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THE RELATIONSHIP BETWEEN EYE GAZE AND VERB AGREEMENT IN AMERICAN SIGN LANGUAGE: AN EYE-TRACKING STUDY*

ABSTRACT. The representation of agreement is a crucial aspect of current syntactic theory, and therefore should apply in both signed and spoken languages. Neidle et al. (2000) claim that all verb types in American Sign Language (agreeing, spatial, and plain) can occur with abstract syntactic agreement for subject and object. On this view, abstract agreement can be marked with either manual agreement morphology (verb directed toward locations associated with the subject/object) or non-manual agreement (eye gaze toward the object/head tilt toward the subject). Non-manual agreement is claimed to function independently as a feature-checking mechanism since it can occur with plain verbs not marked with overt morphological agreement. We conducted a language production experiment using head-mounted eye-tracking to directly measure signers' eye gaze. The results were inconsistent with Neidle et al.'s claims. While eye gaze accompanying (manually/morphologically) agreeing verbs was most frequently directed toward the location of the syntactic object, eye gaze accompanying plain verbs was rarely directed toward the object. Further, eye gaze accompanying spatial verbs was toward the locative argument, rather than toward the object of transitive verbs or the subject of intransitive verbs as predicted by Neidle et al. Additionally, we found a consistent difference in the height of directed eye gaze between spatial and agreeing verbs. Gaze was directed lower in signing space for locative marking than for object marking, thus clearly distinguishing these two argument types. Plain verbs occurring with null object pronouns were not marked by gaze toward the location of the object and always occurred with an overt object topic. Thus, Neidle et al.'s analysis of null objects as licensed by agreement (manual or non-manual) was not supported. Rather, the data

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substantiated Lillo-Martin's (1986) claim that null arguments for plain verbs are licensed by topics. To account for the observed patterns of eye gaze, we propose an analysis of eye gaze agreement for agreeing and spatial verbs as marking the 'lowest' available argument on a noun phrase accessibility hierarchy.

1. Introduction

The study of signed languages is essential to a full understanding of the universal properties of human language. Research over the past thirty years has shown that signed languages conform to the same grammatical constraints and exhibit the same linguistic principles found in spoken languages (see Emmorey (2002) and Sandler and Lillo-Martin (2006) for a survey). Nonetheless, sign languages utilize modality-specific mechanisms to express linguistic structure. The nature of verb agreement is a good case in point. As a crucial feature of current syntactic theory, agreement must be governed by the same universal principles in signed as well as in spoken languages. At the same time, one might also expect there to be idiosyncratic manifestations of agreement marking in signed languages. For example, a unique aspect of sign language structure that is shaped by the visual modality is the use of eye gaze to express linguistic contrasts, including agreement marking (Baker and Padden 1978; Engberg-Pedersen 1993; Bahan 1996; Sutton-Spence and Woll 1999). Specifically, Bahan (1996), Bahan et al. (2000), Neidle et al. (1998), and Neidle et al. (2000), henceforth the 'Boston Group', propose that eye gaze in American Sign Language (ASL) functions independently of manual morphology as a feature-checking mechanism for agreement. In other words, eye gaze is seen as marking agreement features of a noun in much the same way that inflectional morphology does in traditional syntax. However, this proposal is based entirely on judgments of eye gaze by a few native signers and has not been tested empirically with naturalistic data.

We conducted a verb production study using a head-mounted eye-tracking system to investigate the Boston Group's proposed analysis and to clarify the grammatical functions of eye gaze in ASL. Eye-tracking technology allows us to determine with high accuracy and precision exactly where signers are looking, and thus we can pinpoint where and how eye gaze is directed during verb production. We used this technology to examine eye gaze accompanying verbs belonging to distinct verb classes in ASL.

2. Background

2.1. *Verb Classes*

Both verb agreement and pronominal reference in ASL are manifested through the use of locations ("referential loci") in signing space. Discourse referents are associated with spatial locations, and signers can direct verbs or pronominal signs toward these locations to refer to these referents. The association between a locus and a referent remains throughout the discourse until changed by the signer.

Padden (1983, 1988) argues that ASL verbs can be characterized as belonging to three classes: agreeing verbs, spatial verbs, and plain verbs (see Figure 1). Plain verbs are not directed toward spatial locations, while agreeing verbs[1] are directed toward locations in signing space to indicate arguments of the verb. Agreeing verbs mark the person and number features for subject and object, typically marking the subject first and then the object. For example, in Figure (1B), the verb BLAME moves from the subject location ("I") toward the object location ("you"). For ditransitive agreeing verbs, the verb agrees with the indirect object, not the direct object (Padden 1983).

Spatial verbs are also directed toward locations in signing space, but these verbs specify locatives.[2] Only spatial verbs indicate fine-grained distinctions in spatial locations, and therefore they are treated as distinct from agreeing verbs. For example, the spatial verb $_{a}\text{FLY}_{b}$ (fly from location *a* to *b*) has different meanings depending on whether the path movement of the verb is all the way to *b*, half-way to *b*, or to some other location along the continuum between *a* and *b*.[3] In contrast, when a signer produces an agreeing verb such as $_{a}\text{GIVE}_{b}$, variations in the endpoint of the verb along the continuum from *a* to *b* would be treated as phonetic variation, conveying no difference in meaning.

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[1] Padden originally referred to these verbs as 'inflecting verbs'.

[2] The term 'locative' will be used here to refer to an argument/adjunct of a verb, while 'location' or 'locus' will be used to refer to an area in signing space.

[3] Signs in ASL are customarily represented with English glosses in capital letters. Hyphens between glosses such as TWO-WEEKS-AGO represent one ASL sign that is translated with several English words. Subscript letters represent locations in space with which signs are associated (e.g., $\text{MAN}_{a}\ {}_{a}\text{GIVE}_{b}$). Within a sentence, words that share the same subscript are associated with the same spatial location.

Figure 1. Illustration of ASL verb types (from Emmorey 2002).

Another difference between agreeing and spatial verbs is that agreeing verbs encode the grammatical relations of subject and object, while spatial verbs encode locatives with the semantic roles of source and/or goal. Spatial verbs and ditransitive agreeing verbs can also encode the direct object with a handshape indicating object type (e.g., round, flat). To illustrate, consider the sentences below:

(1)a. BROTHER_a $_a\text{GIVE-HAT}_b$ SISTER_b
Subject *agreeing verb + DO* *recipient/goal IO*
'The brother gives the hat to his sister'

b. BROTHER_a $_a\text{PUT-HAT}_b$ SISTER_b
Subject/source locative *spatial verb + DO* *goal locative*
'The brother put the hat on his sister'

In these examples, the handshape encodes the direct object (hat) with a 'closed-x' handshape. Although the agreeing verb in (1a) looks superficially like the spatial verb in (1b), the locations toward which the verbs are directed are interpreted differently. In both sentences, the verb moves from location *a* (the brother) to location *b* (the sister). However, in (1a) the sister is interpreted as simply receiving the hat, while in (1b) the sister is interpreted as the location where the hat is placed. Thus, both spatial and agreeing verbs can encode the direct object, but they differ with respect to whether the verb agrees with an indirect object or a locative NP.

