infers: the speaker's brother is older and/or more venerable.

(This can also receive the "tall" reading, but the point is that it need not be actual height)

We want to be clear that the use of height we have been discussing in the rest of this paper is not simply an extension or special case of these "iconic" uses of height that Schlenker et al. (2013). For one thing, big groups mentioned in our high space need not be in any way made of tall referents or in a high location. We have, in fact, given many examples in which the low versions are proper subsets of the high versions, so it is clear that there is no difference in literal height or in honorability of the members that make up the reference set. The use of height for larger sets is more abstract, a collective property of relative set sizes and not a distributive property of the individuals in these sets. Nevertheless, we suggest that height restricts the context in a similar way in the grammar in the form of a presupposition, since it projects through logical operators like negation, seen above with negative quantifiers, and conditionals (52).

(52) a. (IF/SUPPOSE) ALL -low TRANSFORM-INTO VAMPIRE, MUST RUN .

'If everyone (here/that we were expecting) transforms into vampires, we should run.'

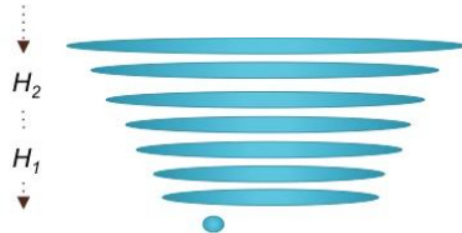
- b. (IF/SUPPOSE) ALL -high TRANSFORM-INTO VAMPIRE, MUST RUN .
'If everyone (in the world) transforms into vampires, we should run.'

We think that viewing this use of height as presuppositional has an advantage not only in correctly predicting the sustained interpretation of height in standard presuppositional holes, but also signers' intuitions about height. Just as it is pragmatically inappropriate to use "he" when pointing to an individual categorized by the relevant parties as female in English, or high space with a singular IX when the referent is short in ASL, it is similarly pragmatically inappropriate to use high space for a set that is a subset of a set that was referenced in a lower signing space. In a typological landscape of presuppositions, this content does not require strong contextual felicity (Tonhauser et al. 2013), i.e, it can be used "out of the blue", as we've also seen above, but otherwise shares at least these two properties with other not-at-issue content, and all of these properties with other uses of height as presuppositions in ASL.

5.2 A generalization about relative set size

How does this presuppositional use of height work? We suggest that it is triggered by the use of a non-default height by a pronoun, either a stand-alone pronoun or a pronoun incorporated into a quantifier or a verb. Moreover, we want the following generalization to hold (53).

- (53) Generalization: The height of a quantifier in ASL indicates the relative size of its domain

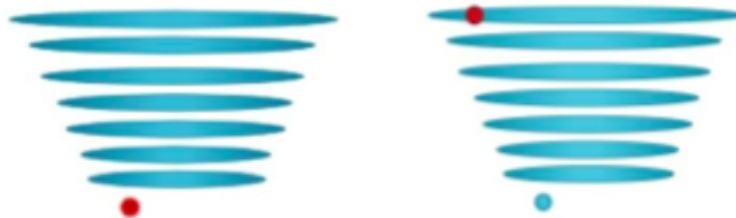


Let H_n be loci in signing space, and $<_v$ a "vertical" ordering relation among loci: for any H_j and H_k , if H_k is physically higher in signing space in the vertical plane (toward the signer's head) than H_j , then $H_j <_v H_k$. In our transcriptions in the examples in this paper, we often use "HIGH" and NEUTRAL" to stand for two heights H where $H_{NEUTRAL} < H_{HIGH}$. The ordering corresponds to the subset relation: Let $S \subset U$ be a set signed in locus H_j , and $S' \subset U$ be a set signed in locus H_k . If $H_j <_v H_k$, then $S \subset S'$.

Our generalization is captured in terms of subsets and supersets, which we argue is the correct relationship expressed by height. We saw earlier (39) that high

space can be used easily even if not everyone in the universe is included in the domain. Conversely, even if something would be considered relatively numerous in the given context but is not a superset of the contextually supplied group of salient individuals, then it isn't expressed using high space. For example, ten spouses might be considered an unusually high number of spouses for an individual to have, but nevertheless all of our consultants judge it to be impossible for high space to be used to discuss this relatively small group. Despite being "unexpectedly large", it is not a larger superset of some contextually default set. (A high use of space could instead have an honorific or tall interpretation for seven spouses as in the use of height discussed by Schlenker et al. (2013), but not a "superset" interpretation).

