UNIVERSITY OF CALIFORNIA, SAN DIEGO

Eye gaze in American Sign Language:

Linguistic functions for verbs and pronouns

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Linguistics and Cognitive Science

by

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The Dissertation of Robin L. Thompson is approved, and it is acceptable in quality and form for publication on microfilm:

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Dedication

To the Three Treasures

Large and Small

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ABSTRACT OF THE DISSERTATION

Eye gaze in American Sign Language:

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by

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This dissertation investigated the grammatical use of eye gaze in American Sign Language (ASL) in three experiments, all of which make use of head-mounted eye-tracking technology. Experiment 1 investigates the use of eye gaze to mark verb agreement by native signers of ASL. The results support the use of eye gaze as a verb agreement marker. However, the findings differ from previous claims that eye gaze marks object agreement across all three ASL verb types (agreeing, spatial, and plain). Instead, the data argue for a system of eye gaze agreement that marks verbs according to a universal accessibility hierarchy: Subject < Direct Object < Indirect Object < Locative. Experiment 2 investigates

the acquisition of eye gaze agreement by hearing late learners of ASL. The focus is how language-specific properties, including modality, might influence the acquisition of a signed second language (L2). Beginning signers (> 2 years of sign exposure) do not direct their gaze appropriately when producing ASL verbs, indicating that the linguistic use of eye gaze does not occur "naturally," but must be learned. Proficient late-learners of ASL followed the eye gaze patterns we had observed for native signers, thus replicating our previous results. However, they overgeneralized the use of eye gaze, marking agreement for plain verbs as well as spatial and agreeing verbs. Overall, L2 learners of ASL eye gaze exhibit the same patterns of L2 acquisition found in spoken languages suggesting that modality had little if any affect on acquisition. Experiment 3 investigated whether directed eye gaze also occurs during the production of pronouns. The use of directed eye gaze to mark pronominal referents is predicted by some analyses of ASL pronominals. However, the results show no systematic gaze distinction occurring with pronouns, thus indicating that the underlying mechanism for verb agreement and pronominal reference is not the same. In sum, this research shows that an exotic language feature such as eye gaze can function as a syntactic marker that follows linguistic principles and can be learned.

1.

Dissertation Introduction

If the study of languages had begun with a signed instead of a spoken language, our views about language universals would likely be very different. The research presented here offers an in-depth look at eye gaze—a seemingly small, and until recently generally overlooked, aspect of American Sign Language (ASL) grammar. While a better understanding of the grammatical functions of eye gaze is an important endeavor in and of itself, the research here also enters into the thick of several fundamental and often controversial questions about the nature of language: what is possible in human languages, how they are learned, and how language features arise.

Given the infinite range of possibilities, languages appear remarkably constrained and almost uniform in their range. To illustrate this point, we might imagine many language features that could but never do arise. As just one example at the level of articulation, it would be quite possible for spoken languages to include sounds made with parts of the body other than the mouth and vocal tract (e.g., snapping or clapping with the hands). Yet this does not occur. Further, while there is variation across languages, what stands out is how the same language patterns arise again and again. Thus, the more we look at languages the clearer it becomes that they are constrained by underlying language principles.

One of the questions raised here is to what degree signed languages are constrained in the same way that spoken languages are. The surface make-up of

spoken and signed languages is obviously different. While spoken languages are expressed in the aural-oral modality (and make use of the ears and mouth), signed languages are expressed in the visual-manual modality (and make use of the eyes and hands). In this dissertation, I investigate the use of eye gaze as a grammatical marker in ASL. While eye gaze is a modality-specific feature of signed languages, it is unclear to what extent the use of this rather exotic feature is constrained by the same universal language principles as spoken languages. For example, does eye gaze mark agreement for the same features that are marked in spoken languages? Spoken languages mark agreement for some or all of three features (person, number, and gender/noun class), and manual agreement in ASL has been found to mark two of these three features on the verb (person and number; Padden, 1988). Eye gaze may likewise mark person and number agreement features redundantly in ASL, or may be shown to mark features outside the realm of spoken languages. In this dissertation I investigate the use of eye gaze to mark verb agreement and ask whether or not the grammar that emerges using eye gaze as an agreement marker follows the same principles found in spoken language agreement systems.

Another question is how language-specific properties, including modality, might influence the acquisition of a signed second language (L2). For example, sign languages are able to make use of iconicity (i.e., some phonological properties of the sign resemble some aspects of the mental representation of the corresponding objects or actions) to a far greater extent than is evident in spoken languages, where iconicity is relegated to infrequent use of onomatopoetic words

(e.g., “buzz” and “splash” in English). Beginning L2 signers have been shown to make use of a sign’s iconicity as a strategy for learning (Campbell, Martin & White, 1992) while, for native L1 acquisition, iconicity appears to play no role in sign language learning (Morgan, Barriere & Woll, 2002). This makes sense given that children learn signs before they are cognitively able to make the connection between the iconic properties of a sign and the real world object that it represents.

In relation to the use of space to mark agreement in signed languages, there are obvious differences compared to spoken language features realized by sound properties. However, it is unclear to what extent these surface phonological differences will impact learning. L2 learners appear to reach fairly high levels of proficiency in producing manual agreement markers, although there have been no formal studies looking at relative levels of attainment. While manual agreement is systematically and comprehensively taught in sign language classes, however, eye gaze agreement is never mentioned – and in fact, most native signers are unaware of its very existence, or of the role that it plays in the language. Thus when it comes to the use of eye gaze to mark agreement, L2 ASL learners may completely overlook the grammatical use of eye gaze and do nothing with their eyes.

Alternatively, language learners may be paying attention to underlying universal patterns of a language. In spoken languages, the difference between so-called unaccusative verbs (Perlmutter, 1978) with a patient-like subject (e.g., break) and other intransitive verbs (e.g., dance) with an agent-like subject can create grammatical effects such as the use of different perfect auxiliary verbs (*be*

vs. *have*) with the two verb types (Sorace, 1993). Yet, akin to the use of grammatical eye gaze in ASL, this difference exists below the level of conscious awareness for most speakers and is rarely if ever taught as such in the classroom (e.g., auxiliary usage for different verbs may be taught, but without mention of the underlying unnaccusative distinction driving the differences). Nonetheless, even with no overt instruction, there is evidence that L2 learners are sensitive to the difference between these two verb types (Oshita, 1996). Thus if L2 ASL learners are similarly cued into underlying universal properties of language, surface modality differences may have little impact on acquisition.