2.2. *Issues Associated with an Agreement Analysis*

Padden (1983, 1988) analyzes ASL agreeing verbs as containing morphological inflections for person and number. However, this

analysis is not uncontroversial. For example, researchers have observed that there are a potentially infinite number of possible locations toward which a verb can be directed (Liddell 1990; Lillo-Martin and Klima 1990; Askins and Perlmutter 1995). This fact is problematic for agreement accounts since all possible locations cannot be listed in the lexicon. The difficulty of positing an exact phonological representation for agreement is underscored by Liddell's (1990, 2003) observations that agreeing verbs are produced at variable heights that change in relation to the nature of the referent. For example, the verb ASK-TO is directed toward the chin and HAVE-TELEPATHY-WITH is directed toward the forehead of a present referent (e.g., an addressee). Further, for an imagined tall person, ASK-TO is directed toward the chin of that person and thus at a higher location in space than for an imagined seated or short person. Liddell (2003) thus concludes that there is no agreement in ASL because spatial loci cannot be represented with a fixed set of phonological features, and an agreement morpheme must be phonologically specifiable.

Askins and Perlmutter (1995) have also argued that the specific location toward which the hand is directed depends on the discourse situation and is unspecified in the phonological and morphological representation of these verbs (see also Mathur 2000; Lillo-Martin 2002; Rathmann and Mathur 2002). Like Liddell, they claim that spatial locations are non-linguistic. However, they posit a grammatical directional morpheme that indicates whether the verb is directed from the subject to the object or from the object to the subject (i.e., ''backwards'' verbs, see section 2.4). Thus, the phenomenon of ''agreement'' is argued to be realized as a combination of linguistic and non-linguistic elements.

In addition, Lillo-Martin (2002) provides evidence that agreement cannot be completely gestural. She argues that there are fixed phonological forms for first person and plural agreement that are co-articulated with the gestural component. For example, a plural morpheme imposes an 'arc' shape on the movement of a verb while the gestural component directs the sign to a particular location in space. While locations in space are infinite and therefore unlistable, the plural marker has a determinate phonological form that combines predictably with verb roots and must be specified in the lexicon. Additionally, she points out that there are specific grammatical constraints on agreement (e.g., agreement only occurs on a subset of ASL verbs) and various syntactic phenomena

interact with agreement (e.g., agreement can license null arguments). An analysis without a linguistic agreement process cannot account for these facts. Lillo-Martin (2002) concludes that while the locations toward which verbs are directed may be gestural and determined by the discourse, they interact with and are constrained by the grammar.

We adopt this type of dual representation (gestural and grammatical) for both eye gaze and manual agreement. That is, we assume that verb agreement in ASL involves a lexically-specified direction morpheme, but that spatial locations are unspecified.

2.3. *The Boston Group's Analysis of ASL Agreement*

The Boston Group assumes Padden's syntactic analysis of ASL verb classes (agreeing, plain, and spatial verbs). However, they further argue that all three verb types can occur in clauses with syntactic agreement. Although plain verbs have no inflectional morphology and spatial verbs inflect to mark a locative, the Boston Group claims that these verbs can also occur with agreement phi-features of the subject and object.

According to Chomsky (1993), fully inflected lexical items inserted into the syntax need to move to the head of the appropriate agreement projection in order to check the features associated with their inflectional morphology.[4] The heads of these agreement projections house syntactic phi-features relevant to agreement morphology. Thus, phi-features (which consist of person and number in ASL) provide a checking system that insures lexical items are inserted into the syntax with the proper inflections. According to the Boston Group, in ASL, phi-features can be checked and thus satisfy agreement requirements through inflectional morphology, via movement of the verb between loci (e.g., as seen in Figure 1B) or through the use of 'non-manual' markers (eye gaze and/or head tilt).

Several non-manual markers have been shown to have grammatical functions in ASL, e.g., to mark yes–no questions, topics, *wh*-questions, relative clauses, and rhetorical questions (Baker and Cokely 1980; Liddell 1980; Baker-Shenk 1983, 1985). For example, *wh*-questions must be accompanied by a specific set of non-manual markers: furrowed brows, squinted eyes, and a slight head-shake

[4] Some current syntactic models employ a feature-checking mechanism that does not require movement, but the idea is basically the same – features need to be checked.

Figure 2. Illustration of eye gaze and head tilt marking in ASL. The signer is producing the verb BLAME (translated as "he/she blames him/her"; cf. Figure 1B). The verb begins at the location of the subject (on the signer's right; first image) and moves toward the location of the object (on the signer's left; second image). The signer tilts his head to the right in order to check the subject phi-features and gazes towards his left to check the object phi-features. This example was found on the BU website: http://www.bu.edu/asllrp/.

(Baker and Cokely 1980). The Boston Group argues that eye gaze and head tilt are non-manual markers that express agreement by referencing the same spatial locations as manual agreement marking. Eye gaze marks the object, and head tilt marks the subject. As can be seen in Figure 2, eye gaze is directed toward the location in signing space associated with the object, and the head is tilted toward the spatial location associated with the subject. In intransitive constructions, either head tilt or eye gaze can mark subject agreement.

The Boston Group assumes a syntactic structure for ASL that includes agreement projections for both subject and object (AgrS and AgrO), following Chomsky's Minimalist Program (Chomsky 1993). They argue that eye gaze and head tilt are overt realizations of abstract agreement features housed in these functional projections, and that non-manual markers operate independently of manual agreement. Thus, non-manual markers must have their own independent functional projections (AgrS and AgrO) within the syntactic structure (see Figure 3).[5] Their analysis therefore provides evidence from ASL to support a syntactic structure containing

[5] For a discussion of the Boston Group's analysis of *wh*-movement as rightward into the (left-branching) spec of CP see Neidle et al. (1998).

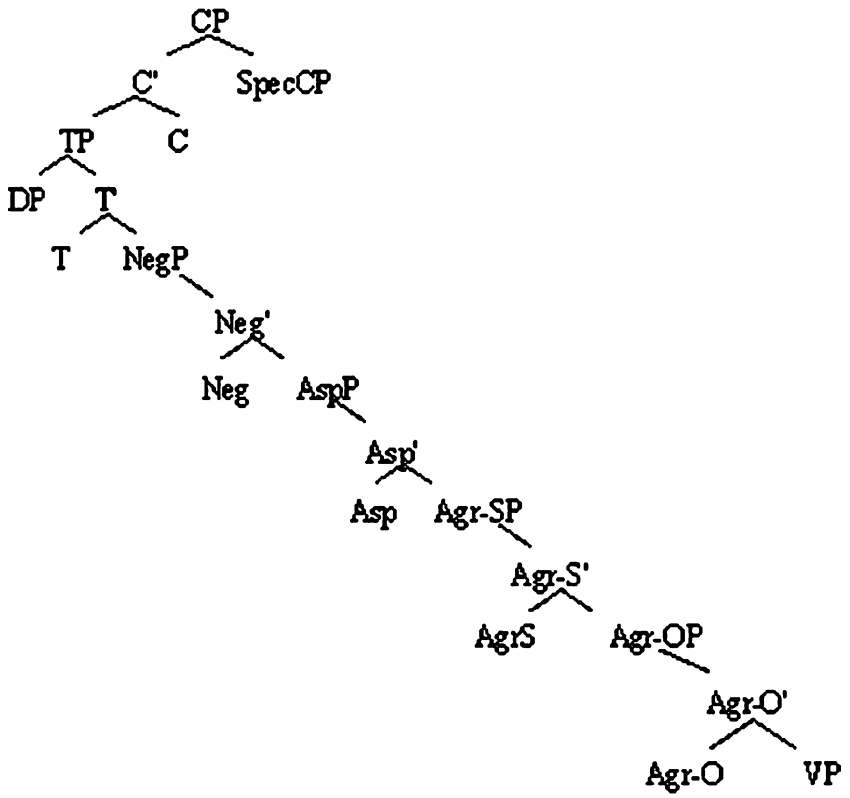

Figure 3. The Boston Group's proposed syntactic structure for ASL, including agreement projections for both subject and object (AgrS and AgrO) which house both phi-features and non-manual agreement features (from Neidle et al. 2000, p. 3).

such functional projections. One goal of our study was to test the Boston Group's theoretical claims by ascertaining whether eye gaze does in fact operate independently of manual agreement as a feature checker.

