

Quantification in American Sign Language

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1. Background on American Sign Language

American Sign Language (ASL) is the sign language of the Deaf community in the United States as well as other parts of North America. In the present chapter, we focus on quantifiers and quantificational strategies in the ASL used in the United States.¹ As a signed language, ASL is a visual-gestural language that is produced with the hands, head, face, and body and perceived with the eyes. Despite differences in the modes of production and perception, signed and spoken languages exhibit extensive similarity of linguistic structure, similarity that is arguably rooted in a shared human language system. There remain, however, linguistic patterns that are unique to or more characteristic of one of these language modalities and that may be driven by the different affordances of sign versus speech. The bodily actions of signed languages, for example, are unavoidably produced in space and the spatial properties of signed languages are frequently grammaticalized throughout the linguistic system, from the structure of individual signs (e.g., phonemic contrasts of sign location) to the systematic combination of signs into phrasal and sentential units (e.g., the spatial system used to modulate reference). The acoustic output of spoken language, however, is simply incompatible with this type of spatialization (though speakers often spatialize their co-speech gesture). In the introductory sections that follow, we provide a brief overview of the core linguistic domains of ASL, noting where modality may play an influential role in each of these domains. This discussion is intended to orient the reader with the necessary background for the remainder of the chapter and is by no means exhaustive (a more comprehensive overview of sign language linguistics can be found in Pfau et al. 2012). In sections 2 and 3, we discuss core existential and universal quantifiers. Other types of quantifiers, including morpho-syntactically complex quantifiers, are the focus of section 4. Section 5 addresses the distribution of quantifiers in ASL, general clause structural patterns of quantification, and the interesting ways in which space is used to convey quantificational information. Section 6 closes the chapter.

1.1 Phonetics & Phonology

The existence of sub-lexical structure in signed languages was first established by Stokoe (1960) for ASL. Stokoe argued that signs are not holistic, unanalyzable units, but rather exhibit systematic phonetic and phonemic structure on a par with that evidenced in spoken languages, albeit with a phonetic feature system based on the manual articulators. As in the study of spoken languages, subsequent research has focused on further identifying and articulating the phonetic structure of signed languages, the status and structure of phonemic units in sign, the phonological

¹ Unless cited otherwise, data are from the authors' own fieldwork with signers of ASL.

² Following the conventions of the literature, signs are glossed using the closest English equivalent in

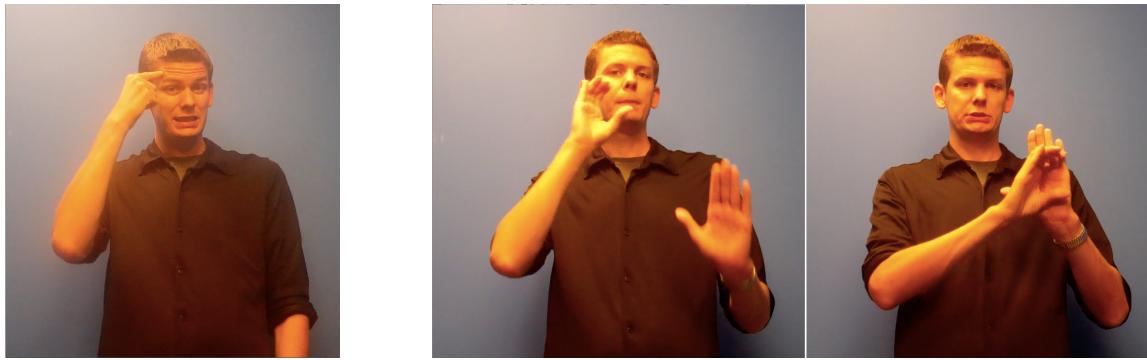


Figure 1. The ASL signs for THINK (left) and PICTURE (right).

constraints and processes that apply in sign language, and the patterns of similarity and variation in these domains across signed languages.

For present purposes, it is sufficient to review the four core articulatory parameters that are standardly used to describe individual signs: handshape, movement, location, and palm orientation. These parameters are exemplified by the signs THINK and PICTURE in figure 1.² The sign for THINK is produced with the extended index finger of the dominant hand touching or tapping the forehead. The sign for PICTURE is produced starting with the dominant hand in a cupped C-shape at the side of the upper face. The dominant hand then moves from the signer's face to make contact with the palm of the non-dominant hand. This sign also illustrates the articulatory asymmetry between the two hands in sign language production. Though the hands could, in principle, behave as two independent articulators, there is instead a dependency relationship between the two hands in the linguistic system of signed languages. The dominant hand functions as the primary manual articulator, responsible for the production of one-handed (THINK) signs. The non-dominant hand only comes in as a dependent, secondary articulator in two-handed signs (PICTURE). The non-dominant hand may also serve other structural roles in linguistic units larger than the individual sign. The four articulatory parameters of THINK and PICTURE are fully specified in (1).

- (1) a. THINK
 - i. Handshape: Extended index finger (IX handshape).
 - ii. Movement: Small movement toward forehead (may feature repeated motion).
 - iii. Location: Forehead, same side as dominant hand.
 - iv. Palm Orientation: Palm toward body.
- b. PICTURE

² Following the conventions of the literature, signs are glossed using the closest English equivalent in small capitals font (PICTURE). If necessary for adequate representation of a single sign's meaning, a sequence of hyphenated English words may be used (TAKE-PICTURE). Throughout the text, we include figures of certain key signs. Video productions of these and other signs included in the data and discussion here should be largely accessible at Spread the Sign (www.spreadthesign.com), an online dictionary also used by Kimmelman (this volume).



Figure 2. Production of the possessive marker POSS with second/third (left) and first (right) person possessors.

- i. Handshape: Dominant hand in a cupped handshape (C-handshape); non-dominant hand in an open flat handshape (B-handshape).³
- ii. Movement: Movement from upper dominant side of face to contact with non-dominant palm.
- iii. Location: Upper dominant side of face to non-dominant hand.
- iv. Palm Orientation: Dominant hand palm to center; non-dominant hand palm outward.

As discussed below, these articulatory parameters may be manipulated in the morphological processes of ASL (and other signed languages).

1.2 Morphology

The morphology of ASL and other signed languages is an area of the grammar that shows a significant influence of modality. Unlike the concatenative affixal morphology that is common in spoken languages, signed languages overwhelmingly prefer non-concatenative morphology wherein phonological parameters of the ‘root’ sign itself are modified to encode additional morphemic meaning (see Aronoff et al. (2004) for a recent discussion of this phenomenon and Wilbur (2015) for a discussion of how such processes may be analyzed sequentially, as has also been done more recently for classic Semitic templatic morphology). For example, ASL makes use of a spatial reference system wherein real world or discourse-established spatial locations are used to modulate semantic reference (see section 1.5 below). This is illustrated in figure 2 for the possessive marker, POSS, which is produced with a static flat B-handshape. The location toward which the hand moves and the

³ The terminology ‘C-handshape’ and ‘B-handshape’ refer to the handshapes of the ASL fingerspelling system, a language contact or language borrowing phenomenon used to represent English words in ASL signing. The handshapes of this system have been adopted as a means of conventionally referring to the handshapes of signs (though they are only a subset of possible sign handshapes).

orientation of the palm, change depending on the identity of the possessor. With first person possessors, POSS is produced with inward palm orientation and movement toward the chest of the signer (the picture on the right of figure 2). With second and third person possessors, POSS is produced with outward palm orientation and movement toward the real world location of the interlocutor or the discourse-established abstract spatial locus of the third person referent (picture on the left of figure 2). Spatial modulation of this nature is used throughout the semantic and pragmatic system and illustrates how the ‘root’ properties of the sign (e.g., movement, location, and orientation) are modified to indicate additional morphemic meaning (e.g., person), rather than sequential affixation of a morpheme (e.g., a person morpheme).

In terms of the morphological processes relevant to the study of quantification, it is important to note that ASL has no obligatory number marking. An unmarked noun may be interpreted as singular or plural depending on context and the surrounding linguistic environment. There are, however, two processes of morphological reduplication that can optionally be used to express information about number. The first of these is the dual inflection. Dual inflection is produced with reduplication at two distinct spatial locations, usually to the left and to the right of signing space. The second of these is produced with reduplication at multiple locations along a trajectory in signing space and can be conceptualized as a plural marker with a restriction to quantities greater than two. Termed ‘exhaustive inflection’ by Padden (1988), this second type of number marker appears to behave like a distributive plural. This exhaustive/distributive plural inflection does not appear to be as common or as compatible with lexical (versus classifier) nouns as the dual number marker is. As observed by Supalla and Newport (1978), the morphological patterns of ASL exhibit significant categorical symmetry. One instance of this is the fact that the dual and exhaustive/distributive inflections are used to mark number on both nouns and verbs. In the latter case, the number marking encodes the quantity of the direct or indirect object. Because this number marking involves spatial reduplication, it is morpho-phonologically limited to signs that are not anchored on the body.

1.3 Syntax & Semantics

ASL is standardly classified as a subject-verb-object (SVO) language. However, it makes robust usage of null arguments and has relatively flexible word order. Within the verbal domain, for example, verbal morphology such as agreement and locative markers may license object-shift and concomitant alternation between verb-object and object-verb order (Fischer and Gough 1974, Fischer 1975, Kegl 1976, Liddell 1980, Chen Pichler 2010).

- (2) a. MEAT EAT_[aspect:continuative]⁴

⁴ Subscripts are used to transcribe morphological marking. The subscripted [aspect:continuative] in (2a), for example, indicates that the verb EAT is inflected with the morphological marking of continuative aspect, which involves reduplication of the movement of the verb in combination with a

- b. *[I] just ate and ate meat.*
MONEY PUT[location:can]
- c. *[He] put the money in the can.*
- c. *BALL HIT[handling:bat]*
[He] hit the ball [with a bat].

(Chen Pichler 2010: 163, #4-6)

Constituents may also be fronted for topicalization or focalization purposes (Fischer 1990, Aarons 1994, Neidle 2003). Constituent reordering to a clause-final focus position is also common (Petronio 1993, Wilbur 1994). Bare argumental noun phrases are licensed in all clausal positions and exhibit the quantificational variability expected of a null determiner language (see Zimmer and Patschke (1990) and MacLaughlin (1997) for proposals regarding ‘optional’ determiners in the language and Koulidobrova (2012, accepted) for a recent discussion of the distribution of bare arguments in ASL). Though no determiner-like element is required, nominals may co-occur with pointing signs (IX) and a Y-handshape demonstrative glossed as THAT, which can inflect for proximity and has some functional variants (Liddell 1980). Both IX and THAT can inflect for plurality. In addition to the dual and exhaustive/distributive marker, IX also can inflect with a circular or arc-shaped movement that functions more like a collective plural (arc-shaped plural markers are also found in the verbal agreement system). Finally, ASL—again, like other signed languages—is a classifier language. It does not, however, have classifiers of the nominal domain that are required for individuation (as in, for example, Chinese). Classifiers in ASL are primarily in the predicate system and many serve as spatial morphemes of location and movement. In certain cases, these classifier elements may appear in the nominal domain, as in the cardinally quantified structure in (3). Such constructions, however, are neither obligatory nor standard in quantified nominals.