Most of the examples so far in this paper have involved a single height ordering, but it is also possible to use separate height orderings based on different loci. Recall that left and right sides of the signers' sign space can be associated with separate discourse loci. Now consider example (54), in which two countries (France and England) are associated with the left and right side of the signer's space, respectively.



(54)

WAR -left-right, FRANCE -right, ENGLAND -left, GENERAL IX -left-low,
 SOMEONE -right-high SHOOT -right-high-toward-left-low
 'In a war between France and England, an English general was shot by an
 unknown French assassin.'

In this example, the General (a specific member of the group in the left space, England) is placed in low left space (as the red dot on the left in the diagram above), while the shooter (a nonspecific individual, thus chosen from the widest group in the right space, France) is placed in high right space (the red dot on the right in the diagram above). In addition, SHOOT is a directional verb, changing its form depending on its subject and object arguments. In this example, its direction is oriented such that the right high space of the subject (the shooter) is the source and the left low space of the object (the general) is the goal, further establishing these loci as left/low and right/high. More generally, this type of arrangement of loci further illustrates that the ordering of domain sizes need not be absolute even within a local dialogue, but is simply relative for any two loci ordered by height (even differently in the left and right sides of space).

5.3 Composition

As we mentioned above, Schlenker et al. (2013) implement an analysis of gestural/iconic height in ASL and LSF (e.g. for tall individuals) that involves presuppositions on the height of loci. It implements presuppositions under the assumption that loci are indices (Lillo-Martin et al. 1990), and using contextual variables, for which evidence may not be as strong as previously assumed in ASL (Davidson 2015). Nevertheless, in an effort to make our work as compatible as possible to build a theory of presuppositions on non-neutral loci in ASL, we start directly from their analysis of the use of high loci in ASL for tall individuals, which we repeat here in (55) (their example (45)).

- (55) Let c be a context of speech, s an assignment function and w a world (with c_a = the author of c ; c_w = the world of c). If i is a locus, n is a locus with neutral height, $>$ is the natural height ordering among loci, and $>_c$ is an ordering (given by the context c) of objects according to their heights in c_w ,
- a. If $i > n$, $[[IX - i]]^{c,s,w} = \#$ iff $s(i) = \#$ or it is not the case that $s(i) >_c c_a$ in c_w . If $[[IX - i]]^{c,s,w} \neq \#$, $[[IX - i]]^{c,s,w} = s(i)$.
 - b. If $n > i$, $[[IX - i]]^{c,s,w} = \#$ iff $s(i) = \#$ or it is not the case that $c_a >_c s(i)$ in c_w . If $[[IX - i]]^{c,s,w} \neq \#$, $[[IX - i]]^{c,s,w} = s(i)$.

In other words, if IX is associated with a locus that is above neutral height, it must be the case that it picks out a referent which is taller than the signer, otherwise it results in presupposition failure (55a). Similarly, if IX is associated with a locus that is below neutral height, it must be the case that it picks out a referent that is less tall than the author, otherwise it results in presupposition failure (55b). We also note that the in the final analysis by Schlenker et al. (2013) of iconic height, they used a presuppositional notion that involved actual/absolute distance measures between loci, but in our case we only need to implement something like this more conservative notion for relative heights. To extend this notion to the set widening use of loci that we have been discussing, we propose the following extension to presuppositions on loci in ASL, which include a component for plurality (marked morphologically as -arc movement) and for comparison of set magnitude (56).

- (56) Let c be a context of speech, s an assignment function and w a world, with c_w = the world of c and $c_{D(plural)}$ the domain of all plural individuals in the context.

If j and k are loci, n is a locus with neutral height, $>$ is the natural height ordering among loci, and $>_i$ is the partial ordering of sums by the individual part relation (Link 83), then:

- a. $[[IX - ARC - j]]^{c,s,w} = \#$ iff $s(j) = \#$ or $s(j) \notin c_{D(plural)}$.
If $[[IX - ARC - j]]^{c,s,w} \neq \#$, $[[IX - ARC - j]]^{c,s,w} = s(j)$.
- b. If $j > n$, $[[IX - ARC - j]]^{c,s,w} = \#$ iff $s(j) = \#$ or it is not the case that for all $x \in c_{D(plural)}$, $s(j) >_i x$.