As noted above, agreement can be checked either manually or non-manually. The Boston Group claims that while non-manual agreement occurs quite frequently, it is essentially optional. For agreeing verbs, this claim is reasonable, given that eye-gaze agreement in these cases would be redundant with manual agreement. Plain verbs, however, do not occur with any manual agreement, and spatial verbs mark locatives, not person and number features for subject and object. For these verb types, the claim that non-manual agreement is optional is problematic. This is because for syntactic well-formedness, one would expect eye gaze agreement in the absence of manual agreement for

person and number. Below, we discuss some of the issues specific to plain and spatial verbs that arise from the Boston Group's analysis.

2.3.1. *Eye Gaze Agreement: Plain Verbs*

The Boston Group claims that the use of eye gaze to mark agreement plays an additional role in the licensing of null objects with plain verbs. In this environment, eye gaze agreement is said to be obligatory in order to license the null argument. An example from Neidle et al. (2000: 71–72) is given in (2), with the notations for functional projections deleted for simplicity.

(2) a. eye gaze$_j$
JOHN LOVE *pro*$_j$
'John loves (him/her).'

b. *JOHN LOVE *pro*
'John loves (him/her).'

In ASL, null arguments are permitted with all verbs regardless of whether the verb expresses manual agreement (Lillo-Martin 1986). Lillo-Martin argues that there are two separate licensing processes. Null arguments with agreeing verbs are licensed by agreement (as in Spanish and Irish). However, null arguments with plain verbs (which she analyzes as having no agreement) are licensed by topic-hood (as in Chinese; see Huang 1982). Thus, under her analysis, both (2a) and (2b) with non-topic objects are ungrammatical, but they are grammatical if the object is the discourse topic or an overt topic as in (2c):

(2) c. t
MARY, JOHN LOVE *pro*
'It is Mary, John loves.'

In contrast, the Boston Group argues that both non-manual and manual marking of agreement can license null arguments. Thus, their analysis predicts that (2a) with eye-gaze agreement will be grammatical, while (2b) without eye-gaze agreement will be ungrammatical. Sentences such as (2c) with an overt topic that can be interpreted as co-referential with *pro* are still ungrammatical under their analysis without some form of agreement.

In our verb production study, we attempted to elicit (a) plain verbs, in order to ascertain the independence of eye gaze as an agreement marker in the absence of manual agreement and (b) plain

verbs with null objects, in order to assess the function of eye gaze in the licensing of null arguments. Plain verbs have only non-manual marking available for checking agreement because (by definition) they do not exhibit manual agreement. Therefore, it is reasonable to hypothesize that eye gaze should be employed more frequently as a feature checker for plain verbs than for agreeing verbs. Furthermore, eye gaze should be directed only toward the object location or toward the addressee (the default gaze direction; see Siple 1978). That is, eye gaze should not be directed toward other locations because its function as an agreement marker would then be lost.

2.3.2. *Eye Gaze Agreement: Spatial Verbs*

For transitive spatial verbs, Bahan (1996) claims that the location associated with the object is expressed by the location of the hands at all times during the articulation of the verb. In other words, as the hands move through space, so does the location of the object's phi-features. If eye gaze marks person and number features, then for spatial verbs with an object (e.g., transitive MOVE, as in "He moved the book to the table"), eye gaze should be directed toward the initial object location and track the hand to the end location in order to 'continually' check the object phi-features. Similarly, for intransitive spatial verbs such as MOVE (Figure 1C), as in "He moved to New York," the location of the subject is understood as moving with the hands, and the predicted pattern of eye gaze is the same. That is, gaze should be directed toward the subject location at all times when it occurs.

Alternatively, spatial verbs may agree with locative features rather than with features of the subject and object (contra the Boston Group). Although spatial verb morphology manually marks locatives in much the same way that agreeing verbs mark subject and object, a formal analysis of locative agreement in ASL has not been proposed. Thus, while Padden (1983, 1988) argued that spatial verbs take locative affixes, she did not present an agreement analysis for this verb type. Fischer (1996) did argue that for Japanese Sign Language, affixes indicating source and/or goal are in fact a form of agreement, but with location rather than person. While locative agreement is rare, Croft (1988) observed that some spoken languages, such as Abkhaz, have verbs of motion that show agreement with the goal:

(3) a-xaħ°-c°àħ° à-ʃaq'a j- à- k°- i- c'eit'
the-beam the pillar it(beam)- it(pillar)- on- he- put
'he put the beam on the pillar' (Hewitt 1979, p. 186)

In (3) the verb 'put' requires a morpheme indicating the goal of the action, 'the pillar'.

If eye gaze marks locatives for spatial verbs, rather than subject or object arguments, then eye gaze should not follow the hands. Instead, eye gaze should be directed toward the location in signing space associated with the locative. This means that for MOVE in either 'He moved to New York' or in 'He moved the book to the table', eye gaze would be directed toward the final location of the verb to mark the agreement features of the locative. If eye gaze marks the locative argument of spatial verbs, we will be able to add to our limited knowledge of locative agreement cross-linguistically. Therefore, to discover whether eye gaze marks the subject, object, or locative of the verb, we included spatial verbs in our study.

2.4. *Additional Issues for a Syntactic Analysis of ASL Eye Gaze Agreement*

A potential problem for an agreement analysis of eye gaze is posed by Nespor and Sandler (1999), who hypothesize that non-manual marking (e.g., mouth movements, eyebrow position, and head position) is the sign language equivalent of prosody in spoken language (see also Wilbur 2000). It is therefore possible that eye gaze may serve a prosodic function instead of marking grammatical roles. If eye gaze marks prosodic elements within a sentence, the behavior of eye gaze should be consistent across verb types. For example, if the role of eye gaze is to group syntactic constituents into hierarchical prosodic domains, the pattern of eye gaze should not differ for agreeing, spatial and plain verbs. If the role of eye gaze is to mark focus, we would also expect eye gaze to be similar across verb types, because the verb types should not differ systematically with respect to discourse focus.

A second potential problem with regard to a syntactic analysis of eye gaze is that it has also been analyzed as a way to mark the point of view of a discourse referent (e.g., Engberg-Pedersen 1993; Lillo-Martin 1995). In this case, the eye gaze of the signer imitates the referent's gaze. For example, when giving an object, a person may be likely to look toward the recipient of the object. Thus, when signing GIVE from the perspective of the agent, the signer would also look toward the location associated with the recipient. If eye gaze simply marks point of view, then the salience of participants or objects in the discourse should drive eye gaze patterns.