- (3) IX₁ BUY THREE CL:C“loaf”,[reduplication:horizontal, 3x] BREAD⁵
I bought three loaves of bread.

1.4 Manual and Non-Manual Channels

Though signed languages are often described as being manual languages, actions of body parts other than the hands play an important role in signed communication. These non-manual signals can convey information regarding affect, but they can also play an important grammatical role. Non-manual signals such as body movement, facial expression, and eye blinking are functional components of the prosodic system of ASL and other signed languages. Non-manuals also serve more narrow

transitional circular movement. The bracketed material ([I]) in the translation indicates material that is not overtly present in the ASL data but is necessary to provide a grammatical translation in English.

⁵ The CL:C“loaf”,[reduplication:horizontal, 3x] transcription of the classifier represents that a classifier (CL) using the C-handshape (:C) was used to represent a loaf of bread and was reduplicated horizontally across space three times.



Figure 3. Video stills corresponding to the sign sequence in (4). The sign VOTE-FOR is pictured in the first still. The sign name OBAMA is pictured in the middle two stills. The interrogative sign WHO is pictured in the last still.

grammatical functions. For example, specific mouth gestures co-articulated with the verbal predicate may convey adverbial information about manner (e.g., *carelessly*, produced with the tongue protruding from the mouth while signing the verb). Facial expression and body action are also used to mark grammatical constructions, including topicalization and interrogatives. In (4), pictured in figure 3, the signer produces two distinct non-manual markings concurrently with the manual sign stream. The first of these, co-produced with the manual sequence VOTE-FOR OBAMA, consists of a backwards lean of the body and head, widened eyes, and raised eyebrows followed by a pause, indicated here with the comma. This marks the initial portion of the sentence as topicalized or focalized. The second non-manual signal, co-produced with the wh-interrogative WHO, consists of a forward lean, furrowed eyebrows, and squinted eyes. This is the grammatically required non-manual marking of a wh-question in ASL. These and other non-manual signals are transcribed on a line above the manual gloss. The scope of the line indicates the manual signs that the non-manual marking co-occurs with and the annotation at the end of the line indicates the type of non-manual marking present. Because it is not directly under investigation here, non-manual markings are often omitted in the data presented.

- (4) _____ br wh
 VOTE-FOR OBAMA, WHO
Who is it that voted for Obama?

1.5 Use of Space

We have to this point noted some of the domains in which the spatial properties of signs play an important linguistic role: spatial location serves as a discriminatory feature of the phonetic/phonological (1) and morphological (section 1.2) systems of signed languages. Indeed, throughout all domains of the grammar, space plays a significant role in ASL and other sign languages. In section 5.3, we focus on how placement and movement of signs in space plays a role in the structure of quantified expressions. Throughout the examples presented here, we also transcribe spatial locations as they are used to track discourse referents. For example, the possessive markers in figure 2 would be transcribed as POSS₁ for the first person possessive marker on the right. The non-first possessive marker on the left would be

transcribed as POSS₂ if the movement and palm orientation of the possessive marker indicate the interlocutor (second person) and POSS_i if the movement and palm orientation indicate a third person. The subscripted *i* is a third person index much like those familiar from the transcription of reference in syntax and semantics. The novel property of signed languages is that discourse referents are spatially marked and spatially tracked. The spatial location of first and second person referents are the real world spatial locations of the signer and interlocutor(s), respectively. For third person referents, however, abstract spatial locations may be established in discourse and referenced as necessary, such as on possessive markers (POSS₁, POSS₂, POSS_i), pronoun-like pointing signs (IX₁, IX₂, IX_j), and predicates (₂GIVE_i). The empirical patterns of the spatial reference system are still being documented and their linguistic status is a long-debated issue in the study of signed languages. For more information about spatial reference, the reader is referred to Lillo-Martin and Klima (1990) and, more recently, Kuhn (2015). Finally, it should also be noted that spatial location and movement of sign language can also be used to represent properties of real world space—not only in referencing the real world spatial location of the signer and interlocutors, but also in, for example, predicates of motion and location and other spatial descriptions.

2. Generalized Existential Quantifiers

2.1 D-Quantifiers

2.1.1 Lexical D-Quantifiers

As discussed above, ASL allows bare argumental noun phrases. These bare noun phrases may be interpreted as being existentially quantified. However, a variety of overt existential quantifiers also exist in the language. There are two quantifiers that may be translated as *some* and are glossed below as SOME/PART and SOMEONE and pictured in figure 4.

- (5) SOME/PART ELECTION GOOD, SOME/PART BAD⁶
Some elections are good, some are bad.

- (6) a. SOMEONE DOG BITE IX₁
Some dog bit me.

⁶ The sign glossed here as ELECTION is a result nominal derived via reduplication from the verbal form VOTE-FOR. For a recent analysis of this nominalization process, see Abner (2015).



Figure 4: ASL signs for *some*: SOME/PART (left) and SOMEONE (right). (Source: www.lifeprint.com)

- b. SOMEONE _iGIVE_j JOHN_(j) BOOK
Someone gave John a book.

(Adapted from MacLaughlin 1997:118, #294)⁷

The sign SOME/PART has a partitive-like interpretation that makes it compatible with mass nouns or count nouns in a context that yields a preferred plural interpretation. The sign SOMEONE is related to the cardinal number sign ONE (produced with an extended index finger). The difference between SOMEONE and ONE is the presence of circular movement on the existential quantifier SOMEONE. As illustrated in (6a), SOMEONE is not limited to human referents. Both SOME/PART and SOMEONE may appear without their nominal restrictor. The licensing of nominal ellipsis is generally true of quantifiers and nominal modifiers in the language.

ASL has a one-handed numeral system for numbers 1 through 999. The position of cardinal number quantifiers is relatively flexible within the noun phrase (7). As with nominal ellipsis, this is also generally true for quantifiers and nominal modifiers in the language. At this time, it is not clear how the semantics of the individual quantifier or of the quantified noun phrase play a role in licensing this word order flexibility (but see Padden 1988 for the argument that at least some postnominal modifiers are predicative).

- (7) a. IX_i WANT THREE BOOK
I want three books.
- b. IX_i WANT BOOK THREE
I want three books.

(Adapted from Boster 1996:160, #3, 4)

In certain cases, the position of the cardinal quantifier with respect to other nominal modifiers can have semantic consequences. This is illustrated by the interaction of the cardinal quantifier with the possessive marker in (8). In the order POSSESSOR-

⁷ Data adapted from cited sources has been changed only to ensure consistency of transcription with the conventions adopted here.

POSSESSIVE MARKER-CARDINAL-POSSESSEE (8a), the noun phrase is ambiguous between a maximal and non-maximal interpretation. In the order POSSESSOR-CARDINAL-POSSESSIVE MARKER-POSSESSEE (8b), however, only the maximal interpretation, construed here with English definite determiner, is possible.

- (8) a. CRAIG_i POSS_i THREE COMPUTER
the three computers of Craig's
three of Craig's computers
- b. CRAIG_i THREE POSS_i COMPUTER
the three computers of Craig's
*#three of Craig's computers*⁸

There is a lexical sign FEW. It is produced with the thumb sliding along the inside of the four fingers as they extend from a closed fist handshape. This sign is sometimes provided by signers as a translation of English *some* with count nouns (9b). It is unclear at this time if FEW has properties of a value judgment quantifier. It may be the case that a quantity reading (*a few*) is non-manually distinguished from a value judgment/proportional reading (*few*) via the addition of a squint-like facial expression with the value judgment reading (similar to the facial expression used with negation and perhaps signaling the presence of a covert negator), as in (9c). Additional fieldwork is necessary to address this matter.

- (9) a. PIE, IX₁ WANT SOME/PART
I want some pie.
- b. BOOK, IX₁ WANT FEW
I want some books/a few books.
- c. bl/squint
FEW STUDENT READ[reduplication] BOOK
Few students read books.

With respect to other quantifiers that may have a value judgment interpretation, there is a sign for MANY (10) and a sign that is traditionally glossed as ENOUGH, but the latter is not used as a quantifier.

- (10) NOW CRAIG, BABYSIT MANY KID NEIGHBOR
Craig is babysitting many of the neighbor's kids.

There is also a sign COUPLE that is produced with the V-handshape (extended index and middle fingers) of the dominant hand tapping the tips of the fingers of a V-handshape non-dominant hand. Though this sign may be related to the numeral sign TWO, it functions as a nominal and not a quantifier. A fingerspelled loan sign for *dozen*, D-O-Z, exists. It is an English borrowing and is only used in reference to eggs.

⁸ As an anonymous reviewer points out, it is also possible to co-locate THREE in the referential space associated with ,CRAIG. Whether or not this co-location is consistent or obligatory is currently unclear.



Figure 5. The negative quantifier NOTHING-OPEN (Source: www.lifeprint.com)

Finally, there are several negative quantifiers and pronominal negatives, most of which are morphologically related through the iconic 0-handshape. The first of these, NOTHING and NO⁰ (traditionally glossed as NONE) can combine with overt nominal restrictors, though pronominal-like usages with nominal ellipsis are also common. NO⁰ is produced with two 0-handshapes held palm-out in neutral signing space and then quickly moved outward and downward in a 7-shaped trajectory. In some cases, the sign is produced with a palm rotation such that the palms face toward the center at the end of the sign. It is not yet clear if this variation is meaningful—that is, if these are two behaviorally distinct negative quantifiers—or if it is a matter of individual variation or emphasis. The sign glossed as NOTHING is also produced with two 0-handshapes held palm out in signing space, but instead of moving the hands in the aforementioned 7-trajectory the hands are shaken repeatedly back and forth in space. Neither of these quantifiers is related to the polarity particle NO (*no*).

- (11) JOHN NOTHING/NO⁰ FAN BREAK
John did not break any (part of the) fan.

(Wood 1999:38, #2)

As the translations above suggest, both NOTHING and NO⁰ may be interpreted partitively when an overt nominal restrictor is present. In her detailed examination of negation in ASL, Wood (1999) reports that these two negative quantifiers behave differently with respect to the arguments with which they can combine. She observes that NO⁰ can combine with a nominal functioning as the clausal subject so long as it is displaced to clause-final position (12a-c), whereas NOTHING cannot combine with a clausal subject regardless of position (12d-f).

- (12) a. SHOW-UP ON-TIME INTERPRETERS NO⁰
 b. *NO⁰ INTERPRETER SHOW-UP ON-TIME
 c. *INTERPRETER NO⁰ SHOW-UP ON-TIME
 d. *SHOW-UP ON-TIME INTERPRETERS NOTHING
 e. *NOTHING INTERPRETER SHOW-UP ON-TIME
 f. *INTERPRETER NOTHING SHOW-UP ON-TIME

No interpreters showed up on time.

(Wood 1999, 50,53:#26, 28, 29, 35, 36, 38)

Given that the restriction on the clausal position of NO⁰ is not universally observed by other researchers (see Davidson and Gagne (2014:120, #17) and (14) below), it is likely that this is a locus of inter-signer variation. As this volume makes clear, variation in quantified structures is robust across languages and, thus, variation within a language is relatively unsurprising. Moreover, Cecchetto et al. (2009) report that negative quantifiers in Italian Sign Language are also obligatorily placed in clause-final position, so the patterns documented by Wood are attested in other (sign) languages.