In other words, if the pronoun IX is marked for plurality, then it must be the case that it picks out a referent from the domain of plural individuals, otherwise it results in a presupposition failure. Furthermore, if a plural marked IX (IX -arc) is signed higher than non-neutral height, then it must be the case that for all elements of the domain of plural individuals in the context, they are in the individual-part relation (are a proper part of) the plural individual picked out by the marked height. We note that there is no "lower than" corollary in our case, since there is no case we are certain of yet that involves lower-than-neutral loci being used for subsets of sets in default height. (In such cases, typically subsets within the horizontal plane are used, as in (14).)

Returning to our original example of height in quantification ((3), repeated as (57)), the composition proceeds as in (58): IX -arc_a contributes a plural pronoun, and this is a syntactic argument of the universal quantifier, with a semantics of universal quantifier from Matthewson (2001) and the form resulting in incorporation (simultaneous pronunciation). This quantificational DP is then followed by the (here, simplified) predicate *become a vampire*. Example (57) illustrates the same for the higher height, which carries with it the presupposition that it should be larger than the default context.

(57) Context: Signer has just said, "Last night I watched a movie with my friends about vampires. Afterwards I went to bed and I dreamt that... "

- a. ALL -low/neutral BECOME VAMPIRE
'All of my friends became vampires'
- b. ALL -high BECOME VAMPIRE
'All of the people in the world became vampires'

- (58) a. ALL : $\lambda x \in c_{D(plural)} \lambda f (\forall y <_i x [atom(y) \rightarrow f(y) = 1])$
 b. BECOME VAMPIRES : $\lambda x.x$ becomes a vampire
 c. IX -arc-a: $[[x]]^{c,s,w} = s(a)$

- d. ALL -low / ALL IX -arc-a(low/neutral) : $\lambda f(\forall y <_i s(a)[atom(y) \rightarrow f(y) = 1])$
- e. ALL -low BECOME VAMPIRE : $\forall y <_i s(a)[atom(y) \rightarrow y \text{ becomes a vampire}]$
 'Every atomic member of the plural picked out by the arc (here, the friends who watched the movie), transformed into vampires.

In other words, we compare the same sentence where the quantifier ALL is associated with two different loci a and b . In one, the locus (a) is at a neutral height, and in the other the locus (b) is at a higher than neutral height. In the case of the first there are no additional requirements beyond the pragmatic mechanisms that associate the locus (a) to the most available plural individual at that point in the discourse (the friends who watched the movie). In the case of (b) all of the same applies, except that this must resolve to a superset of the default domain (a), and in this case the only contextually available superset is everyone in the world. This puts a pronoun into the structure even though it is not overtly pronounced for some pronouns, as we have argued should be the case. It also provides the flexibility of multiple loci, as in (54).

5.4 An alternative quantificational analysis of height and/or IX?

So far, we have argued that domain size information enters quantificational noun phrases through a presupposition on height of IX, and we have been assuming an analysis of IX based on the previous literature that treats it as pronominal, arguably always a demonstrative pronoun. However, the kind of inferences that arise in our high version of IX here are similar to those seen in other well known lexical items that also carry a universal free choice inference, like English *any* or Italian *qualsiasi* (Chierchia 2013). Here we ask whether IX, combined or not with height marking, is instead itself quantificational, and conclude that this is untenable.

First, recall our earlier examples of failed height on noun phrases, repeated here at (59)-(60). If height, or the combination of IX plus height, is quantificational, it should be possible to combine it with a noun, as attempted in (59) ('some dog', 'any dog', 'all dogs'), but this is impossible, and instead a lexical quantifier (60) must be used.

- (59) Context: Talking about adopting a pet.
 IX-1 WANT DOG -high.
- a. #'I want any/all dog(s).'
- b. ?'I want the/a dog that is high (e.g. up on that roof).' [and only with eyegaze to DOG]

- (60) IX-1 WANT DOG SOME(ONE) -high.
'I want a dog (any kind of dog).'

Second, universal quantification clearly does make use of height in this way, but when it does it has a different meaning from IX alone. We saw this earlier, repeated below as (61), where actual universal quantifiers EACH and ALL-B are followed by IX, and they are not redundant, and other quantifiers with very different meanings (MOST, FEW) can also be followed with IX.