A particular sub-class of agreeing verbs that mark the object first and the subject second ('backwards verbs'; see Figure 4) presents an additional problem for a syntactic analysis of manual verb agreement. Within such an analysis, backwards verbs have to be stipulated as exceptions in the lexicon. Semantic analyses of manual agreement can account for backwards verbs by positing that agreeing verbs mark source and goal, rather than subject and object (Friedman 1975; Shepard-Kegl 1985; Meir 1998b; Janis 1995; Taub 2001). However, semantic analyses cannot account for certain syntactic phenomena, such as optional subject agreement but obligatory object agreement. This agreement pattern can only be explained in terms of grammatical relations (see Padden 1983, 1988). The pattern of eye gaze agreement for backwards verbs is unknown. Thus, if eye gaze is directed toward the goal, a semantic analysis is supported, whereas if eye gaze is directed toward the object, a syntactic analysis is supported.

2.5. *The Goals of the Paper*

Our primary aim in this study was to determine the relationship between eye gaze and verb agreement in ASL. Specifically, we tested several predictions that follow from the Boston Group's proposal that eye gaze functions as an independent feature checker for verb agreement. First, it follows from the Boston Group's analysis that eye gaze during verb production should be systematic for all verb types. That is, gaze should be directed toward the addressee (the

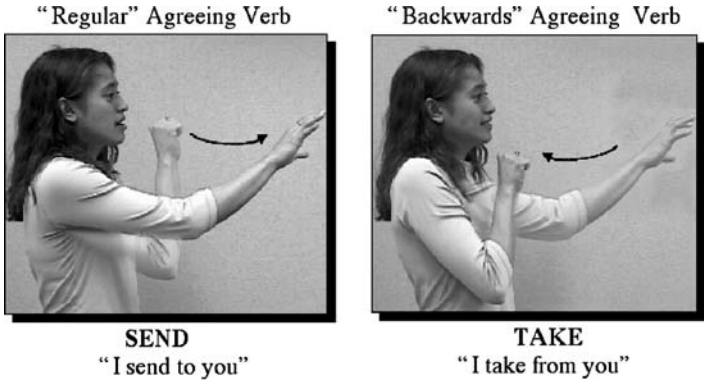

Figure 4. Illustration of a regular agreeing verb which moves from subject to object location and a backwards agreeing verb which moves from object to subject location (from Emmorey 2002).

default gaze location), toward the object location (for transitive verbs), or toward the subject location (for intransitive verbs). Gaze should very rarely be directed toward other spatial locations. If a systematic eye gaze pattern is not observed across clauses containing all verb types, it will indicate that not all ASL verbs types occur freely with agreement. Second, the Boston Group analysis predicts that eye gaze will be frequently directed toward the object location for plain verbs. If object agreement does *not* occur with plain verbs, there will be no evidence that eye gaze functions as an *independent* feature-checker, because plain verbs represent the only opportunity for eye gaze to mark agreement separately from manual morphology. Third, null object pronouns are claimed to be licensed by agreement, and therefore eye gaze should always be directed toward the location associated with the object for sentences with plain verbs and no overt object. Fourth, the Boston Group predicts that eye gaze accompanying spatial verbs should be directed toward the initial location and then track the hand to the final location, marking the object for transitive verbs or the subject for intransitive verbs. Alternatively, we suggest that eye gaze may mark locative agreement, in which case gaze should be directed only toward the locative location.

Finally, we explored the possibility that eye gaze might function as a prosodic marker or as a point of view marker. If so, the pattern of eye gaze should be not determined by verb class. If eye gaze is used to mark prosody or point of view, then the salience of participants or objects in the discourse should drive eye gaze patterns. We also investigated the eye gaze pattern associated with backwards verbs in order to distinguish between a syntactic and a semantic analysis of eye-gaze agreement.

3. Methods

3.1. *Subjects*

A total of ten native signers (four men and six women) participated in the study (mean age = 28.6 years). All subjects were from Deaf families and exposed to ASL from birth (nine Deaf, one hearing native signer).

3.2. *Materials*

A picture story consisting of eight pictures was used for the first two tasks of the study: picture-by-picture telling of the story and then

re-telling of the story from memory. The pictures depict a classroom scene in which three boys take turns drawing a caricature of their teacher until the teacher catches one of them. The picture story was specifically designed to induce signers to associate the characters with distinct locations in signing space. This was accomplished by drawing the three boy students (the main characters) so that they look almost exactly alike. With similar-looking characters, the signer cannot use physical features (e.g. the black-haired one) to describe who is doing what. The easiest way to distinguish the characters in the story is by setting them up at distinct locations in space. This strategy was very successful, and all the subjects adopted it. The story elicited several agreeing, spatial, and plain verbs.

For the third task of the experiment (see below for details), subjects were asked to make up a story using a list of 26 ASL verbs (12 plain,[6] 7 agreeing and 7 spatial; see Appendix). More plain verbs were included in the list because, according to the Boston Group's analysis, these are the only verb types that require non-manual agreement. The entire list of verbs was randomized so that each subject was presented verbs in a different order.

3.3. *Procedure*

Signers' eye movements were monitored using *iView*, a head-mounted eye-tracking system (SensoMotoric Instruments, Inc.). The eye-tracking device consists of two miniature cameras: one, the scene camera, films the subject's field of view, and the second, the eye camera, tracks the subject's eye movements. In the resulting video, a cursor indicating the subject's eye position is superimposed onto the image of the subject's field of view. Another camera recorded the subject's signing and was time-locked to the eye position video via a digital mixer. The composite video also contained an image of the signer's eye, which was used to identify eye blinks and to corroborate eye gaze direction (see Figure 5). The eye-tracker is attached to a lightweight bicycle helmet and is fairly unobtrusive. A major advantage of

[6] Three of the plain verbs used (MAKE, WANT, and LOSE) can optionally show agreement with subject or object. These verbs have been analyzed by Padden not as agreeing verbs, but as plain verbs occurring with pronoun clitics (1990). Within our data, we compared plain verbs that can show optional agreement with those that can't and found no significant difference between the groups when comparing verb type with eye gaze ($F(3,27) = 0.195$, $p < 0.89$ ns). We therefore followed Padden's analysis and treated them as plain verbs.

head-mounted eye-tracking is that participants' head movements are unrestricted. Subjects reported that they were not disturbed by the helmet and almost forgot it was there during the study.

The study took about 40 minutes to run, including fitting the eye-tracker helmet, calibrating the instruments and running the actual experiment. The first author, a fluent hearing signer, did the fitting and calibration of the eye-tracker, while a native Deaf signer conducted the actual experiment.

The subjects sat in a chair placed six feet from the Deaf researcher, and after a few minutes of conversation for the subjects to settle in, they performed the three tasks. The accuracy of the eye-tracker was checked between tasks, and re-calibration was performed as needed (re-calibration was required only three times during the entire study). When re-calibration was required, data from the preceding task were discarded.