Finally, this dissertation investigates how particular features or patterns of a language emerge. While there is generally agreement that languages are constrained by underlying language principles, the mechanism(s) responsible for constraining languages are not well understood. If we accept that signed languages are true languages, then we might expect them to be limited by the same constraints as spoken languages. However, it is also possible that different language modalities will result in different processing needs, and that the constraints that apply to signed languages will therefore differ in certain ways from those that apply to spoken languages. For example, one effect that appears to be directly related to language processing in a visual/manual modality is that signed languages tend to be more simultaneous in nature. Thus at the morphological level, signed languages evidence a preference for non-concatenative morphology over the concatenative or affixal morphology found

predominantly in spoken languages (Klima & Bellugi, 1979; Aronoff, Mier, & Sandler, 2000). The preference for morphology that is either simultaneous or linear is likely the result of language modality. Non-concatenative morphology is thought to be dispreferred in spoken languages due to the processing complexity that comes from altering the structure of the base form, while the processing advantage of concatenative morphology provides a straightforward mapping between the surface form of a word and its underlying representations (Hall, 1992; Anderson, 1992). For signed languages the opposite preference is exhibited.

Emmorey (2002) points out two likely reasons for this. First, the hands are relatively slow articulators (particularly compared to speech articulators), which may put an extra burden on working memory. If signed languages were to have mostly sequential morphemes, the burden might be too much for efficient processing. Second, the problem of complexity that arises from non-concatenative morphology is not a problem in a visual mode. This is because vision can more easily encode spatially distinct information in parallel. Thus specific language effects could arise as the result of processing advantages related to modality (e.g., different anatomical or environmental constraints).

The expression of grammatical person is also an area where differences between signed or spoken languages may be found. Specifically, there is also evidence that while spoken languages encode three-person systems of reference (first, second & third), signed languages only have two-person systems (first and non-first). From one perspective, the system of person marking might be

considered an independent universal principle of grammar and as such, should exhibit no differences between signed and spoken languages. However, there may be different processing constraints between the two languages that could create such a difference. Thus this dissertation further investigates the possible difference in person marking systems with an examination of the relationship between eye gaze and the ASL pronominal system.

The work presented here represents three experiments (Chapters 2, 3, and 4). These experiments all make use of a head-mounted eye-tracker to look at eye gaze during the production of ASL. Chapter Two investigates the unique and modality-specific use of eye gaze to mark verb agreement by native signers of ASL. In Chapter Three, I extend this work by investigating the acquisition of eye gaze agreement in late L2 learners. Chapter Four turns to an investigation of eye gaze during the production of pronouns in order to compare gaze within different linguistic paradigms and also to address questions about person marking in ASL. Chapter Five concludes with a general discussion of the findings.

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2

The Relationship Between Eye Gaze and Verb Agreement in American Sign Language

Abstract

The representation of agreement is a crucial aspect of current syntactic theory, and therefore should apply in both signed and spoken languages. Neidle, Kegl, MacLaughlin, Bahan, & Lee (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. (2000). 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 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.

2.1. 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.

2.2 Background

2.2.1 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 2.1). 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

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

(2.1B), 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 $_{a}$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 $_{a}$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.

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

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[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., MANa $_{a}$GIVE$_{b}$). Within a sentence, words that share the same subscript are associated with the same spatial location.

Figure 2.1. Illustration of ASL verb types (from Emmorey, 2002).

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:

(2.1) a. BROTHER$_a$ $_a$GIVE-HAT$_b$ SISTER$_b$
Subject *agreeing verb+DO* *recipient/goal IO*
'The brother gives the hat to his sister'

b. BROTHER$_a$ $_a$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 (2.1a) looks superficially like the spatial verb in (2.1b), 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 (2.1a) the sister is interpreted as simply receiving the hat, while in (2.1b) 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.

2.2.2 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 2.2.4). 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.

2.2.3 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

[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 2.1B) 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 (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 2.2, eye gaze is directed toward the location in signing space associated with the object, and the head

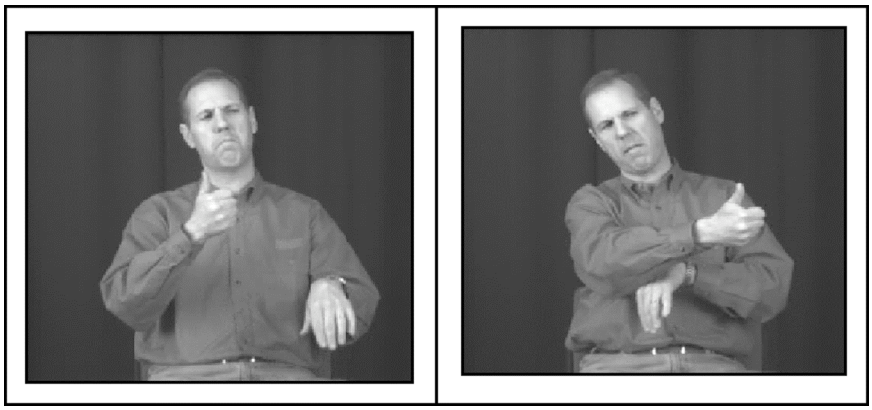

Figure 2.2. Illustration of eye gaze and head tilt marking in ASL. The signer is producing the verb BLAME (translated as "he/she blames him/her"; cf. Figure 2.1B). The verb begins at the location of the subject (on the signer's right; first image) and moves toward the location of the object (on the signer's 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/.

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 2.3).[5] Their analysis therefore provides evidence from ASL to support a syntactic structure containing 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

[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).