There is also a negative NOTHING-OPEN (figure 5) in the 0-handshape negative family that does not seem to be used with an overt nominal restrictor and is perhaps exclusively found at the right edge of the clause or as a standalone negator. It is unclear if this is driven by the morpho-syntax or the phonology of this negative marker. Phonologically, the disyllabic structure of NOTHING-OPEN may simply be too 'heavy' to occur in the standard (though not only) prenominal quantifier position. Morpho-syntactically, the explanation may lie in re-analyzing NOTHING-OPEN as a negative predicate in something like a null copular structure. NOTHING-OPEN is sometimes produced near the nose with an idiomatic meaning along the lines of *doesn't care at all*.

A final negative quantifier thus far documented can be glossed as NONE-BLOW, since it is produced by blowing air over the fingertips of a clawed handshape as it opens (though it may also be produced with the palm open at sign onset), like blowing seeds off a dandelion globe. This sign is formationally similar to gestures of dismissal or disregard that are found in the co-speech gesture of American English speakers. The usage of NONE-BLOW seems to imply that the non-existence is somehow counter to the signer's expectations. The example in (13), then, would be appropriate if the signer expected the dancing boy to have some dancing ability and (counter to expectations) he did not or if the dancing boy previously had some dancing ability and no longer does.

(13)

IX_i BOY_i DANCE IX_{+,i}, NONE-BLOW DANCE ABILITY
The boy dancing has no dancing ability.

As with negative A-quantifiers, discussed below, negative D-quantifiers co-occur with negative non-manual marking consisting of a headshake and oftentimes a scowl-like facial expression. This negative non-manual marking is included in the transcription for the NONE-BLOW example above, though its distributional patterns are, like those of other non-manuals, outside the scope of the present chapter.

With respect to other distributional patterns of these negative quantifiers, some signers report that spatialized pronouns cannot be referentially dependent upon negative quantifiers. That is, while an overt pronoun bound to the positively

quantified DP EACH POLITICS PERSON is grammatical in (14a), this binding is not possible for when instead the negative determiner NO⁰ is used (14b).

- (14) a. EACH POLITICS PERSON_i TELL-STORY (IX_i) WANT WIN
Each politician said he wants to win.
- b. NO⁰ POLITICS PERSON_i TELL-STORY (*IX_i) WANT WIN
No politician said he wants to win.

These patterns are used by Graf and Abner (2012) as evidence that dependencies such as these may be achieved via discourse binding in ASL.⁹ Moreover, the patterns in (14) provide additional support for Koulidobrova's (2012, *accepted*) proposal that null and overt arguments in ASL are structurally distinct in ways beyond their phonological realization, as (14b) is grammatical (and has the expected bound interpretation) as long as no overt point (IX) is present. Finally, while these and other quantifiers may be semantically decreasing, there are no expressions that are sensitive to this property. Neither negative nor positive polarity items have been identified in the language.

ASL has an interrogative intersective D-quantifier WHICH (15) that also functions as a marker of disjunction in certain dialects (Davidson 2013).

- (15) MARY_i IX_i READ WHICH BOOK YESTERDAY
Which book did Mary read yesterday?

ASL signs for *what* may also be used as an interrogative quantifier, like WHICH, for some signers, though it is unclear the extent to which this pattern is a consequence of English contact. The interrogative D-quantifiers WH-MANY and WH-MUCH, which have the expected count and non-count distinction, respectively, are derived from the corresponding non-interrogative quantifiers MANY and MUCH by the addition of slower movement and a non-manual wh-question marker.¹⁰ This and the aforementioned relationship between SOMEONE and the cardinal numeral ONE are the only clear cases of a relationship between a quantifier and an indefinite or interrogative in ASL. There is, however, a relationship between the universal quantifier EACH (produced with two extended thumb handshapes), the free choice quantifier ANY (produced with an extended thumb handshape tracing in a circular motion over the spatial location of the referent) and the cardinal numeral ONE in French Sign Language (Langue des signes française, LSF), which is also produced with an extended thumb handshape. Because the cardinal numeral sign has been replaced by the extended index finger ONE, it is unclear if this morphological relationship is active in modern day ASL. We return to this relationship briefly in section 3.1.

⁹ The binding restriction in (14b) may also suggest that the negatively quantified NO⁰ POLITICS PERSON is not semantically equivalent to sentential negation of an existentially quantified noun, as argued for in other languages.

¹⁰ This process is likely related to 'covert' question formation where the wh-question non-manual marker alone serves to form a wh-question in the absence of an overt wh-word (Lillo-Martin and Fischer 1992, Petronio and Lillo-Martin 1997).



Figure 6. The distinct spatial location productions associated with the dual inflected form ELECTION_{plural-dual}.

2.1.2 Morphological Existential D-Quantifiers

Cardinal existential D-quantification is also morphologically encoded in one of two ways. The first of these, dual inflection, was mentioned in the overview of ASL morphology in section 1.2 above. Dual inflection is a type of reduplicative number morphology wherein the dual inflected noun is reduplicated at two distinct spatial locations, usually to the left and to the right, though reduplication in closer proximity is also possible. This is illustrated in (16) for the derived result nominal ELECTION (*election*). This nominal is produced with downward movement of the F-shaped dominant hand into the fist-shaped non-dominant hand. When inflected for dual, this downward movement is reduplicated at two distinct spatial locations, pictured in the two stills of figure 6.

- (16) NEWSPAPER DISCUSS ABOUT TWO DIFFERENT ELECTION_{plural-dual}
The newspaper talked about two different elections.

As noted above, dual inflection may also be used on the object agreement marker of agreeing verbs, in which case the verb exhibits object agreement with two distinct spatial locations. In this case, the interpretation is that of a cardinally quantified indirect or direct object argument (see Cormier 2002 for evidence that this is quantification over referents, not events). Dual inflection encodes cardinal quantities of two and, as noted above, is morphologically distinct from the exhaustive/distributive inflection used to encode plural quantities of greater than two.

Cardinal quantities may also be morphologically marked through a process of numeral incorporation. Numeral incorporation is a morphological process whereby cardinal number handshapes are used as the handshape specification in the production of other signs. For example, the ASL sign for MONTH may be produced with the cardinal number handshape SIX to produce a multi-morphemic sign meaning SIX-MONTHS (bottom picture in figure 7). Morpho-phonologically, it is

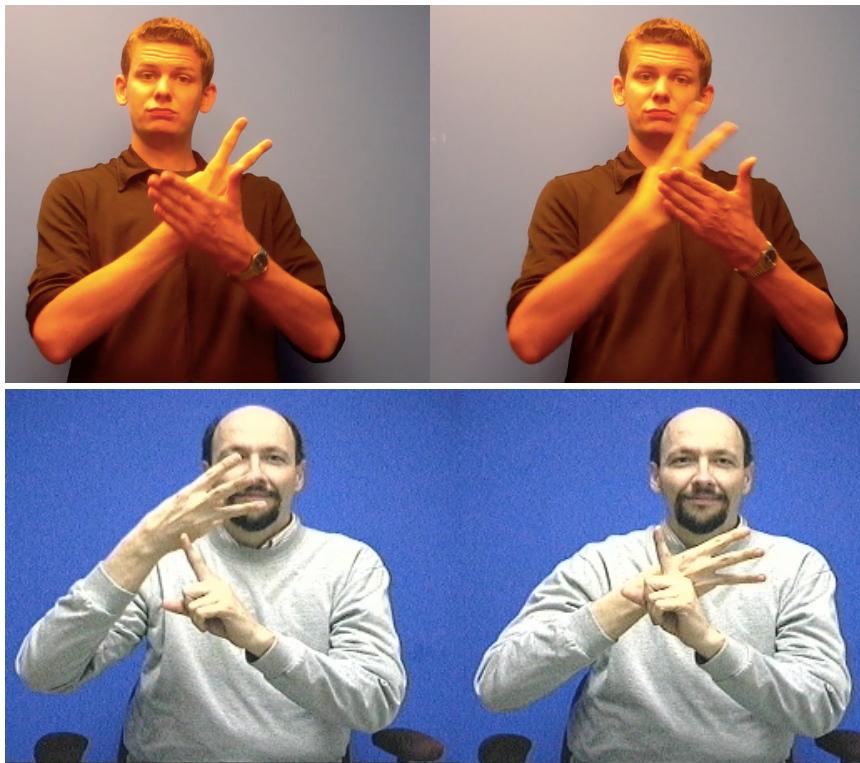


Figure 7. The numeral incorporated signs TWO-WEEK (top) and SIX-MONTH (bottom; Source: www.lifeprint.com).

unclear whether this process should be understood as one that changes an existing phonological feature or as one that specifies an otherwise underspecified phonological feature. Regardless, numeral incorporation only applies to a closed set of lexical items and there is variation in which cardinal numbers can combine with each of these lexically specified signs. This variation can be characterized as an upper bound for each of the lexically specified signs. For example, DAY-FUTURE and DAY-PAST appear to be limited to cardinal number two, whereas inclusive and exclusive pronouns ($\text{IX}_{\text{inclusive}}$, $\text{IX}_{\text{exclusive}}$) can incorporate cardinal numbers up to nine. The cardinal number NINE is agreed upon as an upper limit for numeral incorporation in general, but this can be phonologically explained by the observation that cardinal numbers greater than nine are polysyllabic in ASL. A list of lexical signs allowing numeral incorporation is provided in (17); future work may uncover other signs that should be added to this list.

- (17) a. Time Signs: YEAR, MONTH, WEEK, DAY, HOUR, MINUTE, SECOND, TIME, X-TIMES[†], ONCE, FOR-X-WEEKS, DAY-FUTURE[†], DAY-PAST[†]
- b. Other Quantity Signs: MORE, DOLLAR, POINTS (counting), POINTS (comparing), IN-ONE, HEIGHT, ORDINAL-NUMBER, MULTIPLY-BY, HUNDRED, PLACE (in competition), GROUP-SIZE, LISTING, JERSEY-NUMBER, ONLY[†]
- c. Nominal Signs: HIGHWAY, PERSON, TWIN, MILITARY-BADGE, STORY, ROWS, $\text{IX}_{\text{inclusive}}$, $\text{IX}_{\text{exclusive}}$

(Adapted from Jones 2013:26-28; [†]indicates signs added to Jones's list.)