As noted, the first task was to sign the classroom story picture by picture. The second task was to repeat the story from memory without referring to the pictures, which allowed for a more natural flow of signing. For the third task, subjects were told the beginning of a second story involving the characters 'Jack' and 'Jill'. They were told that Jack and Jill had recently met and become friends. The signer set up Jack on the left of signing space and Jill on the right. Subjects were then asked to continue the story using verbs that were signed to them

Figure 5. A videoframe from the scene camera mixed with signer's eye image (upper right corner) and view of the signer (lower left corner). The white dot indicates the direction of the signer's gaze, which is to the right of the addressee.

one at a time by the researcher. The story was begun for subjects in an attempt to elicit sentences in 'third person' without having to explicitly ask for it. We wanted to avoid 'first person' narratives because eye gaze cannot be directed toward first person (i.e., the signer's own body). By setting up story characters in space and asking subjects to continue the story, we were able to elicit third person constructions, which were then compared across verb types. All the subjects adopted the placement of Jack and Jill as signed to them by the experimenter, although two subjects later moved them to new locations.

3.4. *Analysis*

For each task, the full screen videotape of the subject signing was time-coded and transcribed. Verb types were classified according to Casey (2003). The transcription was used to determine (a) the exact start and end times for each verb, (b) where subjects placed referents in signing space, and (c) whether they referred to these referents overtly or used *pro*-drop. The videotape with the eye-position cursor was used to record the exact position of gaze during verb production. Eye gaze coordinates were determined by using a graph overlay with one-inch cells on the video monitor. (For reference, the addressee's head took up about 4 cells.)

Eye gaze was coded as follows. Gaze to the addressee was coded as anywhere on the addressee's face or falling within one inch around the addressee's head. Eye gaze was coded as toward the object location for the direct object of transitive verbs and toward either the direct or indirect object for ditransitive verbs. Eye gaze toward the assigned subject location was coded as subject gaze. For transitive spatial verbs, eye gaze was coded as toward the object if it tracked the hand and toward the locative if gaze was directed solely toward the final location. For intransitive spatial verbs, the subject and the locative were almost always associated with the same location in signing space, and gaze was therefore coded as subject/locative. Finally, eye gaze was coded as 'other' when gaze was directed above the addressee's head or toward the addressee's body (the majority of cases) or toward an unassigned location in signing space. Approximately 11% of the verbs collected were not used in the study. Verb productions were discarded when the eye gaze data were unclear or uncodable, e.g., when the subject blinked during the production of a verb. Using this coding system, inter-rater reliability for gaze position was 91% (based on two coders analyzing a subset of the data).

4. Results

Across all three tasks, a total of 290 agreeing verbs, 251 plain verbs, and 210 spatial verbs were produced with clear gaze direction. For each subject, we calculated the mean percentage of eye gaze toward each location for all three verb types (see Figure 6 and Table I). The same pattern of eye gaze was observed for all three tasks, and the data were therefore collapsed across these tasks (e.g., gaze directed toward the object location for agreeing verbs was 74% for task 1, 75% for task 2 and 73% for task 3). Further, eye gaze was consistently toward the indirect object (98.4%) for ditransitive verbs. Thus, direct object gaze for transitive verbs and indirect object gaze for ditransitive verbs were collapsed into one 'object' category. Collapsing these two object types was done for simplicity of presentation and did not affect the results.

To determine whether eye gaze differed significantly across verb types, we utilized a repeated measures analysis of variance (ANOVA), with the mean percentage of eye gaze toward each location as the dependent variable. First, we compared the gaze data for the agreeing and plain verbs with a 2 (verb type) $\times$ 4 (gaze direction: subject, object, addressee, other) experimental design. There was a main effect of eye gaze direction, indicating that the direction of eye gaze was not random ($F(3,27) = 17.55$, $p < 0.001$). Additionally, there was a significant interaction between verb type and gaze direction ($F(3,27) = 47.01$, $p < 0.001$) such that eye gaze was

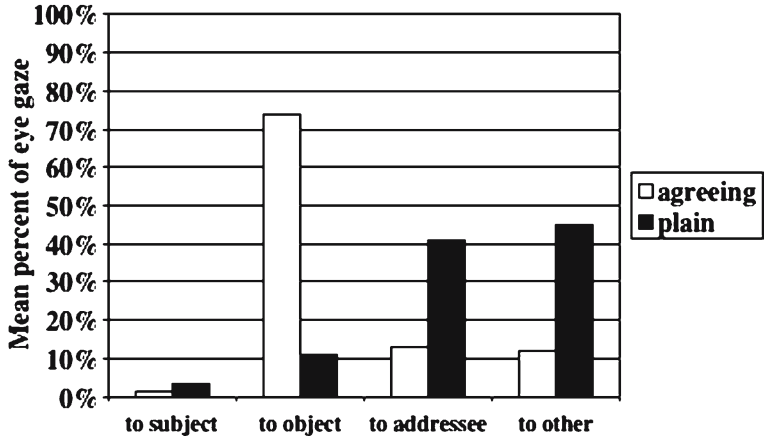

Figure 6. Mean percent eye gaze toward verb arguments, the addressee's face, or another location.

TABLE I

Mean percent eye gaze toward verb arguments, the addressee's face, or another location for spatial verbs. SD = standard deviation

	Direction of eye gaze									
	Subject		Object		Locative		Addressee		Other	
Spatial Verb Type	%	SD	%	SD	%	SD	%	SD	%	SD
Transitive	2.5	5.0	2.62	5.22	72.22	24.09	13.58	13.15	9.01	10.97
Intransitive	68.15*	15.8	N/A	N/A	68.15*	15.18	23.07	14.12	8.78	8.20

*For intransitive verbs, the subject and locative arguments are associated with the same location in signing space.

directed most often toward the object location for agreeing verbs (73.8%) but not for plain verbs (11.1%) ($t(9) = 10.1$, $p < 0.0001$) (see Figure 6). For plain verbs, gaze was most often directed toward the addressee (40.71%) or 'other' locations (44.88%). Null object pronouns with plain verbs were rare, occurring only two times and always with an overt topicalized object. For both of these sentences, gaze was directed at the addressee.[7]

Recall that for backwards agreeing verbs, the movement is from the object (source) toward the subject (goal) location, rather than from the subject (source) toward the object (goal) location (the pattern for regular agreeing verbs). We examined eye gaze data from backwards verbs to determine whether gaze was toward the syntactic object or the semantic goal. The analysis revealed that gaze was uniformly directed toward the syntactic object (82.5%) rather than the semantic goal (0%).

Next, two separate repeated measures one-way ANOVAs were conducted for the transitive and intransitive spatial verbs. The results for transitive spatial verbs revealed a significant effect of gaze direction ($F(4,36) = 24.15$, $p < 0.0001$) (see Table I). Eye gaze was directed

[7] Bahan (1996) claims that 'body lean' (leaning the body toward a specified location in space) can also be used instead of eye gaze to mark agreement and thus license a null object in these cases. However, in Neidle et al. (2000) the role of body lean as a marker of agreement is not discussed, and the current analysis of body lean is unclear. In any case, for these sentences, there was no body lean toward the location associated with the object.

most often toward the location associated with the locative (72.22%), rather than the object (2.62%) ($t(8) = -7.93$, $p < 0.0001$). Results for the intransitive spatial verbs also revealed a significant effect of gaze direction ($F(2,18) = 37.22$, $p < 0.0001$). Eye gaze was directed most often toward the locative/subject location (68.15%), rather than toward the addressee (23.07%) or 'other' location (8.78%).