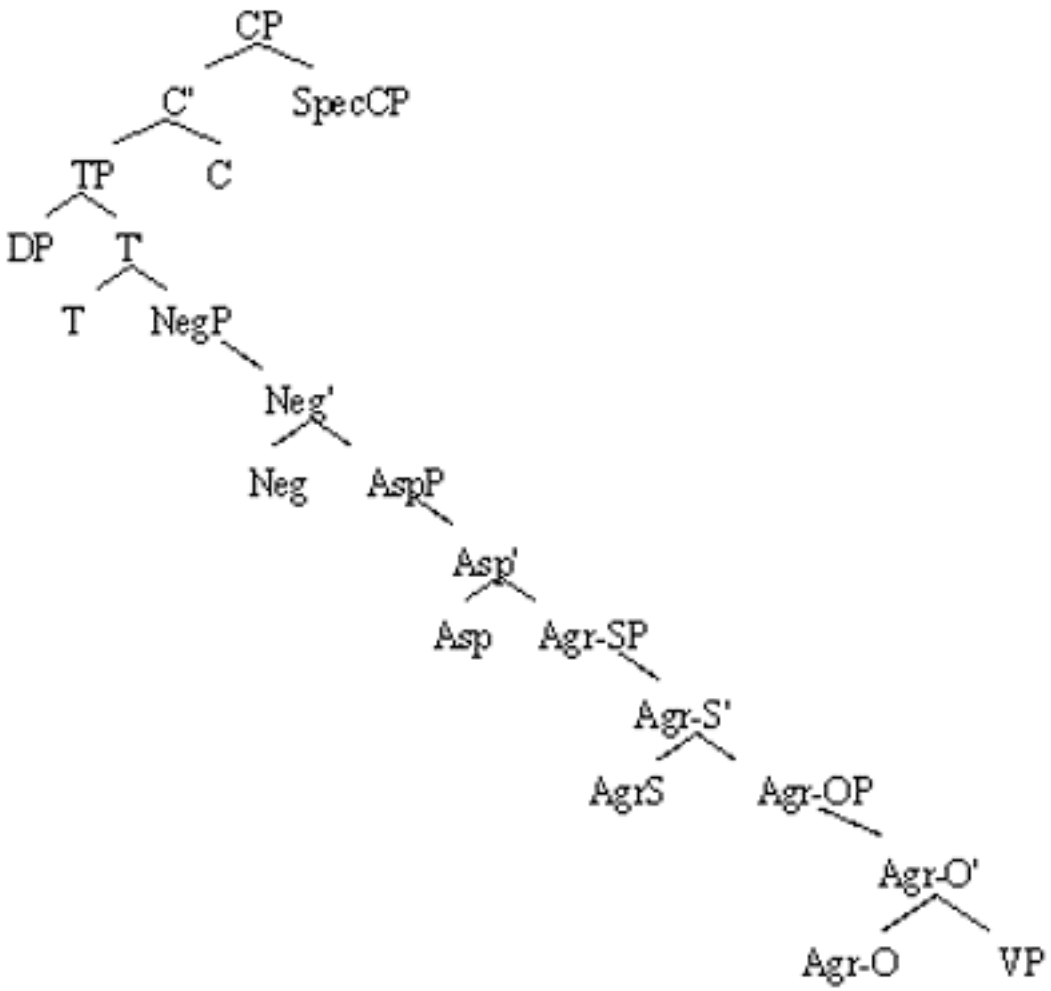

Figure 2.3. The Boston Group's proposed syntactic structure for ASL, including agreement projections for both subject and object (AgrS and AgrO) which house both phi-features and non-manual agreement features (from Neidle et al., 2000, p. 3).

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.

2.2.3.1 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 (2.2), with the notations for functional projections deleted for simplicity.

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

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

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 (2.2a) and (2.2b) with non-topic objects are ungrammatical, but they are grammatical if the object is the discourse topic or an overt topic as in (2.2c):

(2.2) c. MARY, JOHN LOVE *pro* (t)
'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

(2.2a) with eye-gaze agreement will be grammatical, while (2.2b) without eye-gaze agreement will be ungrammatical. Sentences such as (2.2c) 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.

2.2.3.2 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 2.1C), 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:

(2.3) a-xah°-c°àḥ° àʃaq'a j-à-kº-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 (2.3) 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.

2.2.4 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 2.4) 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.

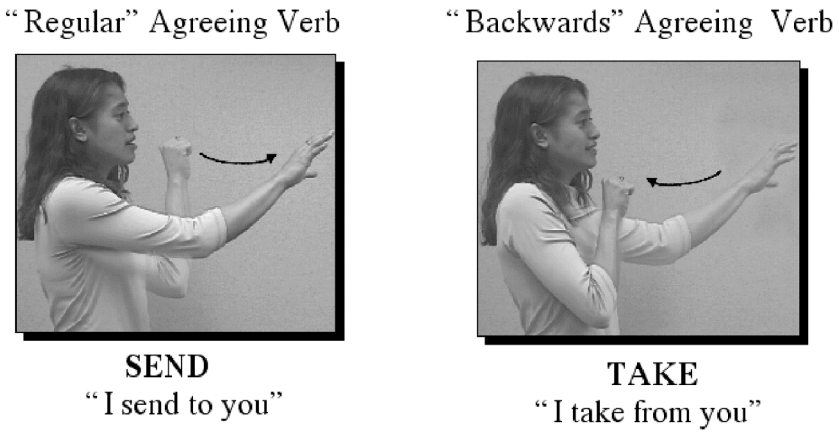

Figure 2.4. Illustration of a regular agreeing verb which moves from subject to object location and a backwards agreeing verb which moves from object to subject location (from Emmorey 2002).

2.2.5 The Goals of the Verb Agreement Study

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 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.

2.3 Methods

2.3.1 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).

2.3.2 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.

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[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 ($F(3,27) = 0.195$, $p < 0.89$). We therefore followed Padden's analysis and treated them as plain verbs.

2.3.3 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 2.5). The eye-tracker is attached to a light- weight bicycle helmet and is fairly unobtrusive. A major advantage of 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.

Figure 2.5. A video-frame 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.

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 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.

2.3.4 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).

2.4 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 2.6 and Table 2.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) X 4 (gaze direction: subject, object, addressee, other)

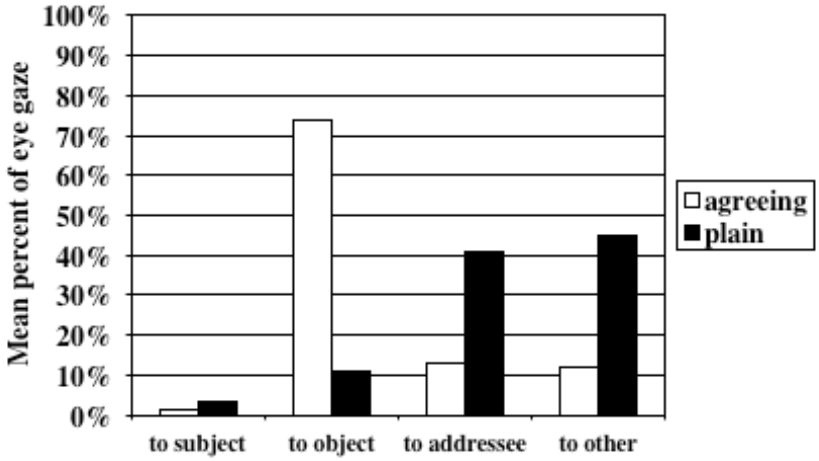

Figure 2.6. Mean percent eye gaze toward verb arguments, the addressee's face, or another location.