- (61) Context: 'My family goes to the beach every year.'
EACH/MOST/FEW/ALL-B IX -arc-high SICK .
'Each/most/all (of all of the people) were sick.'

Finally, if height provides quantification on its own somehow independently of IX, we might expect to see other instances of quantification over situations/times, etc. (i.e. A(dverbial)-quantifiers). At first blush, we see that in some cases both ALWAYS and NEVER can be signed bigger and higher when intended to apply to even more situations (62)-(63), similar in this way to the kind of quantifiers over individuals that we started with (D-quantifiers). (The existential version, SOMETIMES, is restricted in movement due to phonological reasons.)

- (62) a. IX-1 ALWAYS -low+small HUNGRY .
I'm always hungry (in the usual situations).
b. IX-1 ALWAYS -high+big HUNGRY .
I'm always hungry, all of the time!
- (63) a. IX-1 NEVER -low+small HUNGRY .
I'm never hungry (in the usual situations).
b. IX-1 NEVER -high+big HUNGRY .
I'm never hungry, ever!

However, in each case height cannot be used alone to signal domain size, but rather is accompanied by a wider sign in general. For example, ALWAYS can't be signed high and small, like A-L-L, which can signal large set size through height alone. We hypothesize that this use of height in (62)-(63) is instead merely emphatic: in general in ASL, signing outside of the expected low/neutral space is taken to be emphatic similar to increased intonational contour in English, and typically is accompanied by bigger movements in general (like those in (62)-(63)). The effect is similar to focusing the adverbs *always* or *never* in the English translations of

(62)-(63), in which focus would likely mean an unexpectedly larger set of situations, but could also be emphatic for some other reasons (e.g. contrastive focus with a previous utterance). A further dissimilarity between height in (62)-(63) and height in the D-quantifiers in the rest of the paper is that there are no cases of adverbs followed by IX -arc, and seemingly no use of IX -arc signed high to mean that something happens in a lot of situations (or, conversely, low to mean occurring in restricted contexts). There are also no plural pronouns that seem to be able to be used for situations, as there are for individuals. Thus, despite some surface similarity, the system of grammaticalized height via pronouns found in D-quantifiers is absent in A-quantifiers.

We suggest that one motivated reason that the use of height seen in individuals does not extend in the same way to times or situations is that there is a reliance on the metaphor MORE IS UP that is more generally restricted to individuals, which then restricts its usage in this way, too. For example, consider even in English: we do not use height as a metaphor for increased time passing, instead using a left-to-right configuration, or back-to-front, to mark the passage of time (Cooperrider & Núñez 2009, Núñez & Cooperrider 2013). It seems that "more" time, then, is not metaphorically represented as "up", and Meir (2010) showed in a separate set of phenomena that metaphors regularly constrain lexicalizations in ASL. Thus, although this is certainly an area that deserves more space than we can devote to it in this paper, we think that it could be a fruitful area for investigating the relationship between sign and gesture further given the dissociation we see so far between individuals and times and/or situations.

6 Comparison across languages

6.1 Contrast with the use of height to mark contextual restriction in spoken language

Although English doesn't initially appear to do what ASL does for marking domain sizes, many English speakers confronted with the above data about ASL quantifier height who do not otherwise know ASL have remarked that they find this use of height intuitive. They are supported in this by some data from the Embodied Cognition literature, which has argued that English speakers associate the concept of "more" with "high" in a variety of ways. For example, Langston (2002) reports that while reading English sentences, participants show increased processing difficulties when height and amount fail to correlate, as in (64a). Such mismatches were found to be more difficult to read than an example where they do correlate (64b).