Finally, we noticed that eye gaze for locatives tended to be slightly lower in signing space than gaze for objects. We therefore systematically coded gaze height using grid coordinates for each fixation toward an object or locative location for each subject. Eye gaze fixations were significantly lower in signing space for locative agreement than for object agreement ($t(9) = 8.06$, $p < 0.0001$) by approximately two one-inch cells (cf. section 3.4).

5. Discussion

5.1. *Empirical Predictions of the Boston Group Analysis*

The eye-tracking results confirmed that in ASL, eye gaze accompanying agreeing verbs is directed toward the object location, as claimed by the Boston Group. However, we found no evidence to support the claim that all ASL verb classes occur with abstract agreement, or that eye gaze functions as an independent feature checker. If all verbs occur in clauses marked for abstract agreement, then eye gaze toward the object should have been observed for all verb types, which was not the case. Rather, we found that eye gaze was directed primarily toward the 'other' category for plain verbs, toward the object for agreeing verbs, and toward the locative for transitive spatial verbs. According to the Boston Group, non-manual marking can be used to check agreement phi-features even with plain verbs that have no manual agreement morphology. This means that directed eye gaze should almost always be toward the object for these verbs. However, eye gaze was only rarely directed toward the object location for plain verbs (see Figure 6). Eye gaze was consistently directed toward the object location *only* for agreeing verbs.

Furthermore, if eye gaze serves to check the agreement features of the object with all verbs (including plain verbs), then gaze should be constrained in such a way that only meaningful eye gaze (i.e., toward the object location or toward the addressee's face) would occur during the production of a transitive verb. The location associated with the object referent is not fixed; that is, there is no single ''standard'' object

location in signing space, and referent-location associations can change throughout a discourse. Therefore, the addressee must evaluate each gaze within the context of the discourse to determine if it is relevant or not. As can be seen in Figure 6, eye gaze for plain verbs was most often directed toward the addressee's body or an unassigned spatial location (i.e., the 'other' category: 44.88%). Thus, the addressee would be unlikely to interpret those few instances of gaze toward the object location (11.1%) as intentionally marking agreement.

There is additional evidence against the view that the few examples of eye gaze toward the object location for plain verbs constitute instances of agreement: hearing novice signers, whose gaze pattern during verb production appears to be random, also look toward the object location for plain verbs a small percentage of the time (25%). The gaze pattern of novice and native ASL signers is similar for plain verbs, but differs dramatically for agreeing and spatial verbs (Thompson and Emmorey 2004, 2005), suggesting that native signers are not marking eye gaze agreement for plain verbs. Since plain verbs constitute the only environment where eye gaze might occur independently of manual agreement, there is thus no evidence to support the Boston Group's claim that eye gaze functions as an *independent* feature checker.

The Boston Group also claims that eye gaze agreement is obligatory for the licensing of null object pronouns with plain verbs. However, in this environment, eye gaze was toward the addressee and again not directed toward the location associated with the object. This result provides counter-evidence to the claim that eye gaze agreement licenses null objects. Furthermore, our data contained no examples of null object pronouns with plain verbs in the absence of an overt topic, despite our attempts to elicit them. We therefore assessed the grammaticality of such constructions by showing example (2a) from the Boston Group (repeated below) to seven native signers. All signers judged the sentence to be ungrammatical. Finally, these data are consistent with Lillo-Martin's (1986) account of null arguments with plain verbs as licensed by topic. Under her analysis, examples like (2a) with non-topic objects are ungrammatical (and example (2a) should therefore be starred), while example (2c) with a topic that is co-referential with *pro* is grammatical.

(2) a.* JOHN LOVE pro_j
eye gaze$_j$
'John loves (him/her).'

_____t
c. MARY_j, JOHN LOVE pro_j
'As for Mary, John loves her.'

If eye gaze marks only person and number features, as hypothesized by the Boston Group, then for transitive spatial verbs, eye gaze should be directed toward the object location. However, this was not the pattern we observed (see Table I). For transitive spatial verbs, eye gaze was toward the locative rather than the object location. Eye gaze did not track the hand, continually checking the object phi-features, as predicted by Bahan (1996). Rather, gaze was directed toward the locative location and moved away before the hand arrived at that location.

The Boston Group's analysis predicts eye gaze toward the subject for intransitive verbs. For most intransitive spatial verbs (e.g. SIT), the locative and subject were associated with the same location, and gaze was directed toward that location. However, for a small subset of these verbs (e.g., WALK-TO), the subject and locative are separable. For these cases ($N = 22$), eye gaze was toward the locative (54%), rather than the subject location (0%). Together, these data indicate that eye gaze marks the locative of spatial verbs, rather than the subject or object.

In sum, while the data show evidence of systematic eye gaze agreement for agreeing verbs, there is no such parallel pattern for plain verbs. In addition, eye gaze agreement for plain verbs was not observed in the one environment where it was claimed to be obligatory (i.e., to license null object pronouns). We therefore conclude that eye gaze agreement occurs only in conjunction with manual agreement. Finally, eye gaze accompanying spatial verbs was found to mark agreement with the locative, and thus the claim that agreement marks only person and number features must be revised.

5.2. *Some Problems with the Boston Group's Account of Eye Gaze Agreement*

The Boston Group claims that manual agreement is expressed by morphological inflections on the verb, while non-manual agreement markers are the expression of agreement features housed in the heads of functional projections (see section 2.3). Both of these forms of agreement can also be found in English:

(4) a. I want.
b. He wants.

(5) a. They were going.
b. He was going

In sentences (4), agreement is expressed on the verb. In sentences (5), agreement features are expressed within the functional head. In English and in other languages, these two expressions of agreement exist in complementary distribution, occurring either within the VP (in which case the features need to be checked with the corresponding features in the functional head), or within the functional head, but not in both places. The unusual part, then, of the Boston Group's claim is that agreement can optionally be expressed at the same time in both the VP (manual agreement) and the AgrP (non-manual agreement).

The Boston Group states that their analysis of clausal agreement "... relies crucially on a feature checking mechanism, whereby features are located both on lexical items (added to the lexical item prior to its insertion into the syntax) and in the heads of functional projections" (pp. 76), a standard assumption of minimalism (Chomsky 1993). What is not discussed and remains unclear is how feature checking proceeds under this analysis. With respect to all three verb types, how does feature checking differ when object agreement is syntactically expressed as eye gaze versus when it is not? For agreeing verbs in particular, what is the relation between optional eye-gaze versus obligatory manual expression of syntactic agreement in terms of feature checking? In English and elsewhere, when agreement features are overtly realized in the head of a functional projection (see example 5), the verb itself does not have features that need to be checked. With overtly realized phi-features in AgrO (i.e. eye gaze toward the object location), there is no clear mechanism for checking the features expressed by the manual agreement morphology of agreeing verbs.

The Boston Group claims that non-manual markers (e.g., negation, *wh*-question marking, agreement) are housed in AgrP and that they function independently of manual marking, located in the VP. The evidence for the independence and location of non-manual markers relies on facts about 'distribution' (non-manual markers are said to occur independently of manual markers), 'spread' (a non-manual marker is claimed to spread, or continue over the c-command

domain of the node with which it is associated), and 'intensity' (non-manual markers should be articulated with the greatest effort at the syntactic node of origin).