As a final note on the morphology of existential D-quantification, we have also observed that number (cardinal and ordinal) and partitive quantifiers tend to use the horizontal left-right axis in front of the signer. Moreover, when producing cardinal and ordinal quantifiers, the signer may explicitly sign these expressions along the horizontal left-right axis, invoking the metaphorical left-right number line. For partitive expressions, the signer may use a more complex spatial construction where the larger set is first expressed and established in space and the partitive reference to the smaller set is then moved horizontally away from this spatial location, a pattern that may be related to the spatial plural reference patterns discussed by Schlenker et al. (2013). In the example below, we use an arrow to represent this horizontal movement. The two distinct lines of transcription are used to represent the signer's alternation between the dominant and non-dominant hand. The first line represents the dominant hand. As shown in the transcript, the signer first introduces the larger set referent (FOUR) with the non-dominant hand and holds this sign in space as a buoy while signing the partitive referent (TWO). The partitive reference here is established by initiating the TWO sign in the location of the whole (FOUR) and moving it horizontally in space away from this location. The signer then completes the predicate by explicitly referencing the numeral of the dominant hand, which, as represented by the dashes, is held in space while the non-dominant hand completes the remainder of the utterance, and specifying that the referent of that numeral (two legs of a four-legged pig) is green. A potential literal translation of this expression may be *Of the pig's four legs, two are green*.

(18)	$\text{IX}_i \text{ PIG}_i \# \text{LEG},$	$\rightarrow \text{TWO}_i \dots$
		$\text{FOUR}_{i,\text{nd}} \dots \text{IX}_{\text{dom}} \text{ COLOR}_{\text{nd}} \text{ GREEN}_{\text{nd}}$
<i>Two of the pig's legs are green.</i>		

We review these and other quantificational uses of space in section 5.3 below.

2.2 A-Quantifiers

2.2.1 Lexical Existential A-Quantifiers

Existential A-quantifiers equivalent to *once*, *twice*, *three times*, *four times*, etc. are productively formed via the numeral incorporation process discussed above. The nominal sign X-TIMES (index finger tapping on the upper side of the wrist) can incorporate a numeral handshape (x) to yield an A-quantifier with the associated cardinal interpretation. There is also a non-incorporated sign for TWICE, though it also uses the two handshape. In this case, the bent fingers of the two handshape are flicked against in the palm of the non-dominant hand.

(19)	$\text{IX}_i \text{ EXAMINE POSS}_i \text{ CLASS TWO-TIME}$
<i>He examined his class two times.</i>	

(20)	$\text{DRIVE LICENSE HARD PASS, WHEW, FAIL TWICE}$
------	--

The driver's license test is hard to pass – [he] failed twice!

The A-quantifier TWICE can also be used as a modifier in comparative constructions. In the example in (21), the comparative is expressed using a predicate BEAT, which can be used when comparing performance between individuals (e.g., teams, stocks) or against expectations. The construction may, then, be the ASL equivalent of an *exceeds*-style verbal comparative (Stassen 1985).

- (21) IX_i FINISH SMOKE_[habitual] BEAT TWICE MORE THAN IX₂
She smokes twice as much as you.

There is also a group of morphologically related A-quantifiers that may be glossed as OFTEN, FREQUENTLY, and INCESSANTLY. Each of these quantifiers is produced with a dominant bent B-handshape tapping the palm of the upturned non-dominant hand. Consultants report that two taps, at the base and fingertips of the palm, correspond to the OFTEN interpretation (figure 8), whereas multiple taps along the palm correspond to the FREQUENTLY interpretation. Thus, the taps of the hand along the palm can be thought of as iconically representing temporal instances. The INCESSANTLY interpretation arises when the multiple taps along the palm are produced with fast, short movements in combination with a clenched teeth non-manual marker. A formationally similar A-quantifier standardly glossed as SOMETIMES is also pictured in figure 8. In this case, the quantifier is also produced with contact on the up-turned palm of the non-dominant hand. However, the dominant handshape for SOMETIMES is an extended index finger and the dominant hand undertakes a circular movement between contacts with the non-dominant palm. Circular movement can also be added as a morpho-phonological modifier to the OFTEN/FREQUENTLY/INCESSANTLY quantifier and the resulting movement is something like RARELY/NOT-OFTEN. In this case, the signer increases the spatio-temporal distance between palm taps by the introduction of a large circular movement away from the palm between taps. This circular movement may optionally be combined with a wiggling of the fingers. Both of these components are independently attested in the verbal morphology system. Circular movement repetition has been observed to mark increased durativity of verbal events (Fischer 1973), while finger wiggling has been argued to mark that a state continues, unchanged over time (Unchanging State in Elapsing Time (USET), Wilbur 2008). Comparable modification is also possible with the formationally similar sign SOMETIMES, yielding an A-quantifier glossed here as INFREQUENTLY (22).



Figure 8. The shared initial point of contact for the lexical A-quantifiers OFTEN, FREQUENTLY, and INCESSANTLY (left) and the formationally similar SOMETIMES (right, source www.lifeprint.com).

- (22) br
 IN-GENERAL STUDENT INFREQUENTLY READ BOOK
In general, students, [they] infrequently read books.

The combination of these two morphemes to modulate adverbial meaning provides further evidence of the morpho-syntactic symmetry across categorial domains in ASL and language more generally. Finally, as was true for MUCH/WH-MUCH and MANY/WH-MANY above, an interrogative WH-OFTEN (*how often*) can be derived from the non-interrogative sign (OFTEN) through the addition of non-manual wh-marking and, potentially, a slower movement.

Unsurprisingly, existential A-quantifiers have also been observed to exhibit positional preferences. For example, our consultants reported that OFTEN/FREQUENTLY in (23) was only possible in a clause-peripheral position. These patterns may result from the fact that sentence structure in ASL, as in many other languages, signed and spoken, is discourse configurational and heavily determined by information structural status of the sentential constituents. However, as is generally true of attested word order variation in ASL, these patterns are not yet well understood (see discussion of (12) above as well as section 3.2 below). We leave these word order variants and their potential structural origins as a matter for future research.

- (23) a. IX_i VOTE-FOR REPUBLIC OFTEN/FREQUENTLY
 b. OFTEN/FREQUENTLY IX_i VOTE-FOR REPUBLIC
 c. ?*IX_i OFTEN/FREQUENTLY VOTE-FOR REPUBLIC
He often/frequently votes for republicans.

There is also sign that is sometimes translated as *usually* because it is related to the signs for USE/USUAL. This sign is produced with two extended finger handshapes held with the palm toward center of the body and the base of the

dominant hand tapping repeatedly on the thumb-side of the non-dominant hand as the hands trace a downward trajectory in space. However, one consultant reported that the sign would be better glossed as REGULARLY.

- (24) TEND CHURCH REGULARLY (EVERY-WEEK)
[He] tends to go to church regularly (every week).

A-quantifier meanings corresponding to something like the English *usually* or *typically* may also be expressed using a complex verbal construction with the sign TEND, as in (25a). Indeed, this appears to be the more common or preferred strategy, used even when an adverb like REGULARLY is also present (24). Given this, TEND is commonly found in expressions of genericity (Wilbur 1998, Wilbur and Patschke 1999), such as (25b).

- (25) a. CHURCH GO[habitual] THREE-TIME WEEK,TEND
Usually he goes to church three times a week.
b. MAN TEND MORE TALL WOMAN
Men tend to be taller than women.

Quer (2012) uses these and other data to suggest that TEND is the lexicalization of the generic operator, while an anonymous reviewer suggests that TEND may in fact have adverbial status. At present, the categorical status of TEND cannot be fully resolved. Unlike quantificational adverbs, TEND is produced with neither movement along a spatial axis or repeated movements. Moreover, not only does TEND co-occur with a verbal predicate in a raising-like construction (25a), but it also surfaces in sentences in which no other verbal predicate is overtly present, as in (24) and (25b). Finally, like other verbal predicates, TEND can occur in clause-initial and clause-final position as part of a doubling construction that is used for emphasis (Petronio 1993). In the example in (26), the signer describes an individual using an emphatic double of TEND as well as a reduplicated possessive mark, POSS, also a common strategy for discussing personal characteristics.

- (26) IX_i iBRUNO IX_i TEND STRONG RELIGIOUS POSS_i,[reduplication] TEND[reduplication] IX_i
Bruno is very religious.

In the domain of negative existential A-quantifiers, there is a lexical sign NEVER, produced with a flat B-handshape moved sideways and then downward (7-shaped) in neutral signing space. As is true with the sentential negator NOT, the negative A-quantifier NEVER can occur in pre-verbal and clause-final position. There, however, an interpretational difference between these two positions.

- (27) a. JOHN NEVER EAT FISH
John has never eaten fish.
b. JOHN EAT FISH NEVER
John won't eat fish.

(Wood 1999:24-25, #12b, 13)

The D-quantifier NO⁰ can also be used as a negative existential A-quantifier in clause-final position.

- (28) UNDERSTAND' RESPECT_i NO⁰ PLUS RESPECT_j NO⁰
But the horse doesn't respect [him_i] at all and [it] doesn't respect [him_j] at all.

Moreover, as with negative D-quantifiers, negative A-quantifiers trigger non-manual negation marking, produced with a combination of side-to-side headshake and a scowl-like facial expression.

- (29) _____ neg
BRUNO NEVER DANCE
Bruno never danced.

2.2.2 Morphological A-Quantifiers

The verbal morphology of ASL and other signed languages has received a relatively large amount of attention in the research literature. It is especially relevant to the issue of quantification because both event and argument quantification may be expressed via non-concatenative verbal morphology. Recall from above that the dual and exhaustive/distributive inflections can apply in the verbal domain, reduplicating the object agreement marker horizontally across signing space. This reduplication of the spatial agreement morphology yields a quantified object interpretation – that is, morphological marking on the verb is being used to express D-quantification. Morphological A-quantifiers, however, may also be expressed in the verbal morphology system and here, too, the exponence is frequently (perhaps exclusively) reduplication.

Fischer (1973) was the first to carefully study these patterns, identifying two types of reduplicative verbal morphology in ASL: slow and fast reduplication. She observed that the meaning of the inflected verbal form is dependent, in part, on the lexical semantics of the verb (see Rathmann 2005 and Wilbur 2009, 2010 for more recent discussions). With atelic events, slow reduplication is interpreted as elongating the temporal duration of the event. With telic events, both fast and slow reduplication have a semantic effect of iteration. The distinction between them is that fast reduplication yields a habitual interpretation of the iteration, which may constitute a universally quantified interpretation. In some cases, the habitual interpretation associated with fast reduplication yields an idiomatic reading (30c).

- (30) a. IRON[reduplication:slow]
to keep on ironing
b. KILL[reduplication:slow]
to keep on killing
c. FORGET[reduplication:fast]
to be absentminded

- d. $_1\text{MOOCH-FROM}_x[\text{reduplication:slow}]$
I always mooch from one person
 (Adapted from Fischer 1973:474,476 #12, 14, 24, 25)

Idiomatic interpretations also frequently arise with a suffixal process that is used to mark negative A-quantification: ZERO suffixation. This process suffixes a 0-handshape (like that of NO⁰, NOTHING, and NONE-BLOW, and NOTHING-OPEN above) to one-handed, non-agreeing predicates, yielding a ‘not P at all’ (Aronoff et al. 2005). The process differs in productivity across signers and sometimes yields idiomatic interpretations (31c). As discussed by Aronoff et al. 2005, ZERO suffixation is a case of atypical concatenative morphology in signed languages.