- (64) a. Pepsi has more calories than Coke so we put it below Coke on the shelf.
(incongruent)
- b. Pepsi has more calories than Coke so we put it above Coke on the shelf.
(congruent)

In addition, Sell & Kaschak (2012) found that when people read sentences that involved discussion of "more" quantities (e.g. "The Yankees scored more runs") and had to press an "up" button to move to the next sentence they performed the task faster than when height and amount did not correlate. For example, they were slower if they had to press the "down" button in a "more" scenario to go on to the next sentence. These kinds of studies provide some evidence that English-speaking nonsigners do have some association, at least in processing, between the concepts of "more" and "high," discussed by Lakoff & Johnson (1980) as the metaphor MORE IS UP. Those authors note that this metaphor could be motivated by certain physical examples such as the pouring of liquid into a container, where more liquid reaches a higher level, followed by extrapolation to a wider variety of cases for which this physical relationship no longer exists. Of course, formal semanticists use this very metaphor every time they discuss upward and downward entailment, which refers to abstract superset/subset relationships, and not actual height. It is a natural question to ask, then, whether English speakers use height in precisely this way to represent information about contextual restriction like ASL does, perhaps concurrently with our speech either in our intonation or with co-speech gestures.

To address this question, we first considered intonation, and found some similarities but ultimately also important differences between higher intonational pitches in English and higher sign space in ASL. First, intonation contours with extreme high points can be used to bring attention to things in English, and sometimes this means "more"/larger context under consideration, but many times it does not. For example, consider (65), where both sentences in English have high pitch on the capitalized word. In (65a) our intuition is that high pitch does bias the interpretation toward an exceptionally large or unexpectedly wider context. However, this requirement seems to be able to be overridden by surrounding context without a loss of grammaticality (by following with an explanation that it was just one's friends), while this is impossible in ASL. Another contrast is that while at least there is the possibility of doing this to quantifiers in English, the option of adding high pitch to a pronoun to bias it to be a wider domain is entirely out in English. For example, (65b) can never mean that everyone in the world transformed into vampires. In English, the pronoun THEY requires an antecedent, and here the only option is the friends, so the high intonation signals something like surprise or unexpectedness, not a wider domain, whereas this is perfectly grammatical in ASL (see (16) above and especially (17) below).

- (65) a. Last night my friends and I watched a movie about vampires and later I dreamed that EVERYONE transformed into vampires!
- b. Last night my friends and I watched a movie about vampires and later I dreamt that THEY transformed into vampires!

If not intonation, one might wonder whether a similar connection between height and set size may also occur in the gestures of some English speakers (who do not know ASL). Preliminary results suggest that they might, although it may not be able to be dissociated from wider gestures in horizontal space in the same way as it can be dissociated in ASL (Durkin et al. 2016). Whether and how related gestures compare to the use of height in the wide variety of grammatically integrated circumstances that it is found in ASL is still an open question.

6.2 The source of height in other sign languages

Going forward, we can also ask whether other sign languages show the same pattern as ASL. Preliminary data suggest that at least some other sign languages have similar uses. Example (66) is a spontaneously occurring example from Japanese Sign Language in which a native signer used the following set of three contrastive sentences, starting low (reported as "@ chest") for his class, moving to a mid level (reported as "@cheek") for his school, and a high level (reported as "@forehead") for the entire prefecture. Example (67), which we elicited in Nicaragua, shows the quantifier TODO ('all') in Nicaraguan Sign Language used with the same form but differing only in height, low in one context where it was clear that he was referring to the pragmatically restricted context (all of his friends turning into zombies, analogous to our vampire example), and high in another context where he was referring to a widened context (everyone in the world turning into zombies).

(66) Glosses of Japanese Sign Language:

- a. CLASSMATE DEAF-FAMILY NONE (@chest) SELF FINISH
'There is/was nobody from a deaf family in my class. Just me.'
- b. SCHOOL DEAF-FAMILY NONE (@cheek) SELF FINISH
'There is/was nobody from a deaf family in my school. Just me.'
- c. WAKAYAMA DEAF-FAMILY NONE (@forehead) SELF FINISH
'There is/was nobody from a deaf family in (the prefecture of) Wakayama. Just me.'

(67) Glosses of Nicaraguan Sign Language:



ALL [of us here]

ALL [of us here in Nicaragua]

We take this to suggest much more interesting work to be done with and within those sign language communities to understand whether the use of height we report here for ASL is an area of cross-semantic variation, or is drawing on more universal cognitive tendencies. In our opinion, either would be an interesting finding, and moreover, could potentially be connected to more or less general use of a metaphor equivalent to MORE IS UP in English in each culture. We leave this for future research.