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 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 2.6). 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%).

Table 2.1. Mean percent eye gaze toward verb arguments, the addressee's face, or another location for spatial verbs. SD = standard deviation. *For intransitive verbs, the subject and locative arguments are associated with the same location in signing space.

	Direction of Eye Gaze									
	Subject		Object		Locative		Addressee		Other	
Spatial Verb Type	%	SD	%	SD	%	SD	%	SD	%	SD
Transitive	2.5	5.0	2.6	5.2	72.2	24.1	13.6	13.1	9.0	11.0
Intransitive	68.2*	15.8	N/A	N/A	68.2*	15.2	23.1	14.1	8.8	8.2

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 2.I). Eye gaze was directed most often toward the location associated

[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.

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 2.3.4).

2.5 Discussion

2.5.1 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 2.6). 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 2.6, 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 & 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 (2.2a) 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 (2.2a) with non-topic objects are ungrammatical (and example (2.2a) should therefore be starred), while example (2.2c) with a topic that is co-referential with pro is grammatical.

eye gaze$_j$

(2.2) a.* JOHN LOVE *pro*$_j$
'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 2.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.

2.5.2 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 2.2.3). Both of these forms of agreement can also be found in English:

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

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

In sentences (2.4), agreement is expressed on the verb. In sentences (2.5), 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'' (p. 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 2.5), 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.

2.5.3 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 250ms 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 & 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 2.2.3, 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'' (p. 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 2.7A). However, when no specific location in signing space is encoded, a neutral base hand must be added to the sign (see Figure 2.7B). 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

[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.

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.

Figure 2.7. 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.

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

[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.

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]

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 2.2.4. 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

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[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.

[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.

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 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

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

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 2.4) 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.

Chapter 2, in part, is a reprint of the material as it appears in Natural Language & Linguistic Theory 24, 571-604,Thompson, R. L., K. Emmorey and R. Kluender, May, 2006

2.6 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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3.

Learning to Look: The Acquisition of Eye Gaze Agreement During the Production of ASL Verbs

Abstract

In American Sign Language (ASL), native signers use eye gaze to mark agreement (Thompson, Emmorey & Kluender, 2006). Such agreement is unique (it is articulated with the eyes) and complex (it occurs with only two out of three verb types, and marks verbal arguments according to a noun-phrase accessibility hierarchy). We conducted a language production experiment using head-mounted eye-tracking to investigate the extent to which eye gaze agreement can be mastered by late second-language learners.

The data showed novice signers with less than 2 years of ASL exposure do not direct their gaze appropriately when producing verbs, but nonetheless produce a pattern of gaze different from English-speaking non-signers. Even though eye gaze agreement is never explicitly taught in ASL classrooms, proficient late learners mastered a cross-linguistically prevalent pattern within the eye gaze agreement system (accessibility hierarchy) but ignored an idiosyncratic feature (marking agreement on only a subset of verbs). Proficient signers thus produced a divergent grammar for eye gaze agreement that is different from native signers, but more consistent with language universals.

3.1 Introduction

Motivation for the study of language acquisition is based in part on the assumption that understanding how specific languages are acquired will inform us about the general principles that underlie all languages. For example, an important question for both first language acquisition in children and for second language acquisition (SLA) in adults is whether universal aspects of language develop in a different way and on a different time scale from the language-specific details of any one language.

Another important issue is the role that both implicit and explicit learning play in language acquisition. It has often been assumed that implicit learning plays a larger role in first language acquisition in children, while adults rely more heavily on explicit learning strategies for purposes of acquiring second languages. However, there is now evidence that implicit learning plays a much larger role in adult SLA than was previously thought (Harley, 1989; White, 1991). Adult second language learners, like children acquiring their first language, acquire linguistic features that they are never explicitly taught (e.g., Sorace, 1993a) and make systematic errors of overgeneralization never heard in their input. This suggests an underlying processes of structural reanalysis which may be in part influenced by the language-universal vs. language-specific aspects of the language being learned (e.g., Oshita, 1998). Finally, another question relevant to the study of SLA addresses the degree to which age of acquisition can influence the acquisition of the second language (L2). It is well known that the age at which one

begins learning a second language affects ultimate proficiency (Johnson and Newport, 1989; Berk, 2004).

Over and above these considerations in the study of spoken language acquisition, the study of signed language acquisition poses additional challenges because of the intrinsic perceptual and motor differences between the oral/aural and the visual/manual modalities. Research has shown that signed languages conform to the same grammatical constraints and linguistic principles found in spoken languages (for reviews see Emmorey, 2002; Sandler & Lillo-Martin, 2006) and that children exposed to sign languages from birth acquire their native sign language with the same ease as children exposed to a spoken language (Newport & Meier, 1985). Further, we now know that early exposure to a language in the visual/manual modality is just as critical as early exposure to spoken language (Newport, 1990; Mayberry, Lock & Kazmi, 2002). However, virtually nothing is known about the degree to which language-specific properties, including modality of a spoken L1, might influence the acquisition of a signed L2, the degree to which implicit vs. explicit learning plays a role in sign language acquisition, or about how language-universal vs. language-specific aspects of a signed language are attained.

We have recently demonstrated experimentally that eye gaze plays a systematic role in marking the arguments of ASL verbs that are also marked by manual agreement (Thompson, Emmorey & Kluender, 2006). As outlined in more detail below (see section 3.2.2), ASL signers associate referents with locations in

space, and agreement can be marked by directing eye gaze to a referent location while manually producing a verb. There are three facets of this visual linguistic behavior that are of relevance for questions of SLA.

First, there seems to be no real possibility of first language transfer in the acquisition of agreement marked by eye gaze. No spoken language has ever been shown to mark the arguments of verbs with eye gaze, and thus there is no mechanism for transfer. Therefore, the study of whether and how L2 learners use eye gaze to mark agreement will help to determine whether or not adult second language learners are capable of acquiring linguistic features encoded in a way that they have never been previously exposed to in a lifetime of spoken language experience.