- (31) a. SEE.ZERO
not see at all
 b. TASTE.ZERO
not at all to my tastes

(Adapted from Aronoff et al. 2004:22-23)

With respect to the above paradigms of morphological reduplication, there does seem to be a general pattern as to how the spatial axes used in reduplication map to the quantificational interpretation. Pure frequency readings tend to use the front-back axis, moving horizontally away from the signer’s body. Frequency readings with a habitual or regularity interpretation, however, incorporate the up-down axis, moving vertically downward. Finally, quantification over the object argument uses the left-right axis, moving horizontally across the signing space.

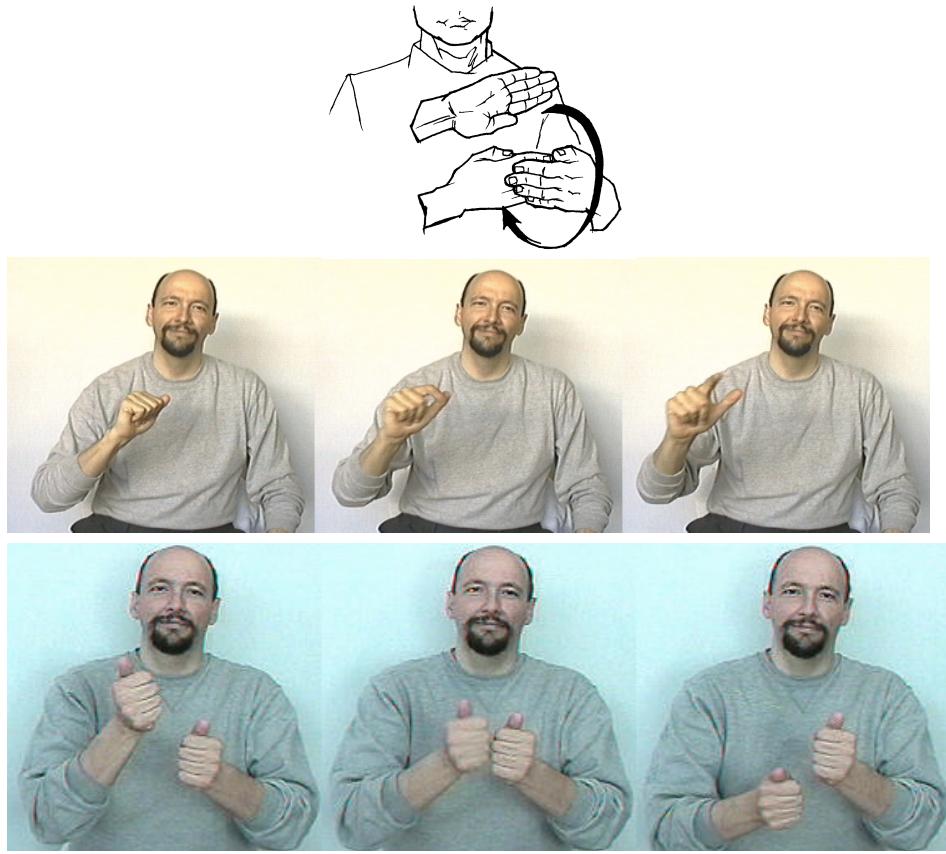


Figure 9. The lexical universal A-quantifiers ALL-CIRCLE (top) #ALL (middle), and EACH (bottom).

3. Generalized Universal Quantifiers

3.1 Universal D-Quantifiers

ASL does not have a three-way distinction in universal quantifiers equivalent to the English *all*, *every*, and *each*. There are, however, three distinct universal quantifiers, ALL-CIRCLE, #ALL, and EACH, as illustrated in figure 9.¹¹ EACH is a two-handed sign with matching extended thumb handshapes in which the dominant hand moves downward next to the non-dominant hand. ALL-CIRCLE is produced with a circular movement in space, which serves as the basis for the transcription of the sign. The dominant hand begins the sign palm down in contact with the non-dominant hand, undergoes a circular movement, and ends palm up in the same position in contact with the dominant hand. The circular movement may either be produced orbiting the non-dominant hand or horizontally away from the non-dominant hand. #ALL is derived from the fingerspelling of the English quantifier (A-L-L) and its current

¹¹ Some signers will use a calque-like process to meta-linguistically distinguish *each/every* interpretations, repeating the movement of EACH so that it matches the multi-syllabicity of English *every*.

status as a lexicalized borrowing is conventionally indicated by the ‘#’ in the transcription. The #ALL quantifier has two morpho-phonological variants, the existence of which provide evidence of its lexicalization. First, #ALL may be produced as a one-handed or a symmetrical two-handed sign, which means that the non-dominant hand simultaneously mimics the action of the dominant hand. Second, #ALL may be spatialized such that its movement is produced along the spatial location associated with the quantified referent, along both horizontal (e.g., referring to individuals established on the horizontal spatial plane) and vertical (e.g., referring to all of the items on a list) axes. Spatialization is also available with the universal quantifier ALL-CIRCLE, though in this case the spatialization of the quantifier is limited to location: the dominant and non-dominant hands may be located in the horizontal space associated with a referent when producing the sign, but they do not move in space (save for the circular movement in the base form of the sign). In this respect, spatialization of the quantifier looks like spatialization in the spatial reference system (section 1.5). However, other spatial components may also be incorporated into the production and interpretation of the sign, a topic to which we return in section 5.3.

In terms of their distributional and interpretive properties, both #ALL and EACH may have distributive interpretations, but ALL-CIRCLE is stubbornly collective in its universal quantification. This is evidenced by the incompatibility of ALL-CIRCLE with the stubbornly distributive predicate (*have long hair*) in (32).

- (32) #ALL / *ALL-CIRCLE / EACH IX_i,plural-arc iGIRL HAIR LONG-HAIR
All the girls have long hair.

Thus, ASL supports Keenan and Paperno’s (2012) generalization that languages distinguish between collective and distributive universal quantifiers.

When combined with the universal quantifier EACH, the noun may be morphologically marked as a distributive plural. This pattern is sometimes preferred, but nevertheless does not appear to be obligatory, as evidenced by the collective plural arc in (32) and the absence of plural morphology in (33). EACH and ALL-CIRCLE both yield relatively strong definiteness effects, but #ALL does not. This is illustrated with the HAVE-sentence in (33). This construction is equivalent to an existential/presentational construction and does exhibit definiteness restrictions on its object pivot.

- (33) IX_i i GARDEN HAVE #ALL / ???ALL-CIRCLE / *EACH GIRL
There are all/each girl(s) in the garden.

Again, as with OFTEN/FREQUENTLY/INCESSANTLY, there is also a morphological relationship within the class of universal D-quantifiers. Both EACH and the free choice quantifier ANY are produced with an extended thumb handshape, as was noted in section 2.1.1. In the case of EACH, it is a two handed sign with a downward movement. In the case of ANY, it is a one-handed sign with circular movement over the spatial location associated with its referent. This sign does not parallel English *any* in leading a double life as a negative polarity item. Both EACH and ANY (as well as

other signs referring to individuals, such as SELF) are likely related to the LSF signs for EACH, EACH-ONE, or ONE, all of which are produced with this fist handshape. This relationship is unsurprising given the well-documented historical relationship between ASL and LSF. LSF was one of the languages in use at the first school for the deaf in the United States and its grammar and lexicon contributed to the emergence of ASL.

3.2 Universal A-Quantifiers

ASL has a simplex universal A-quantifier ALWAYS, which is produced with an extended index-finger handshape tracing a circle in space. ALWAYS can occur clause-finally or pre-verbally, following negation if present (35), but unlike temporal adverbs such as YESTERDAY, ALWAYS cannot precede an overt clause-initial subject (34c). Braze uses these patterns as evidence that ASL, like English, is not a verb raising language (Pollock 1989), though contrasts with the patterns in (23) confirm that further study of word order variation in adverb placement is necessary.

- (34) a. JOHN ALWAYS LOSE PAPER
b. * JOHN LOSE ALWAYS PAPER
c. * ALWAYS JOHN LOSE PAPER
John always loses his papers.

(Braze 2004:38, #16-17)

- (35) _____neg
KIDS NOT ALWAYS EAT CORN
The kids don't always eat corn.

(Braze 2004:38, #18)

As noted above, morphological universal A-quantification may also be present in the reduplicative inflection used to mark the habitual in ASL. To express an A-quantifier meaning *every Friday*, the signer can produce the sign for FRIDAY and move it downward in space, appealing to the noted correspondence between the vertical axis and habitual interpretation. Similar downward reduplication can also be used to indicate that an event happens at other regular intervals, such as weekly or monthly (see also (44) and (48) below). Finally, as is the case with free relatives in general, there is no apparent *whenever* or a *whenever-like* A-quantifier construction in ASL.

4. Other Quantifiers

4.1 Proportional Quantifiers

As noted above, the meaning that would be expressed with an adverb like *usually* in English is expressed through a complex verbal construction using the verb TEND in ASL. Moreover, as is generally true, it is difficult to discern whether A-quantifiers such as OFTEN/NOT-OFTEN (or RARELY) and ALWAYS convey information about number

or ratio (i.e., whether they have a genuinely proportional reading). This, again, is also true for D-quantifiers such as MANY, FEW, and MOST. In contemporary ASL, MOST is formationally similar to the sign EACH. However, while in EACH, the dominant hand moves downward next to the non-dominant hand, in MOST the dominant hand moves upward next to the non-dominant hand. Historically, MOST was derived from MORE plus an upwards movement that functioned as a superlative marker. As discussed by Bernath (2009), both plurality (36a) and majority (36b) interpretations are available for MOST, a pattern which he uses as evidence for the presence of a null article in ASL bare noun phrases (cf. Bošković and Gajewski 2009).

- (36) a. Context: There exist ten movies featuring Superman. André owns four of these movies, while Jeff owns only two, and Diane just one.

ANDRE OWN MOST SUPERMAN MOVIE

André owns the most Superman movies. [plurality, not majority]

- b. Context: There exist ten movies featuring Superman. Jeff owns copies of all 10, while André owns eight of them and Diane owns just four.

ANDRE OWN MOST SUPERMAN MOVIE

André owns most Superman movies. [majority, not plurality]

(Bernath 2009:8, #14)

With respect to purely proportional quantities, fractional quantifiers are expressed by spatially mimicking the vertical lay out of a fraction. For a fractional quantity like *one-third*, for example, the signer would sign a ONE and then move the hand quickly downward and sign THREE. Fractional quantifiers may show up with nominal restrictors but are also common as bare quantifiers.

- (37) HALF STUDENT Aplural-distributive-downward
Half of the students got A's.

There are also means of expressing percentage quantities. There is a sign PERCENT, which is produced by tracing the outline of the percent symbol (%) using an O-handshape. This sign may combine with cardinals to form different percentage expressions that may surface with an overt nominal restrictor or as a bare quantifier. Percent quantifiers may appear in a position preceding an indexical pointing sign (38), a pattern that could shed light on the functional role of the IX when it co-occurs with a nominal.

- (38) SIXTY PERCENT IX_i,plural-circle AMERICA T-E-E-N-A-G-E-R, TEND INCREASE FAT
Sixty percent of American teenagers tend to be overweight.