7 Conclusions

In this paper we started with the observation that in American Sign Language, the use of vertical height in signing space has the effect of providing domain restriction information for quantifiers, seeming to make a distinction that English lacks. We compared possible analyses of quantifier domain restriction and morphosyntactic analyses of quantified noun phrases across languages, to consider whether ASL fits these patterns. We then argued that despite first impressions as an overt manifestation of a contextual domain variable for quantifiers, in ASL the use of height extends to all, and only, the phenomena that make use of the abstract locus system equivalent to pronouns. This includes overt pronouns themselves, quantifiers, and directional verbs. This led us to a compositional analysis of height via a presupposition attached to non-default height pronouns, whether stand alone pronouns or incorporated with quantifiers or verbs. In some sense this mirrors other presuppositions accompanying the use of non-default height with pronouns in ASL, in iconic or honorific uses. However, it expands this notion in two ways, extending it to plurals and also to a more abstract notion of set membership via height.

Several open questions remain. First, what is the nature of this use of height in other sign languages (cross-linguistically/typologically). Second, is this related to the use of height in metaphor in the surrounding culture in the United States,

and possibly extending to other cultures? Is there a general cognitive tendency for this mapping? And at the level of composition, our data lend further evidence to the increasing understanding that the nature of plural loci, quantification, and verbs is incredibly rich. We hope that this spurs new work not just on quantificational domains in sign languages, but also the relationship between sign and gesture and how the semantic and pragmatic components should divide the work of each, an area that we were only able to touch upon briefly but we think is especially promising given the potential insight to inform even classic problems in semantics/pragmatics such as quantifier domain restriction.

References

- Bach, Kent. 1997. The semantics-pragmatics distinction: What it is and why it matters. In *Pragmatik*, 33–50. Springer.
- Barberà, Gemma. 2012. A unified account of specificity in catalan sign language (lsc). In *Proceedings of sinn und bedeutung*, vol. 16, 43–55.
- Barberà Altimira, Gemma et al. 2012. The meaning of space in catalan sign language (lsc). reference, specificity and structure in signed discourse .
- Barwise, Jon & Robin Cooper. 1981. Generalized quantifiers and natural language. In *Philosophy, language, and artificial intelligence*, 241–301. Springer.
- Bošković, Željko. 2005. On the locality of left branch extraction and the structure of np. *Studia linguistica* 59(1). 1–45.
- Boster, Carole T. 1996. On the quantifier-noun phrase split in american sign language and the structure of quantified noun phrases. *International review of sign linguistics* 1(1). 159–208.
- Caponigro, Ivano & Kathryn Davidson. 2011. Ask, and tell as well: question–answer clauses in american sign language. *Natural language semantics* 19(4). 323–371.
- Chierchia, Gennaro. 2013. *Logic in grammar: Polarity, free choice, and intervention*. OUP Oxford.
- Cooperrider, Kensy & Rafael Núñez. 2009. Across time, across the body: Transversal temporal gestures. *Gesture* 9(2). 181–206.
- Coppock, Elizabeth & David Beaver. 2015. Definiteness and determinacy. *Linguistics and philosophy* 38(5). 377–435.
- Davidson, Kathryn. 2015. Quotation, demonstration, and iconicity. *Linguistics and Philosophy* 38(6). 477–520.
- Davidson, Kathryn & Deanna Gagne. 2014. Vertical representation of quantifier domains. In *Proceedings of sinn und bedeutung*, vol. 18, 110–127.
- Durkin, Allison, Deanna Gagne & Kathryn Davidson. 2016. English speakers and american sign language (asl) signers extend the more is up to subset/superset relationships for quantification. In *International society for gesture studies*, .