In terms of eye gaze agreement, evidence from distribution and spread can be potentially found only in the absence of manual agreement. This is because gaze is only claimed to be *necessarily* present and *required* to spread over the entire c-command domain of AgrO when there is no manual agreement present, i.e. with plain verbs. However, since eye gaze agreement in our study did not occur with plain verbs, its independence as an agreement marker is not supported, and facts about distribution and spread cannot be used as evidence for its location within a syntactic structure. With respect to the intensity of eye gaze, the Boston Group suggests that maximal intensity refers to gaze that is directed toward the location of the object, and less intensity refers to gaze that has returned to a more neutral position. If eye gaze is associated with AgrO, then it should be the most intense at this node and decrease in intensity after that. Unfortunately, since the syntactic structure proposed by the Boston Group places AgrO string-adjacent to the VP, with no intervening material, we cannot distinguish the node of origin as AgrO or as part of the VP. Thus, the 'intensity' of eye gaze likewise cannot be used as evidence for its location within a syntactic structure.

5.3. *Our Proposed Analysis and its Theoretical Consequences*

The first theoretical consequence of our findings is that the phi-features of non-manual eye gaze agreement need not be housed in an independent functional projection. Manual and non-manual agreement appear to be integrally tied together, and we therefore suggest that they are two parts of one morpheme. This is analogous to circumfixes occurring in spoken languages (e.g., the circumfix, *ka—an* in Tagalog that means 'the class or group of X', or *nda—i* used for negation in Guarani). Circumfixes consist of a prefix and suffix: an envelope into which a word is inserted. However, in ASL concatenative morphology is rare, with morphemes usually occurring simultaneously with the verb. In the case of agreement, eye gaze does occur before the beginning of the verb, usually beginning about 160 ms before the onset. In contrast, manual object agreement occurs concurrently with the verb, not as a separate suffix. Thus, we use the term circumfix here not to describe the linear nature of eye gaze, verb, and manual agreement, but to capture the

nature of a circumfix as two recognizably different parts that must still be analyzed as a single morpheme. Such a single morpheme analysis of agreement is preferred over the Boston Group's analysis because their analysis posits a cross-linguistically unattested system of feature checking, the mechanics of which remain unclear. Additionally, a single morpheme analysis does not require an AGR projection, and thus is more in keeping with recent work that rejects agreement as an independent functional head with its own phrasal projection (see Chomsky 1995; Baker 1996).

However, if eye gaze marking is the prefixal part of a single agreement morpheme, then we must explain why it does not *always* co-occur with its manual agreement counterpart. One possibility is that while eye gaze should be marked on all agreeing and spatial verbs, it must also compete with the other functions of eye gaze, such as regulating turn taking, checking addressee comprehension, and marking role shift (Baker 1977; Padden 1986). Such competition may create a co-articulation problem in which eye gaze performing agreement functions is blocked. It is perhaps the redundancy of eye gaze with manual agreement that allows it to be blocked in these situations. Another possibility is suggested by the use of *ne—pas* in French. In spoken French, there is variable deletion of *ne*. This variation is due to a variety of social and stylistic variables (e.g., socioeconomic status, formal/informal register) (see Armstrong 2002). It is possible that the use of eye gaze is similarly stochastic, varying in use depending on stylistic choices. Clearly, more research is needed to test these different hypotheses.

The patterns of eye gaze agreement we observed can be summed up as follows:

A. Gaze occurring with agreeing verbs marks the object

1. the direct object for transitive verbs
2. the indirect object for ditransitive verbs

B. Eye-gaze with spatial verbs marks the locative

The pattern of agreement in (A) is common cross-linguistically, e.g., Bahasa Indonesia (Chung 1976), Southern Tiwa (Allen and Frantz 1983), and Tzotzil (Aissen 1983). Thus, an idiosyncratic agreement marker, namely eye gaze, still follows a predictable pattern in natural languages. As noted in section 2.3, locative agreement is uncommon but not unattested, e.g., Abkhaz (Hewitt 1979) and Manam (Lichtenberk 1983). We propose to account for the ASL pattern by

appealing to the Accessibility Hierarchy proposed by Keenan and Comrie (1977), shown below. This hierarchy was originally proposed to account for patterns of relative clause formation across languages, but it appears to capture a universal 'natural' ordering of arguments. For example, the hierarchy is able to explain other phenomena such as causativization and case marking (Comrie 1976; Croft 1988).

Subject > *Direct Object* > *Indirect Object* > *Oblique* > *Genitive* > *Object of Comparison*

The Accessibility Hierarchy applies only to verbal arguments, not to adjuncts. Keenan and Comrie (1977) state, "... we intend here NP's that express arguments of the main predicate, as *the chest* in *John put the money in the chest* rather than ones having a more adverbial function like *Chicago* in *John lives in Chicago* or *that day* in *John left on that day*" (pp. 66).

We argue that locatives are in fact arguments of spatial verbs in ASL. Evidence for this proposal is the fact that locatives are required by spatial verbs. Normally, spatial verbs are produced with a locative (e.g., STAND, see Figure 7A). However, when no specific location in signing space is encoded, a neutral base hand must be added to the sign (see Figure 7B). Our proposal is that when a base hand is added to a spatial verb, it serves as an argument filler for the locative. In other words, it takes the place of the required locative argument.[8] The base hand represents a neutral non-specific location, e.g., for STAND, the base hand simply specifies "stand on a flat surface." This pattern also holds for spatial verbs with implicit arguments (e.g., WRITE, DRAW, READ). For example, the sign WRITE can be produced with or without the base hand. To illustrate, in the classroom picture story from our study, one picture shows the teacher writing on a blackboard on the left side of the room. To describe this scene, subjects produced WRITE without a base hand on a vertical plane to their left, indicating a specific location within the scene. At other times, WRITE was produced with a base hand, and in these instances, the meaning was "write on a flat surface." Thus, spatial verbs require a locative argument, encoded either with a specific location in signing space or with the base hand.

[8] Verbs like STAND can sometimes occur with a base hand even though they are located in a non-neutral location. In such cases, the meaning of the verb can only be understood as emphatic. We claim that this emphatic form is different from the generic verb.

Figure 7. Illustration of A) STAND with no base hand and B) STAND with a neutral base hand.

In cases where there are two locatives (e.g., 'fly from New York to California'), eye gaze was consistently directed toward the goal location – not the source. We suggest that it is again the distinction between arguments and adjuncts which predicts gaze direction in this situation.

Namely, spatial verbs such as PUT or MOVE subcategorize for a locative with the thematic role of 'goal', making 'source' an adjunct rather than an argument. Cross-linguistic data show that verbs do not take two locative arguments, and for languages that employ locative arguments through the use of applicatives, it is the goal that is encoded (see Peterson 1999 for cross-linguistic data and Baker 1988 for discussion). Similarly, for ASL, if a spatial verb can mark both source and goal, it is the goal that is obligatorily marked. For example, GO-TO can mark both source and goal ($_{a}$GO-TO$_{b}$) or just the goal (GO-TO$_{b}$), but crucially it cannot mark just the source (*$_{a}$GO-TO).[9] These facts suggest that spatial verbs are limited to one locative argument, and in cases when two locatives occur it is the goal locative that is the required argument. Under such an analysis, the direction of gaze during the production of a spatial verb is easily predicted: gaze is always directed toward the locative argument of the verb.