In ASL, arguments of verbs are also marked by manual agreement (i.e. with the movement of the sign) and L2 learners appear to reach high levels of proficiency in correctly producing such manual agreement markers. However, manual agreement is systematically and comprehensively taught in sign language classes, while eye gaze agreement is never mentioned – and in fact, most native signers are unaware of its very existence, or of the role that it plays in the language. Thus, the second aspect of eye gaze agreement in ASL relevant to SLA is whether it can be acquired at all despite the fact that it is never taught and can only be attained through implicit means.

The third aspect of interest to issues in SLA is that the directed eye gaze of native signers (those exposed to ASL from birth) marks agreement with the lowest

ranked argument on a universal accessibility hierarchy of arguments (Thompson et al., 2006). This accessibility hierarchy has been previously shown to have a variety of important syntactic consequences across spoken languages (Keenan & Comrie, 1977). Thompson et al. (2006) presented the first evidence for the potential influence of the accessibility hierarchy in signed as well as spoken languages, buttressing the case for the universality of its cross-linguistic application. If eye gaze agreement follows a universal hierarchy, then the use of eye gaze to mark syntactic arguments in ASL might be easier to acquire, or might be acquired earlier, than properties that are idiosyncratic to a particular sign language. With regard to agreement marking in ASL, one such idiosyncratic property is the division of the lexicon into verbs that do take agreement markers and those that do not (see section 3.2.2).

Finally, while the grammatical use of eye gaze with a spoken language is unattested and unexpected, cognitive functions of eye gaze have been widely reported. Specifically, eye movements have been argued to be a behavioral expression of attention, providing a real-time measure of visual and cognitive processing (for reviews see Hayhoe & Ballard, 2005, and Henderson, 2003). For example, when viewing scenes or performing tasks, gaze is directed toward informative regions within a scene or toward task-relevant objects. It is possible that the grammatical use of eye gaze in ASL originated from an attentional preference for signers to gaze toward discourse-salient spatial locations. Such an origin would suggest a direct relationship between attentional mechanisms and

eye gaze agreement that could be easily learned by second language learners. For example, L2 learners may naturally gaze toward spatial locations associated with key discourse referents. Such a pattern of gaze would be similar but not identical to the native eye gaze pattern, because eye gaze agreement in ASL is controlled by syntactic, not discourse-attentional factors (see section 3.2.1).

We used head-mounted eye-tracking technology to investigate the linguistic and cognitive factors that might underlie the acquisition of eye gaze agreement by second language learners. Whether and how eye gaze agreement is acquired by ASL L2 learners can thus provide insight into several critical issues related to SLA: the interaction between cognition and language, implicit vs. explicit learning, and the role of universal principles and of language modality.

3.2 Background

This section provides information regarding eye gaze during spoken narratives, linguistic analyses of eye gaze agreement in ASL, and previous L2 research relevant to the current study. First, in section 3.2.1 we explore the possible use of eye gaze during co-speech gesture by non-signers in order to identify potential cognitive influences on the acquisition of eye gaze agreement in L2 learners of ASL. In section 3.2.2 we spell out the linguistic nature of ASL agreement, marked both manually and with eye gaze. In section 3.2.3 we discuss possible differences between implicit and explicit learning. In ASL one aspect of agreement (manual agreement) is explicitly taught, while another (eye gaze agreement) is not.

3.2.1 Gaze as a cognitive process

Discourse referents in ASL are associated with spatial locations, and signers can direct verbs or pronominal signs toward these locations to refer to specific referents. The association between a locus and a referent is usually established by producing a lexical sign (e.g. BOY) and then a pronoun (a pointed index finger) to indicate the location to be associated with this referent. The setting up and use of spatial locations for sign referents follows grammatical rules. For example, if a signer sets a character in a particular location in space (e.g., 'Bob' is established on the right hand side of the signer in signing space) and then referred back to in another location in space (e.g., on the left hand side of the signer in signing space) the result is an ungrammatical sentence.

Similar to signs that are produced in spatial locations to indicate referents, McNeill (1992) found that speakers sometimes gesture toward locations in space when using referring expressions in spoken language. He argued that concepts can be visualized in space, and that this space can be indexed with gestures. For example, when re-telling a cartoon story (*Canary Row*), one character (Tweety) may be associated with the right side of gesture space while a second character (Sylvester) may be located on the left. With this association in place, a gesture toward the right side of space refers to Tweety, and not to Sylvester. Furthermore, although these gestures are not constrained by the grammar, listeners are nonetheless sensitive to mismatches between anaphoric gestures and referring expressions (e.g., saying "Sylvester" while gesturing to the right, which is

Tweety's location). Thus there is evidence that speakers can create locations for referents in space, demonstrating a clear parallel between co-speech gesture and the anaphoric use of space in ASL.

Once speakers have formed a mental image of referents in gesture space, the tendency may be to gaze toward these specific locations when referents become the focal point of the discourse. Such gaze may signal attention (i.e., attentionally based gaze) to a discourse referent similar to a manual gesture. Gullberg and Holmqvist (1999) found that speakers sometimes look at their own hands while gesturing, providing evidence that directed eye gaze can accompany gesture. Further, addressees frequently look toward a gesture that is being self-fixated by the speaker producing it, suggesting that these attentional gazes are a signal that the gesture being produced is important (Streeck, 1993; Tuite, 1993). It is therefore possible that a parallel also exists between the attentional eye gaze of speakers and the production of eye gaze agreement by signers. In the current study, we investigated the eye gaze patterns of English speakers with no exposure to signed languages to determine the pattern of gaze during spoken language narratives. We made use of the same elicitation procedures for English and ASL participants so that direct comparisons between signers and speakers would be possible.

Further, we investigated the eye gaze patterns of novice signers (beginning signers with less than two years of ASL experience in an instructional setting). If directed gaze during the production of ASL originates as attentionally-based gaze,

novice signers are predicted to produce more directed gaze while signing than non-signers do while talking, because novice signers are taught very early how to establish referents in space while signing so that they can both use and understand referring expressions and manual verb agreement. Once discourse characters are located in space, novice signers may naturally gaze toward these locations as they attend to them, creating a pattern of gaze controlled by the salience of discourse referents. Therefore, while English speakers are not required to set up referents in space and may only do so under certain conditions, novice signers with relatively little signing experience should have a mental image of referent locations, providing them with the best possible conditions under which to produce attentionally-based eye gaze.