- Etxeberria, Urtzi. 2012. Quantification in basque. In Handbook of quantifiers in natural language, 83–164. Springer.
- Etxeberria, Urtzi & Anastasia Giannakidou. 2014. D-heads, domain restriction, and variation: From greek and basque to salish¹. The nominal structure in Slavic and beyond 116. 413.
- Irani, Ava. 2016. Two types of definites in american sign language. In Workshop on definiteness across languages, .
- Janis, Wynne D. 1995. A crosslinguistic perspective on asl verb agreement. Language, gesture, and space 195–223.
- Jelinek, Eloise. 1995. Quantification in straits salish. In Quantification in natural languages, 487–540. Springer.
- Koulidobrova, Elena & Diane Lillo-Martin. 2016. A ‘point’ of inquiry: The case of the (non-) pronominal ix in asl. The impact of pronominal form on interpretation 221–250.
- Koulidobrova, Elena V. 2012. When the quiet surfaces: ‘transfer’ of argument omission in the speech of asl-english bilinguals. University of Connecticut.
- Kuhn, Jeremy. 2015. Asl loci: Variables or features? Journal of Semantics 33(3). 449–491.
- Kuhn, Jeremy & Valentina Aristodemo. 2017. Pluractionality, iconicity, and scope in french sign language. Semantics and Pragmatics 10.
- Lakoff, George & Mark Johnson. 1980. Metaphors we live by. University of Chicago press.
- Langston, William. 2002. Violating orientational metaphors slows reading. Discourse Processes 34(3). 281–310.
- Lillo-Martin, Diane, Edward S Klima et al. 1990. Pointing out differences: Asl pronouns in syntactic theory. Theoretical issues in sign language research 1. 191–210.
- Lillo-Martin, Diane & Richard P Meier. 2011. On the linguistic status of ‘agreement’ in sign languages. Theoretical linguistics 37(3-4). 95–141.
- MacLaughlin, Dawn. 1997. The structure of determiner phrases: Evidence from american sign language .
- Mathur, Gaurav. 2000. Verb agreement as alignment in signed languages. MIT, Department of Linguistics.
- Matthewson, Lisa. 2001. Quantification and the nature of crosslinguistic variation. Natural Language Semantics 9(2). 145–189.
- Meir, Irit. 2010. Iconicity and metaphor: Constraints on metaphorical extension of iconic forms. Language 86(4). 865–896.
- Neidle, Carol Jan. 2000. The syntax of american sign language: Functional categories and hierarchical structure. MIT press.

- Nevins, Andrew. 2011. Prospects and challenges for a clitic analysis of (a) sl agreement. Theoretical Linguistics 37(3-4). 173–187.
- Núñez, Rafael & Kensy Cooperrider. 2013. The tangle of space and time in human cognition. Trends in cognitive sciences 17(5). 220–229.
- Padden, Carol A. 2016. Interaction of morphology and syntax in american sign language. Routledge.
- Petronio, Karen. 1995. Bare noun phrases, verbs and quantification in asl. In Quantification in natural languages, 603–618. Springer.
- Quer, Josep. 2005. Context shift and indexical variables in sign languages. In Semantics and linguistic theory, vol. 15, 152–168.
- Quer, Josep. 2012. Quantificational strategies across language modalities. In Logic, language and meaning, 82–91. Springer.
- Sandler, Wendy & Diane Lillo-Martin. 2006. Sign language and linguistic universals. Cambridge University Press.
- Schlenker, Philippe. 2011. Donkey anaphora: the view from sign language (asl and lsf). Linguistics and Philosophy 34(4). 341–395.
- Schlenker, Philippe, Jonathan Lamberton & Mirko Santoro. 2013. Iconic variables. Linguistics and philosophy 36(2). 91–149.
- Schwarz, Florian. 2009. Two types of definites in natural language. University of Massachusetts Amherst.
- Schwarzschild, Roger. 2002. Singleton indefinites. Journal of semantics 19(3). 289–314.
- Sell, Andrea J & Michael P Kaschak. 2012. The comprehension of sentences involving quantity information affects responses on the up–down axis. Psychonomic bulletin & review 19(4). 708–714.
- Stanley, Jason & Zoltán Gendler Szabó. 2000. On quantifier domain restriction. Mind & Language 15(2-3). 219–261.
- Tonhauser, Judith, David Beaver, Craige Roberts & Mandy Simons. 2013. Toward a taxonomy of projective content. Language 89(1). 66–109.
- Von Stechow, Kai. 1994. Restrictions on quantifier domains: University of Massachusetts at Amherst dissertation.
- Wilbur, Ronnie. 2003. Representations of telicity in asl. In Proceedings from the annual meeting of the chicago linguistic society, vol. 39 1, 354–368. Chicago Linguistic Society.
- Wilbur, Ronnie B. 2008. Complex predicates involving events, time and aspect: Is this why sign languages look so similar. Theoretical issues in sign language research 217–250.
- Zucchi, Alessandro. 2004. Monsters in the visual mode. Unpublished Manuscript, Università degli Studi di Milano .

Domain restriction in ASL

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