4.2 Morpho-syntactically Complex Quantifiers

As noted above, nominal modification by morpho-syntactically complex or morpho-phonologically large constituents is dispreferred in ASL. Consequently, morpho-

syntactically complex quantifier constructions with the quantifier in a pre-nominal position are rare. Complex quantifier meanings are usually expressed using periphrastic or bi-clausal constructions. For example, constructions in which the quantifier is stranded in a peripheral position may be used to express the Boolean meaning *most but not all*. Here and elsewhere, we refer to such peripheral positions as clause-initial and clause-final, though much of the present data are also compatible with an analysis wherein stranding targets a sentence-peripheral (not clause-peripheral) position.

- (39) iIU IX_i, STUDENT WHEW L-I-B-E-R-A-L, #ALL WHEW,
At Indiana University, the students are all really liberal
 ALL-CIRCLE B-WAVE-2H, MOST
Not all [of the students] most [of them]

The constituent negator NOT can be used to modify a quantifier, though it too tends to favor a clause-peripheral position. In (40), for example, NOT MANY occurs in subject position with its nominal restrictor (LINGUIST), but it is also doubled in the clause-final position.

- (40) NOT MANY LINGUIST IX_{plural-circle} MUSICIAN, NOT MANY
Not many linguists are musicians.

This clause-final position is generally available for quantifiers, but preferred in the case of complex quantifiers. Interestingly, the clause-final stranded position is ungrammatical with spatial partitives (41e). This ungrammaticality cannot solely be about spatialization of the quantifier, as a spatialized deictic numeral (41d) is acceptable.

- (41) a. CRAIG_i POSS_i COMPUTER_j IX_j, DAUGHTER BREAK SOME
Craig's daughter broke some of his computers.
- b. CRAIG_i POSS_i COMPUTER_j IX_j, DAUGHTER BREAK MANY
Craig's daughter broke many of his computers.
- c. CRAIG_i POSS_i COMPUTER_j IX_j, DAUGHTER BREAK SEVEN
Craig's daughter broke seven of his computers.
- d. CRAIG_i POSS_i COMPUTER_j IX_j, DAUGHTER BREAK IX_j-THREE
Craig's daughter broke those three of his computers.
- e. *CRAIG_i POSS_i COMPUTER_j IX_j, DAUGHTER BREAK THREE-OUT-OF_j
Craig's daughter broke three of his computers.

Modifiers like MAXIMUM (*at most*) and LESS-THAN (*fewer/less than*) exist, but they tend to also surface in clause-peripheral position, sometimes without an overt nominal restrictor (see also (45) below). As shown in (42), these clause-peripheral modified quantifier constructions can be 'sandwiched' between a doubled modal (SHOULD), suggesting that this is indeed a clause-peripheral position and not a bisentential construction.

- (42) UP-TIL-NOW, PROPOSE, SALT, IX_{plural-circle} IX_{we}, SHOULD,
Before now, it was recommended that salt, we should
 SALT, LIMIT 1,500 #MG LESS-THAN SHOULD
limit salt to less than 1500mg.

Certain modifiers can, however, be used as a modifier preceding cardinal numeral quantifiers with an overt nominal restrictor. These include BETWEEN (produced with an upright B-shaped dominant hand brushing back and forth along the edge of a sideways B-shaped non-dominant hand), APPROXIMATELY (produced with a 5-handshape circling or waving back and forth in space) and ALMOST (produced with a bent-B dominant hand brushing against a bent-B non-dominant hand). The BETWEEN example in (43) is also discussed in section 5.3 below due to the spatial properties of the cardinal quantifiers.

- (43) HAVE ENOUGH FOR BETWEEN TWO_{left} FOUR_{right} STUDENT, YES
[We] have enough [money] for between two to four students.

The lexical modifier ALMOST can also be used in complex A-quantifier constructions. In (44), the signer is using ALMOST to modify the universal A-quantifier meaning that is expressed by the morphological marking of FRIDAY.

- (44) GO-TO ALMOST FRIDAY[plural-distributive-downward]
[He] went almost every Friday.

However, morpho-syntactically complex quantifiers created from lexical modifiers like BETWEEN, APPROXIMATELY, and ALMOST nevertheless seem to prefer a clause-peripheral position, as in (45).

- (45) LINGUISTS IX_{plural-circle}, MUSICIAN, WHEW ALMOST #ALL_{2h}, WHEW
 Almost all linguists are musicians!

Clause-peripheral periphrastic-like constructions are also used to express meaning equivalents of multiply-headed comparative quantifiers (Keenan and Paperno 2012).

- (46) iSTUDENT IX_{i,plural-circle} FINISH STRONG #VEGAN,
Students are strongly vegan,
 MORE THAN jTEACHER IX_{j,plural-circle}
more than teachers.
(≈ More students than teachers are vegan.)

Complex A-quantifier interpretations are also commonly expressed using clause-peripheral constructions. For example, though a sign glossed as EXCEPT/SPECIAL (produced with the dominant hand pulling up on the extended index finger of the non-dominant hand) exists, bi-clausal *but*-type constructions may also be used to express *except*-type meaning. This is illustrated in (47) using the

sentential marker UNDERSTAND' analyzed by Fischer and Lillo-Martin (1990) as a subordinator conjunction (see also (28) above).

- (47) IX_i iANN OVERSLEEP IX_i TEND WEEKEND, HOLIDAY, UNDERSTAND' EASTER NOT IX_i
Ann tends to sleep late on weekends and holidays, but on Easter she [does] not.

Other kinds of complex A-quantifier meanings can also be expressed using this clause-peripheral construction, such as rate or frequency quantifiers with bounding modifiers.

- (48) TEND-T0 GO-T0 CHURCH, ONE YEAR, GO-T0_{2h},[reduplication:habitual]
WEEK[reduplication:downward]
[He] tended to go to church; one year, he went to church each week.

4.3 Type (2) Quantifiers

Certain Type (2) quantificational constructions have a relatively straightforward structure in terms of the manual sign string. The example in (49), however, also manipulates the use of vertical space to express information about quantifier domain, as discussed in section 5.3 below. The signer is referring to general patterns in the world, expressing that different people like different things (the object phrase here is produced with nominal ellipsis). Because the signer is referring to patterns of people in general—a large domain—the signer signs the initial *people*-referring DIFFERENT high in signing space.

- (49) DIFFERENT_{circle-high} PEOPLE IX_{2h,plural-circle} LIKE VARIOUS DIFFERENT
Different people like various different [things].

A comparable construction is also found with interrogative Type (2) quantifiers. In the example below, the signer is finishing a set of instructions on how to use a chart to track students' grades and is instructing the interlocutor to check off which questions were answered by which students.

- (50) ...WHICH STUDENT IX_{plural-horizontal} ANSWER WHICH QUESTION IX_{plural-horizontal}
...which student answered which question

In some cases, however, the binary relation of Type (2) quantifiers may be expressed solely using spatial layout. This is the case with the classifier structure in (51), where two upside down C-handshapes are used to represent towns that are spatially adjacent

- (51) TWO IX-TWO_i GROW-UP TOWN CL:C_j^CL:C_k,“town-next-to-town”
Those two grew up in two towns next to each other.
GROW-UP IX_j^IX_k, LIVE STILL LIVE IX_j^IX_k CL:C_j^CL:C_k,“town-next-to-town”

[They] grew up there and still live there in two towns next to each other.

Again, spatial components of quantification in ASL are reviewed in section 5.3.

5. Selected Topics

5.1. Distribution of Quantifiers

As mentioned at the outset of this chapter, ASL allows bare noun phrases in all argument positions of the clause. Quantified noun phrases are also allowed in all argument positions and, aside from the heretofore discussed preference for displacing large quantificational structures to the periphery of the sentence, no special distributional patterns seem to apply to quantified noun phrases.

- (52) a. Subject Position (and Direct Object)
[NO⁰ CAKE] LEFT, CRAIG EAT #ALL/ALL-CIRCLE
There's no cake left, Craig ate all [of it].
- b. Direct Object Position
IX_iPIG HAVE [TWO COLLAR COLOR GREEN_{plural-dual}]
The pig has two green collars.
- c. Indirect Object Position (and Subject)
ALL-CIRCLE iBOY TELL [SOMEONE_jGIRL] TEACHER WANT SEE_{i+j}
All of the boys told some girl that the teacher wanted to see
TWO-OF-THEM_{i+j} AFTER CLASS,
the two of them after class.
- d. Object of a Preposition
NEWSPAPER DISCUSS ABOUT [TWO DIFFERENT EXAM_{plural-dual}]
The newspaper discussed two different exams.
- e. Possessor
[EACH iSTUDENT] POSS_{i,plural-distributive} BOOK CL:Bsmall-book¹²
The book of each student is small.

The distribution of quantified noun phrases also includes the pivot position of a cleft-like construction traditionally called a rhetorical question because the signer seems to both ask and answer a question (for a detailed structural discussion of this construction, see Wilbur (1994) and Caponigro and Davidson (2011)).

- (53) JOHN BUY WHAT, [EVERYTHING]
John bought everything.
(Caponigro and Davidson 2011:358, #106)

Because ASL rather permissively allows nominal ellipsis as well as displacement of the nominal restrictor of a quantifier, it is also true that bare quantifiers can surface

¹² The sign glossed here as CL:Bsmall-book is a bent B-handshape indicating the (thin) thickness of a book.

in any clausal argument position (such as the direct object position in (52a) above). ASL does not appear to have predicative quantifiers, but quantifiers are permitted as possessors (52e).

Both this and the above observation, however, come with the caveat discussed earlier that morphologically complex quantifiers strongly prefer overt placement in a clause-peripheral position, typically a clause-final 'stranded' position, though their argumental role remains flexible. The clause-final position has been observed to be associated with focus in ASL (Wilbur 1996) and the clause-final position of quantifiers may be related to the clause-final emphatic doubling construction (Petronio 1993). This is especially likely given that one of the common targets of focus doubling are interrogative wh-quantifiers (other targets include modals, verbs, negative quantifiers, and positive non-interrogative quantifiers).

- (54) a. WHO BUY CAR WHO
Who bought the car?
b. HOW-MANY BROTHER SISTER IX₂ HAVE HOW-MANY
How many brothers and sisters do you have?

(Adapted from Petronio 1993:134, #19, 23)

Generally, neither doubling nor clause-final placement affect the asserted, truth-conditional meaning of the sentence. Rather, they contribute to the information structural status of the doubled or clause-final element. However, Wood (1999) does identify one area where the meaning of a quantifier in clause-final position is distinct from its meaning in its clause-internal position. As illustrated in (55), repeated from (27) above, Wood observes that the negative A-quantifier NEVER takes on a modal flavor when it appears in clause-final position.

- (55) a. JOHN NEVER EAT FISH
John has never eaten fish.
b. JOHN EAT FISH NEVER
John won't eat fish.

(Wood 1999:24-25, #12b-13)

In addition to 'stranding' or 'floating' quantifiers in this clause-final position, simplex quantifiers are also relatively free to 'float' in their clause-internal position. This pattern, discussed at length by Boster (1996), frequently results when the nominal restrictor is fronted to the initial topic position, as in (41) above. It is as yet unclear whether quantifier float in 'intermediate' positions or multiple quantifier float are available.