[9] For some spatial verbs, the source can be encoded without the goal (e.g., LEAVE, MOVE-AWAY). However, the majority of these verbs appear to be intransitive, only optionally encoding their source location. We were able to find only two spatial verbs for which the source locative is required: PLANE-TAKE-OFF and JUMP-OFF. Thus, locative *arguments* with the thematic role of source appear to be rare in ASL. Our hierarchy predicts that eye gaze will be directed only toward arguments, and we did not find gaze toward optional source locatives in our data. However, spatial verbs occurring with *required* source locatives were not produced in this study.

Data from other languages further support our claim that agreement in ASL occurs with locative arguments and not locative adjuncts. Cross-linguistically, the status of locatives as arguments may determine their ability to participate in grammatical processes. For example, Bresnan (1994) argues that predicates that undergo locative inversion must take a locative argument (not an adjunct) in uninverted constructions. In addition, Bantu languages with locative agreement (e.g., Zulu, Kinyarwanda, Chishona) use 'locative applicatives' which change the valency of the verb, making the locative an argument and thus allowing agreement. The fact that locatives participate in agreement processes in ASL is further evidence that such locatives are arguments and not adjuncts.

The nature of eye-tracking data allowed us to examine whether eye gaze toward an object location was qualitatively distinct from eye gaze toward a locative. Our analysis revealed that signers consistently directed their gaze lower in signing space to mark locative agreement than when marking object agreement. The height of eye gaze was determined by the type of agreement rather than by where the noun arguments had been established in signing space. For example, in task three (story continuation), the referents "Jack" and "Jill" were assigned to spatial locations on the left and right at roughly equal heights. When signers produced agreeing verbs using Jack and Jill as referents (e.g., 'Jack bothered Jill'), their eye gaze was relatively high in signing space. However, when they produced spatial verbs using the same referents (e.g., "Jack flew over to Jill") their gaze was relatively lower, even though the referents remained in the same location. Thus, signers produced a clear distinction between locative and object agreement with respect to eye gaze, and this distinction was driven by verb type, not by the relative placement (high or low) of the referent NPs.

To capture the facts about eye gaze behavior for both spatial and agreeing verbs, we propose the following eye gaze agreement hierarchy.[10]

[10] It is not clear that ASL has ditransitive verbs with the theme and goal expressed as arguments of the verb (e.g., as direct and indirect object respectively). It is likely that these verbs encode the goal as object and the theme as an oblique, which makes them similar to the English verb 'endow'. Some evidence that there are no true ditransitives in ASL comes from incorporation and agreement facts. For example, with the verb GIVE, the theme is usually not stated or is incorporated into the verb with a change in handshape and thus not a true object; the verb agrees with the agent (subject) and the goal (object). If this analysis is on the right track, then there is no need for the indirect/direct object distinction in the proposed hierarchy and it can be reformulated as Subject < Object < Locative.

Subject < Direct Object < Indirect Object < Locative

Within this hierarchy, eye gaze marks the *lowest* argument. The agreement hierarchy is arranged in this order to demonstrate the similarity to Keenan and Comrie's (1977) Accessibility Hierarchy.[11] The eye gaze hierarchy can also account for the pattern of manual agreement first identified by Padden (1983,1988).[12] That is, manual agreement also marks the lowest argument in the hierarchy. Our account is based on the claims that (a) spatial verbs take locative arguments and (b) agreement is only with arguments of the verb (for further evidence supporting this claim, see Thompson, in preparation).

Finally, we need to address the alternatives to a syntactic agreement analysis raised in section 2.4. One possible alternative analysis is that eye gaze marks prosodic elements such as focus. If the function of eye gaze is to mark prosodic elements, the pattern of gaze should be consistent across all three verb types, which was not observed. Rather, the pattern of eye gaze was related to the syntactic arguments of the verb, which do not differ in focus. A second alternative is that eye gaze simply marks point of view and imitates the gaze of a discourse referent. Under a point-of-view analysis, eye gaze with plain verbs such as HUG should pattern similarly to agreeing verbs such as HIT, with gaze toward the thing/person being hugged or hit. This pattern was not observed. While eye gaze may serve as a focus marker or as a point of view marker elsewhere, it does not serve these functions when accompanying agreeing and spatial verbs.

Another alternative analysis is that eye gaze agrees with semantic roles rather than with syntactic arguments. Backwards verbs provide a case where the grammatical object and the semantic goal are dissociated. We found that eye gaze marked the syntactic object rather than the semantic goal. For example, when producing a backwards verb such as BORROW,[13] signers directed their eye gaze toward the

[11] This ordering also allows for the possibility that the same hierarchy can be used to account for head tilt behavior, with head tilt marking the highest argument. Head tilt was not analyzed in our study because the degree of tilt could not be accurately measured from the video data.

[12] See also Janis (1995) for her use of a hierarchy that includes the grammatical roles of subject, direct object, and indirect object, along with several semantic roles, to account for manual agreement facts.

[13] Verbs of transfer like BORROW and LEND obligatorily show agreement with the source and goal, not the theme. (e.g., MAN_a $_a\text{BORROW}_b$ WOMAN_b 'the man borrowed from the woman').

source. However, when producing a regular agreeing verb such as LEND, gaze was directed toward the goal. Thus, the eye gaze data are at odds with a semantic account of eye gaze agreement and consistent with a syntactic account, since the source of BORROW and the goal of LEND are both mapped onto the syntactic object position.

Finally, the data from backwards verbs show that eye gaze does not follow the movement of the hands through space. That is, eye gaze does not mirror the manual agreement morphology because the verb moves toward the goal/subject and eye gaze is directed toward the source/object. This fact appears to create a problem for our single morpheme analysis of agreement. However, a recent analysis proposed by Meir (1998a, b) may provide the solution to a unified account of eye gaze agreement and manual agreement. Meir (1998a, b) uses data from backwards verbs to propose that verb agreement encodes *both* syntactic and semantic arguments. She claims that the syntactic argument is determined by the facing of the hands and the semantic argument by the movement of the verb. For example, SEND and TAKE (see Figure 4) are both produced with the palm facing out (toward the syntactic object), but move in opposite directions (toward the differing goal locations). We propose that eye-gaze agreement patterns with the facing of the hands in marking syntactic agreement.

To conclude, the eye-tracking data clearly support the use of eye gaze as a syntactic agreement marker in ASL. Alternative accounts of eye gaze as marking semantic roles, discourse focus, prosodic structure, or point of view were not supported by the data. Furthermore, the data do not support the Boston Group's claims that all verbs are agreeing, or that agreement marks only person and number features. We propose a unified account of agreement for both spatial and agreeing verbs. Using an agreement hierarchy, both verb types simply mark agreement with their lowest ranked argument. The proposed hierarchy can moreover account for both eye gaze and manual agreement. ASL has recruited a modality-specific mechanism, eye gaze, to mark linguistic contrasts using a hierarchy that captures a common cross-linguistic ordering of arguments.

Appendix

Verbs used for Task 3

Plain verbs	Agreeing verbs	Spatial verbs
MISS	*TAKE	MOVE
HUG	BOTHER	DRIVE
BELIEVE	HELP	FLY-BY-PLANE
HAVE	BLAME	PUT
LISTEN	ASK-TO	STAND
LOSE	*INVITE	GO-TO
LIKE	*BORROW	ARRIVE
WANT		
MAKE		
UNDERSTAND		
GUESS		
CHERISH		

*backwards verbs

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