If the use of eye gaze in ASL stems from a pre-existing bias such as attentionally-based gaze, which is a cognitive process outside the realm of language, then novice signers' gaze is predicted to be toward the location associated with any salient discourse referent, regardless of grammatical role. In contrast, the pattern of native signers' gaze is toward specific arguments, regardless of their discourse salience.[14] For example, while signing *DOG LOOK CAT* ('the dog looks at the cat')[15] a novice signer producing attentionally-based eye gaze could look at either the location associated with the subject 'dog' or the

[14] For evidence that native signer eye gaze is not related to discourse salience, particularly grammatically encoded topic or focus, see Thompson et al. (2006).

[15] Signs in ASL are customarily represented with English glosses in capital letters. Subscript letters represent locations in space with which signs are associated (e.g., MAN_a $_aGIVE_b$). Within a sentence, words that share the same subscript are associated with the same spatial location.

object 'cat,' depending on which character was the most salient at that point in the discourse. A native signer however, whose gaze is controlled by the syntax, would look at the location associated with the object (the 'cat') regardless of salience.

3.2.2 ASL Verb Classes and Agreement

There are three verb classes in ASL: agreeing verbs, spatial verbs and plain verbs. The verbs in the first two of these verb classes are directed toward referents in space in order to mark agreement manually. Agreeing verbs, the first class, are directed toward locations in signing space to indicate person and number features for subject and object, and spatial verbs, the second class, are directed toward locations in signing space to specify locatives. Plain verbs, the third class of ASL verbs, are not directed toward spatial locations and are not marked for agreement. Thus, agreement in ASL represents a complex system in which three distinct patterns can be found: verbs that show agreement with subject and object, verbs that show agreement with locatives, and verbs that do not show agreement at all. (For further discussion see Padden, 1988.)

In addition to manual agreement in ASL, non-manual markers (e.g., eye gaze and head tilt)[16] are claimed to mark agreement (Bahan, 1996; Neidle, Kegl, MacLaughlin, Bahan, and Lee, 2000). Our previous eye-tracking study showed that eye gaze is used to mark agreement in a pattern similar to that of manual agreement (Thompson et al., 2006). Parallel to the absence of manual agreement

[16] For more information about the claim that head tilt can be used as a marker of subject agreement see Bahan (1996) & Neidle et al. (2000).

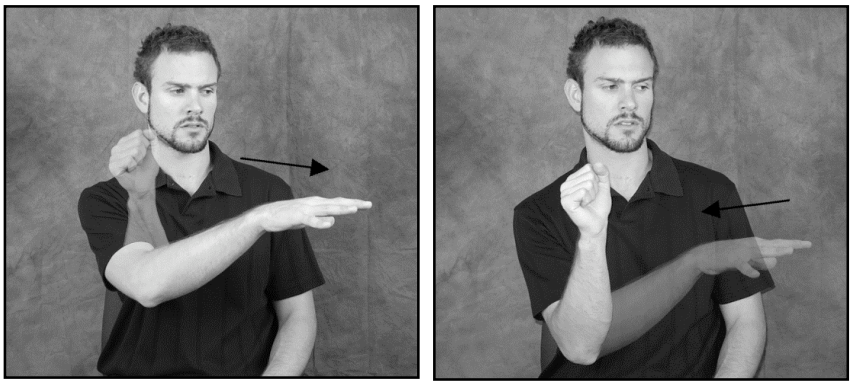
for plain verbs, native signers showed no pattern of directed eye gaze when producing plain verbs. However, when producing agreeing and spatial verbs, native signers most frequently directed their gaze to mark agreement in a way that paralleled their production of manual agreement morphology. In other words, to mark agreement, signers directed their gaze to specific locations associated with referents, either locatives for spatial verbs, or objects for agreeing verbs (the direct object for transitive verbs and the indirect object for ditransitive verbs).

Transitive spatial verbs (e.g., PUT as in: 'I put the hat on the table') mark manual agreement with locatives, and can additionally encode the direct object with a handshape indicating object type (e.g., round, flat). Therefore, it would be possible for native signers to mark eye gaze agreement with either the object (by gazing in the direction of the hands) or with the locative (by directing gaze toward the location in space associated with the locative argument). Thompson et al. (2006) showed that eye gaze again patterns with manual agreement, and that signers consistently direct their gaze toward the locative (the spatial location) rather than toward the object (the hand). Moreover, a significant difference in the relative height of gaze between agreeing and spatial verbs was found. Specifically, gaze when producing spatial verbs was directed relatively lower in space than gaze during the production of agreeing verbs.

Unlike manual agreement, eye gaze agreement occurred only 70% of the time (74% for agreeing verbs, and 72% for spatial verbs). Thompson et al. (2006) suggest two possible reasons for why eye gaze agreement, a grammatical marker,

is not always present. First, eye gaze agreement competes with the other functions of eye gaze, such as regulating turn taking, checking addressee comprehension, and marking role shift. Competing functions of eye gaze may create a co-articulation problem under which eye gaze agreement is sometimes blocked. Second, variation in the presence or absence of directed eye gaze may be stochastic due to a variety of social and stylistic variables. (For further details see the discussion section in Chapter 2/Thompson et al., 2006).

Finally, analyses of manual agreement have been proposed that are syntactically based (Padden, 1988) or semantically based (Friedman, 1975; Shepard-Kegl, 1985; Taub, 2001), but neither of these types of analyses has been able to explain the pattern of manual agreement completely. Such unilateral analyses are problematic because certain phenomena can only be explained in terms of grammatical relations (e.g., in ASL, object agreement is obligatory while subject agreement is optional), while other phenomena are best explained semantically, such as the behavior of 'backwards' verbs. Backwards verbs (e.g., TAKE, BORROW, etc.) are a sub-class of agreeing verbs that mark the object first and the subject second, unlike most agreeing verbs (e.g., GIVE, LEND, etc.), which mark the subject first and the object second (see Figure 3.1). The differing behavior of regularly agreeing vs. backwards agreeing verbs can be accounted for straightforwardly with a semantic analysis positing that agreeing verbs (both regular and backwards) mark source and goal, rather than subject and object.



SEND TAKE

Figure 3.1. Illustration of a regular agreeing verb (SEND) which moves from subject to object location and a backwards agreeing verb (TAKE) which moves from object to subject location. For both verb types, eye gaze is towards the object location (to the signer's left in this illustration).