5.2. Transparent Structure Mapping in (American) Sign Language Quantification

Sign languages exhibit structured iconicity at the sub-lexical, lexical, and phrasal levels (Wilbur 2010, Emmorey 2014) – that is, sign parts can be iconic, individual signs can be iconic, and combinations of signs can be iconic. In the domain of phrasal

iconicity, Wilbur and Patschke (1999) and Quer (2012) have argued that sign languages tend to transparently represent certain semantic properties of quantificational structures (see also Kimmelman this volume). Based on non-manual marking patterns in a variety of constructions, Wilbur and Patschke proposed that brow raise in ASL is used to mark A'-positions of non-wh operators such as negation.

- (56) br
JOHN DOCTOR NOT
It's not the case that John is a doctor.
(Wilbur and Patschke 1999:10: #7)

In these and other structures (Wilbur 1998), the so-called A'-position marked by brow raise can also be aligned with the restriction of the tripartite quantifier structure proposed by Heim (1982) and expanded by Partee (1991): OPERATOR-RESTRICTOR-NUCLEAR SCOPE. The similarity between surface structural properties of signed languages (specifically ASL and Catalan Sign Language) and the proposed tripartite structure of quantification was used by Quer as evidence for the validity of the tripartite analysis itself. His argument proceeds as follows: if sign languages tend to use a tripartite structure in their expression of quantified structures, then we have further evidence—evidence that is, in this case, overt—for this tripartite structure generally being present in human language quantification. With respect to why signed languages exhibit surface transparent mapping of this type, Quer suggests that it may be related to “the discourse-oriented character of their surface structures” (Quer 2012:82). That is, like its connections with information structure, the relationship between word order and the semantic structure of quantification is also likely related to the tendency of signed languages to be strongly discourse configurational and, thus, is not truly a modality-specific effect.

5.3. Scope ambiguities

When multiple quantificational expressions occur in the same clause, the scopes of these quantificational expressions may interact. This interaction may yield multiple, ambiguous interpretations. In a recent overview of ambiguity in sign languages, Quer and Steinbach (2015) discuss cases where the presence of multiple quantificational expressions do and do not result in scope ambiguities. For example, in Catalan Sign Language (LSC), a sentence like (57) is ambiguous, as is true of its English counterpart *Two professors guided every group of new students*.

- (57) br
STUDENT NEW GROUP+++ PROFESSOR TWO GUIDE
a. *There are two professors such that each has shown all the new groups of students around.*
b. *For every new group of students, there are two (possibly) different professors that have shown them around.*
(Quer and Steinbach 2015:153: #10)

In other examples, however, optional reduplicative morphology can be used to disambiguate the sentence. This is illustrated in (58), where sideways horizontal reduplication of the subject (STUDENT ONE+++), object (TEACHER POSS+++), and verbal agreement (ASK++) indicate that there is a distinct student associated with each teacher being asked.

- (58) _____ br
STUDENT ONE+++ TEACHER POSS+++ ASK+++
Each student asked his/her teacher.
(Quer and Steinbach 2015:153: #9)

Petronio (1995) documented similar patterns in ASL. Here too certain morphological markers may serve to unambiguously mark the intended interpretation of a sentence. Thus, whereas the English sentence *Ann gave the students a book* is ambiguous and could mean either that each student got his or her own book or that the students were given a book to share, the ASL sentence in (59) has only the former interpretation.

- (59) t
 a STUDENT, BOOK ANN GIVE_{a-[exhaustive]} (Petronio 1995:611, #28)

The disambiguation in (59) is the consequence of the reduplicative [exhaustive] marker on the verb. Like the LSC morphological marking in (58), exhaustive inflection is reduplicative and moves sideways in ASL (see sections 1.2, 1.3, 2.1.2, and 2.2.2). In the absence of such marking, however, the familiar ambiguities may arise:

- (60) t
BOOK, TWO STUDENT BUY
a. *Two students each bought a book.*
b. *Two students together bought a book.*
c. *Two students bought books.*

Quer and Steinbach (2015) note that such ambiguities can differ across sign languages. They observe that in LSC, only (b) is a possible reading for (60). To obtain reading (a), dual marking would be required, and to obtain the (c) reading, another form of reduplication (allocative) would be necessary. As in other areas, significant work remains to be done in order to better understand patterns of scope ambiguity within and across sign languages. Scope ambiguities involving elements of the verbal domain (e.g., modals, A-quantifiers) are especially underdocumented. Below, we look more closely at how spatial structure, like that involved in the reduplication in (58) and (59), plays a role in quantification.

5.4 Role of Space

Like many sign languages (and potentially all Deaf community sign languages), ASL uses space for grammatical purposes. As introduced in section 1.5, grammatical domains such as co-reference, verbal agreement, and even conjunction can be spatially structured and modulated. If a noun phrase and a subsequent pronoun are intended to be referentially dependent, then this dependency can be marked by co-location in the same spatial locus in front of the signer. When the referent of that noun phrase is plural, then sub-locations within that spatial location can be used to refer to sub-sets of the plural noun phrase referent. This gives ASL the ability to express referential meanings (e.g., complement set anaphora) that are unattested in spoken language semantics (Schlenker et al. 2013). Moreover, quantified noun phrases themselves can be spatialized, allowing spatial discrimination of bound pronominals and also giving rise to structural patterns that are generally deemed unacceptable in a spoken language like English (the English translation in (61), for example, is unacceptable). Because these patterns are limited to positive quantifiers, Graf and Abner (2012) analyze this kind of spatial modulation as an instance of discourse binding and assume that the quantifier itself introduces a discourse referent.

- (61) ALL WRESTLER_i INFORM SOMEONE SWIMMER_j THAT IX_i IX_j
Every wrestler told some swimmer that him and him
WILL RIDE-IN-VEHICLE LIMO GO-TO DANCE
would ride in a limo to the dance.

(Graf and Abner 2012:7, #15)

Grammatical space also plays a role in several other areas of quantificational structure in ASL, some of which were noted earlier in the discussions of the specific quantificational interpretations they are associated with. First, there is the general pattern that non-negative D-quantifiers can, like other argumental material, be spatialized. This was discussed earlier with respect to the quantificational layout of Type (2) quantifier interpretations. Spatialization of quantifiers can also be used to construct quantity comparisons. For example, signing MANY in a spatial location associated with one referent and FEW in a spatial location associated with another referent would serve to construct a quantity comparison between these referents. An extension of this pattern is also used to express so-called distributive/dependent numeral interpretations. In (62), the signer is discussing the equal distribution of senators in the United States Senate. In doing so, the signer produces a TWO sign simultaneously with both the dominant and non-dominant, one hand in a location previously associated with California and the other in a location previously associated with Wyoming. This yields a dependent numeral interpretation with the dependency mediated through the spatial reference system. In this same conversation, the signer also generalized the equal distribution of senators in the United States by tracing the two handshape around space following the general outline of the United States border.

- (62) Context: In the US Senate, each state has two senators regardless of population. Even though California has a lot of people and Wyoming has few people...
- STILL TWO_{D,i} ^ TWO_{ND,j}, STAY TWO_{D,i} ^ TWO_{ND,j}
[There's] still two [each], [it] stays two [each].

In (63), spatial distributive numeral morphology is used to distinguish the distributive from the collective interpretation of the 60 exams graded by the teaching assistants. The collective interpretation may be distinguished by the addition of the overt modifier ALL-TOGETHER (63b).

- (63) a. POSS_{1 i}#TA NUMBER-LINE_i GRADE
My teaching assistants graded
 60 EACH IX_{i,plural-distributive} 60_{i,plural-distrbutive}
60 [exams] [each].
- b. POSS_{1 i}AIDE IX_{i,plural-arc} ALL-TOGETHER GRADE 60 EXAM
My aides graded 60 exams all together.

Like (58) and (59), these examples illustrate strategies that may be used to disambiguate potentially ambiguous structures. Without morphological marking such as the distributive inflection in (63a) or the modifier in (63b), these sentences may be ambiguous. However, ambiguities of this type are rare in the language. Indeed, spatialization and the general flexibility of word order in ASL may explain the relative dearth of scope ambiguity as compared to other languages (Keenan 1988, Keenan and Paperno 2012).

There are also patterns in how space is used for different types of quantificational meanings. Spatialized existential D-quantifiers tend to use the horizontal left-right axis in front of the signer. For example, the modified numeral quantifier in (64) (repeated from (43) above) uses horizontal spatialization of the numerals TWO and FOUR: TWO is produced relatively far left in signing space, followed by a more rightward production of FOUR.

- (64) HAVE ENOUGH FOR BETWEEN TWO_{left} FOUR_{right} STUDENT, YES
/We/ have enough [money] for between two to four students.

In this case, the quantifiers are established in spatial loci. Moreover, the positional difference between these spatial loci represents a quantity difference between the quantified expressions. In such cases, the left-right axis can be thought of as metaphorically invoking the horizontal number line. Movement across space, however, can also be meaningfully used in the expression of quantified meaning. Specifically, movement across the horizontal can be explicitly used to express partitive interpretations. The signer can establish a location in space associated with a referent and then move a numeral leftward or rightward from that space to

express the interpretation “*X out of <this referent group>*”. Examples of the spatial partitive structure were provided in (18) and (41) above.

Turning next to the use of the vertical up-down axis, this axis has recently been argued by Davidson and Gagne (2014) to overtly invoke quantifier domain restrictions, providing transparent evidence of this semantic postulate (see Barberà 2014 for comparable patterns in Catalan Sign Language). When producing a quantifier, the signer may produce that quantifier at a relatively high (large domain) or low (small domain) in signing space to indicate the size of the domain of the quantifier.

- (65) *Context: Signer is asked if anyone in her family is deaf beside herself. She replies:*
- a. NONE_{low} ONLY-ONE_i
None, only me.
 - b. NONE_{high} ONLY-ONE_i
None, only me (not even, e.g. ancestors, distant relations).
- (Davidson and Gagne 2014:117, #12)

As noted earlier, these axes may also have specialized interpretations in morphological A-quantification, where reduplication along the horizontal front-back axis expresses existential frequency readings, while along the vertical up-down axis expresses universal habitual quantification.

5.5 One-to-one dependency

An example of an ASL sentence with a one-to-one dependency (Boolos 1981) interpretation is given in (66).

- (66) FLOWER iGROW, RAIN, iDROP-FALL, iGROW, iDROP-FALL, iGROW, iDROP-FALL,
iGROW[aspect:augmentative], iDROP-FALL
For every drop of rain a flower grows.

Crucially, this sentence does not make use of the horizontal axis that is found with distributive (63) and existential (64) quantification. Instead, a single neutral location (marked with the ‘i’ subscript) is used for both raindrops and flowers, with alternation of an equal number of raindrops and flowers at that location. The reduplication ([aspect:augmentative]) that is present at the end of the sentence is produced vertically. This may relate to the up-down axis that is commonplace in the expression of regularity or habituality in A-quantification (section 2.2.2).

6. Concluding Spot Checks

With respect to the final spot checks of the quantifier questionnaire (Keenan 2012), though morphological analysis of ASL is still relatively incomplete, it does appear that ALL, ONE, and MANY constitute mono-morphemic signs. The negative quantifiers NO⁰ and NOTHING exist and can combine with nominal restrictors, though their

morphemic content and determiner status remains unclear. There are three universal quantifiers (#ALL, ALL-CIRCLE, EACH), which display a distinction between collective (#ALL, ALL-CIRCLE) and distributive (#ALL, EACH) interpretations. In general, lexical D- and A-quantifiers do not appear to be morphologically related, so there is no clear morphosyntactic complexity asymmetry between them (i.e., there is no *frequent/frequently* distinction). There is a lexical sign ONLY/ONLY-ONE that is derived from the cardinal numeral ONE and can exhibit numeral incorporation up (e.g., ONLY-TWO, ONLY-THREE, ONLY-FIVE). This sign cannot function as an A-quantifier.

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References

- Aarons, Debra. (1994). *Aspects of the syntax of American Sign Language*. Doctoral Dissertation, Boston University.
- Abner, Natasha. (2013). Gettin' Together a POSSe: The Primacy of Predication in ASL Possessives. *Sign Language and Linguistics* 16:2, 125–156
- Abner, Natasha. (2015). What You See Is What You Get.Get: Surface Transparency and Ambiguity of Nominalizing Reduplication in American Sign Language. Submitted to *Syntax*.
- Aronoff, Mark, Meir, Irit, Padden, Carol and Sandler, Wendy. (2004). 'Morphological universals and the sign language type.' In G. Booij & J. van Marle, eds., *Yearbook of morphology 2004*, 19-39. Dordrecht/Boston: Kluwer Academic Publishers.
- Barberà, Gemma. (2014). Use and functions of spatial planes in Catalan Sign Language (LSC) discourse. *Sign Language Studies*, 14(2), 147-174.
- Bernath, Jeffrey. (2009). Pinning down articles in American Sign Language. Ms., University of Connecticut.
- Boolos, George. (1981). For every A there is a B. *Linguistic Inquiry*, 12, 465–466.
- Bošković, Željko and Gajewski, Jon. (2009). Semantic correlates of the NP/DP parameter. In *Proceedings of NELS* (Vol. 39).
- Boster, Carole T. (1996). On the quantifier-noun phrase split in American Sign Language and the structure of quantified noun phrases. In *International review of sign linguistics*, ed. William Edmondson and Ronnie Wilbur, 159–208. Mahwah, NJ: Lawrence Erlbaum Associates.
- Braze, David. (2004). Aspectual inflection, verb raising and object fronting in American Sign Language. *Lingua*, 114(1), 29-58.
- Caponigro, Ivano and Davidson, Kathryn. (2011). Ask, and Tell as Well: Clausal Question-Answer Pairs in ASL. *Natural Language Semantics* 19(4), 323-371.

- Cecchetto, Carlo, Carlo Geraci, and Sandro Zucchi. (2009). Another way to mark syntactic dependencies. The case for right peripheral specifiers in sign languages. *Language*, 85(2), 278-320.
- Chen Pichler, Deborah. (2010). Using early ASL word order to shed light on word order variability in sign language. In *Variation in the input: Studies in the acquisition of word order (Studies in Psycholinguistics, Vol. 39)*, eds. M. Anderssen, K. Bentzen and M. Westergaard, 157-177. Dordrecht: Springer.
- Cormier, Kearsy. (2002). *Grammaticalization of indexic signs: How American Sign Language expresses numerosity*. Doctoral dissertation, University of Texas, Austin.
- Davidson, Kathryn. (2013). And or Or: General Use Coordination in ASL. *Semantics and Pragmatics*, 6(4), 1-44.
- Davidson, Kathryn and Gagne, Deanna. (2014). Vertical representation of quantifier domains. In *Proceedings of Sinn und Bedeutung* (Vol. 18).
- Emmorey, Karen. (2014). Iconicity as structure mapping. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, 369(1651), 20130301.
- Fischer, Susan. (1973). Two processes of reduplication in the American Sign Language. *Foundations of Language* 9, 469–480.
- Fischer, Susan. (1975). Influences on word-order change in American Sign Language. In *Word order and word order change*, ed. Charles Li, 3–25. University of Texas Press.
- Fischer, Susan. (1990). The head parameter in ASL. In *SLR '87: Papers from the fourth international symposium on sign language research*, ed. William Edmondson and Fred Karlsson, 75–85. Hamburg: Signum-Verlag.
- Fischer, Susan and Bonnie Gough. (1974). Verbs in American Sign Language. *Sign Language Studies* 18, 17-48.
- Fischer, Susan D. and Diane Lillo-Martin. (1990). UNDERSTANDING Conjunctions. *International Journal of Sign Linguistics* 1, 71-80.
- Graf, Thomas and Abner, Natasha. (2012). Is Syntactic Binding Rational?. In *Proceedings of the 11th International Workshop on Tree Adjoining Grammars and Related Formalisms*.
- Heim, Irene. (1982). *The Semantics of Definite and Indefinite Noun Phrases*. Doctoral dissertation, University of Massachusetts, Amherst.
- Jones, Vanessa L. (2013). *Numerical Incorporation in American Sign Language*. Master's thesis, University of North Dakota.
- Keenan, Edward L. 1988. On semantics and the binding theory. In *Explaining Language Universals*, J. Hawkins (ed). Basil Blackwell. 105 – 144.
- Keenan, Edward L. (2012). The Quantifier Questionnaire. In *Handbook of Quantifiers in Natural Language*, ed. Edward Keenan and Denis Paperno, 1-20. Netherlands: Springer.
- Keenan, Edward L. and Denis Paperno. (2012). Overview. In *Handbook of Quantifiers in Natural Language*, ed. Edward Keenan and Denis Paperno, 941-949. Netherlands: Springer.
- Kegl, Judy. (1976). Relational grammar and American Sign Language. Ms., Massachusetts Institute of Technology.

- Koulidobrova, Elena. 2012. *When the quiet surfaces: Argument omission ‘transfer’ in the speech of ASL-English bilinguals*. Doctoral dissertation, University of Connecticut.
- Koulidobrova, Elena. (Accepted). Elide me bare: Null arguments in American Sign Language. *Natural Language and Linguistic Theory*.
- Kuhn, Jeremy. (To appear). ASL Loci: Variables or Features? *Journal of Semantics*.
- Liddell, Scott K. (1980). *American sign language syntax* (Vol. 52). The Hague: Mouton De Gruyter.
- Lillo-Martin, Diane and Fischer, Susan. (1992). Overt and Covert Wh-Questions in American Sign Language. Presented at the *Fifth International Symposium on Sign Language Research*; Salamanca, Spain.
- Lillo-Martin, Diane and Edward Klima. (1990). Pointing out differences: ASL pronouns in syntactic theory. *Theoretical Issues in Sign Language Research*, 1, 191–210.
- MacLaughlin, D. (1997). *The structure of determiner phrases: Evidence from American Sign Language*. Doctoral dissertation, Boston University.
- Neidle, Carol. (2003). Language across modalities: ASL focus and question constructions. *Linguistic Variation Yearbook* 2, 71-98.
- Padden, Carol A. (1988). *Interaction of Morphology and Syntax in American Sign Language*. New York: Garland.
- Partee, Barbara. (1991). Adverbial quantification and event structures. *Berkeley Linguistics Society* 17, 439-456.
- Petronio, Karen. (1993). *A focus position in ASL*. Doctoral Dissertation, University of Washington.
- Petronio, Karen. (1995). Bare noun phrases, verbs and quantification in ASL. In *Quantification in natural languages*, eds., Emmon Bach, Eloise Jelinek, Angelika Kratzer and Barbara Partee, 603–618. Dordrecht: Kluwer.
- Petronio, Karen and Diane Lillo-Martin. (1997). Wh-movement and the position of spec-CP: Evidence from American Sign Language. *Language* 73:18–57.
- Pfau, Roland, Steinbach, Markus, & Woll, Bencie. (Eds.). (2012). *Sign language: An international handbook* (Vol. 37). Walter de Gruyter.
- Quer, Josep. (2012). Quantificational strategies across language modalities. In *Selected papers from 18th Amsterdam Colloquium*. eds. Maria Aloni, Vadim Kimmelman, Floris Roelofsen, Katrin Schulz, Galit Sassoon, and Matthijs Westera, 82-91. Berlin: Springer.
- Quer, Josep and Markus Steinbach. (2015). Ambiguities in sign languages. *The linguistic review*, 32(1), 143 – 165.
- Rathmann, Christian. (2005). *Event Structure in American Sign Language*. Doctoral Dissertation, University of Texas, Austin.
- Schlenker, Philippe, Lamberton, Jonathan, and Santoro, Mirko. (2013). Iconic variables. *Linguistics and philosophy*, 36(2), 91-149.
- Stassen, Leon. (1985). *Comparison and universal grammar*. Oxford: Basil Blackwell.
- Stokoe, William. (1960). The sign structure: an outline communication systems of the American Deaf. *Studies in Linguistics, Occasional Papers*, 8.
- Supalla, Ted and Newport, Elissa. (1978). How many seats in a chair? The derivation of nouns and verbs in American Sign Language. In *Understanding language*

through sign language research, ed. Patricia Siple, 91–132. New York: Academic Press.

- Wilbur, Ronnie B. (2015). Word formation in sign languages. In *Word Formation. An international handbook (HSK - Handbooks of linguistics and communication science)*, eds., Peter O. Müller, Ingeborg Ohnheiser, Susan Olsen, Franz Rainer, 2225–2251. Berlin: Mouton de Gruyter.
- Wilbur, Ronnie B. (1994). Foregrounding Structures in American Sign Language. *Journal of Pragmatics* 22, 647–672.
- Wilbur, Ronnie B. (1996). Evidence for the function and structure of wh-clefts in American Sign Language. In *International review of sign linguistics*, ed. William Edmondson and Ronnie B. Wilbur, 209–256. Mahwah, NJ: Lawrence Erlbaum Associates.
- Wilbur, Ronnie B. (1998, Nov). *Generic and habitual structures in ASL: The role of brow raise*. Presented at Theoretical Issues in Sign Language Research 6, Gallaudet University, Washington, D.C.
- Wilbur, Ronnie B. (2008). Complex predicates involving events, time, and aspect: Is this why sign languages look so similar? *Signs of the time: Selected papers from TISLR 2004*, ed. Josep Quer, 217–250. Hamburg: Signum-Verlag.
- Wilbur, Ronnie B. (2009). Productive reduplication in ASL, a fundamentally monosyllabic language. *Language Sciences* 31:325–343.
- Wilbur, Ronnie B. (2010). The semantics-phonology interface. In *Sign languages: A Cambridge language survey*, ed. Diane Brentari, 355–380. Cambridge: Cambridge University Press.
- Wilbur, Ronnie B. and Patschke, Cynthia. (1999). Syntactic correlates of brow raise in ASL. *Sign Language Linguistics* 2:3–40.
- Wood, Sandra. (1999). *Semantic and syntactic aspects of negation in ASL*. Master's thesis, Purdue University.
- Zimmer, June and Cynthia Patschke. (1990). A class of determiners in ASL. *Sign language research: Theoretical issues*, ed. Ceil Lucas, 201–210. Washington, DC: Gallaudet University Press.