As a solution to the seemingly conflicting behaviors of manual agreement, Meir (1998a, b) has proposed that ASL agreement (along with Israeli Sign Language agreement) encodes *both* syntactic and semantic arguments, with the syntactic argument of a verb encoded by the facing of the hands, and the semantic argument by the movement of the verb. For example, SEND, an agreeing verb, and TAKE, a backwards verb, are both produced with the palm facing out (toward the syntactic object), but move in opposite directions (toward the differing goal locations). In Thompson et al. (2006) we found that eye gaze agreement occurring with backwards verbs was consistently directed toward the location associated with the object (see Figure 3.1). Because eye gaze with these verb types is consistently directed toward the grammatical object, we concluded that eye gaze

patterns with the facing of the hands in marking syntactic rather than semantic agreement for both regularly agreeing and backwards agreeing verbs.

In summary, observations of eye gaze behavior during the production of backwards verbs, ditransitive verbs and spatial verbs provided evidence about the nature of directed eye gaze during verb production. Specifically, during the production of backwards verbs, gaze was toward the syntactic object (the first location of the sign) rather than toward the semantic goal (the final location of the sign). Gaze likewise did not follow the movement of the hands to the end point of the sign. During the production of ditransitive verbs, gaze was toward the indirect object rather than toward the direct object[17]. Finally, during the production of spatial verbs, gaze was directed toward the locative argument rather than toward the object. In the current study we also examine gaze patterns during the production of backwards verbs, ditransitive verbs and spatial verbs, in order to determine what the pattern of gaze is for late L2-learners.

3.2.3 The Role of Implicit and Explicit Learning in Sign Language Acquisition

The use of eye gaze as a grammatical marker of agreement has only recently been detailed (Bahan, 1996, Neidle et al., 2000, Thompson et al., 2006), and the pattern of acquisition is unknown for both L1 and L2 learners. We know that L1 learners of ASL acquire eye gaze agreement implicitly without explicit

[17] As discussed in Chapter 2, fn 10, it is possible that only a single 'object' category is encoded in ASL and that there is no distinction in the grammar between an Indirect Object (IO) and Direct Object (DO). However, we will continue to refer to IO and DO until further research can be done.

knowledge of its existence, and without any overt instruction, as indicated by the regular pattern of eye gaze agreement produced by native adult signers. This is not surprising given that this is the nature of L1 learning. However, the extent to which implicit learning takes place in L2 acquisition is not so clear. A crucial difference between the SLA of ASL manual agreement and that of eye gaze agreement is that while manual agreement rules are taught overtly in the classroom, eye gaze agreement is never mentioned. Thus, if L2 learners of ASL are to acquire the correct use of eye gaze agreement, they must do so implicitly, without the benefit of explicit instruction. In this study we investigate whether late L2 learners from spoken language backgrounds can acquire correct eye gaze agreement implicitly, as is the case with child L1 learners.

3.2.4 Factors that May Influence the Acquisition of ASL Eye Gaze Agreement

Sorace (1993a) has suggested that L2 learners characterized as near-native are not a homogeneous group. Rather, different patterns of acquisition exist among these learners. For example, some adult L2 learners show evidence of not having fully acquired particular target features of a second language, and thus appear to have incomplete mental representations (incomplete grammar). Other adult learners at equivalent levels of proficiency show evidence of having acquired alternative mental representations of at least certain aspects of the target grammar that diverge in systematic ways from those of native speakers (divergent grammar).

If eye gaze agreement can be acquired implicitly by late L2 learners, the next obvious question is: What is the ultimate level of attainment for these late learners when acquiring eye gaze patterns? More generally, can adults past the critical period achieve native-like levels of proficiency in some or all aspects of a second language, or will they arrive at divergent or incomplete representations? In order to address these questions, we studied proficient signers who began signing as adults, had at least 10 years of experience with ASL, and moreover worked as ASL interpreters.

3.3 Hypotheses

3.3.1 L1 Transfer Hypothesis

Most ASL L2 learners come from a spoken language background that could bias their acquisition patterns and cause them to overlook or misinterpret eye gaze usage, thus having a negative impact on the relative success of acquiring a signed L2. Empirical studies on language transfer among learners of different L1 backgrounds have shown that language typology of the L1 overrides other important variables such as proficiency (DeBot, 1992; Poulisse, 1990) and amount of L2 exposure (Jarvis & Odlin, 2000).

In our current study, we examine L1 speakers of English who are L2 learners of ASL. Smith and Tsimpli (1995) propose that for functional categories like agreement there is an early and limited critical period, beyond which it is impossible to learn new features of functional categories in the L2 not already

instantiated in the L1. Under this analysis, the very existence of a subject-verb agreement system in English should help in the acquisition of any verbal agreement system in ASL. This is because L1 exposure guarantees early experience to some form of agreement, which may play a crucial role in SLA despite the differences between the ASL and English systems. In terms of L1 transfer of *language-specific* features of agreement, all English verbs *except* modal verbs mark agreement in the present tense (i.e. *she has to leave* vs. *she must leave* vs. **she musts leave*), providing a possible correlate in English for the division of the ASL lexicon into verbs that mark agreement and those that do not.

A different language-specific feature of ASL agreement that has no English correlate is the way in which agreement is controlled by one of several different verbal arguments: verbs sometimes mark features of the subject and direct object, the subject and indirect object, or a locative argument. This language-specific feature of ASL has no correlate in English, because English agreement always indicates person and number features of the subject only, and of no other grammatical relation. The working assumption that L2 learners will have a better mastery of L2 patterns with L1 correlates suggests one possible outcome for the ultimate attainment of eye gaze agreement that we will call the 'L1 Transfer Hypothesis'. Under this hypothesis, English L1 speakers should do relatively better at learning which ASL verbs mark eye gaze agreement (and which do not) than in determining which argument of a verb controls agreement.

3.3.2 Consistent Patterns Hypothesis

Evidence suggests that success in mastering L2 patterns is determined in part by the patterns of the L2, regardless of L1 influences. For example, Sorace (1993b) investigated the SLA of French perfect auxiliaries for Italian speakers, and SLA of Italian perfect auxiliaries for French speakers. These two populations were chosen because, while the French and Italian auxiliary systems operate in similar ways in this portion of the tense/aspect system, they differ in one interesting respect. The Italian system is very consistent (unergatives and transitives take *avere* 'have' in the perfect tenses, while reflexives, passives and unaccusatives take *essere* 'be'). In contrast, the French auxiliary system is less consistent (auxiliaries behave similarly in the French and Italian perfect tenses, except that some unaccusatives in French take *être* 'be' while others take *avoir* 'have'). French and Italian L2 learners are never explicitly taught how to mark unaccusatives, and Sorace hypothesized, based on the principles of L1 transfer, that speakers of both French and Italian would carry over their native systems into their respective L2s. Instead she found that French speakers (with a less systematic auxiliary system) learning the very consistent Italian auxiliary system were able to make correct choices on an acceptability task, while Italian speakers (with their systematic auxiliary system) were less able to correctly acquire the less consistent patterns of the French auxiliary system. This finding suggests that a system that is internally consistent is easier to acquire than an inconsistent one, even when the (inconsistent) L1 system could transfer straightforwardly to the L2.

Therefore a second possibility, the 'Consistent Patterns Hypothesis,' predicts that more systematic, easily discernible patterns within the ASL agreement system will be easier to acquire than less consistent ones. Within ASL, patterns of eye gaze agreement are not easily predicted (see section 3.2.2) and thus L2 learners are expected to do poorly across the board in the attainment of eye gaze patterns if the Consistent Patterns Hypothesis holds.

3.2.3 Language Universals Hypothesis

Lastly, several studies have either suggested a link between L2 learners' ultimate level of attainment and language universals (e.g., Coppieters, 1987), or suggested that there is no such link between ultimate attainment and language universals (e.g., Birdsong, 1992). Thus another relevant question for SLA is the extent to which ultimate proficiency within a particular language is linked to universal aspects of language. Although this controversy is often couched in terms of Universal Grammar (UG), the current study was not designed to investigate proposed innate universals. Here we use 'universal' in the sense of Greenberg (1966), in which systematic patterns emerge cross-linguistically even though they may or may not be easily predicted or occur within a large linguistic domain.

For example, in Thompson et al. (2006), we proposed that native signers acquire a pattern of eye gaze determined by an eye gaze agreement hierarchy. According to this hierarchy, both agreeing and spatial verbs show agreement with their lowest ranking argument: Subject < Direct Object < Indirect Object < Locative. The proposed hierarchy follows the same ordering of arguments as

originally set forth by Keenan and Comrie to account for universal patterns of relative clause formation (accessibility hierarchy, 1977), and later used to explain other phenomena such as causativization and case marking (Comrie, 1976; Croft, 1988).

In terms of 'universality,' the eye gaze agreement hierarchy appears to capture a typologically universal, natural ordering of arguments that is nevertheless not easily predicted, and which on the surface may even appear to be random. It is just this sort of universality, a pattern that is widely and often inexplicably repeated, that could be relevant to the ultimate attainment of L2 learners. In other words, ultimate attainment may be based on some underlying universal feature found across the world's languages. Under this 'Language Universals Hypothesis,' features of ASL such as the agreement hierarchy based on language universals will be better attained than language features that are more language-specific.

One of the more idiosyncratic morphological features of ASL is the division of the lexicon into verbs that take agreement markers and those that do not (i.e., agreement occurs with agreeing and spatial verbs, but not with plain verbs). This division of the lexicon into verbs that do and do not show agreement appears to be based in part on phonological restrictions (e.g., many verbs with no agreement are produced on the body and are thus not amenable to agreement), semantic restrictions (e.g., psychological predicates do not show agreement), and features of the controller of agreement (i.e., the abstract case of the nominals; see

Janis, 1995). However, it is unclear whether all verb agreement patterns can be entirely predicted in this way, and verb class membership may sometimes be simply arbitrary. If the Language Universals Hypothesis plays a role in acquisition, this language-specific pattern that is quite rare cross-linguistically should be more difficult for L2 learners to acquire than the agreement hierarchy (a common cross-linguistic pattern).

3.4 Possible Outcomes and Predictions

In the current study, we examine three populations to investigate hypotheses about SLA and the nature of eye gaze during both speech and sign. First, we observe the eye gaze behaviors of monolingual English speakers in order to determine whether or not they alter their gaze when producing English verbs. The results from this population will inform us about the use of eye gaze as a form of co-speech gesture, reflecting the attention of the speaker. Next we look at two groups of L2 ASL signers who represent opposite ends of the language-learning spectrum. The first group, novice signers, are just beginning the language learning process, while the second group, proficient signers who are also professional interpreters, are likely at asymptote, meaning that they are unlikely to improve their ASL skills significantly in the future.

If we find that novice signers' eye gaze is controlled by the salience of discourse referents, we can conclude that directing eye gaze toward verb argument locations is relatively 'natural' and stems from more basic cognitive functions, such as a speaker's attention during discourse. Alternatively, novice signers may

simply look at their addressee, since the importance of eye contact while signing *is* taught in ASL classrooms.

The acquisition of morphological features like verb agreement has been shown to correlate not only with age of first exposure, but also with years of study in a formal setting and with the use of the second language in daily life (Flege, Yeni-Komshian & Liu, 1999). Proficient participants in the current study were all formally trained in ASL and they all use ASL consistently on a daily basis. Further, at the time of testing, proficient participants had all been signing for an extended period of time (mean number of years 18.8; range 11-30 years). They therefore represent the best possible scenario for successful ASL acquisition, and will help determine to what extent eye gaze agreement patterns can be acquired after extensive language exposure. The pattern of acquisition that emerges from the proficient L2 data will inform us about the impact of several possible SLA influences. The first possible influence is the visual/manual modality of ASL. We know that L2 learners with spoken English as their L1 are able to learn the manual signs of ASL. However, given the unexpected form of eye gaze agreement, it may be that L2 learners completely overlook this feature of ASL. If L2 learners are able to even partially acquire eye gaze agreement, we can postulate that implicit learning has taken place. Thus, to the extent that eye gaze agreement is found in the L2 productions of proficient signers, it will inform us of the relative success of implicit learning in adult L2 learners.

In section 3.3, we laid out several hypotheses that make distinct predictions regarding SLA (for a summary of these predictions, see Table 3.1). The L1 Transfer Hypothesis predicts that those patterns of the ASL agreement system will be learned better that have correlates in the English agreement system. Specifically, under this hypothesis, L2 learners of ASL should perform relatively better at categorizing verbs into those that mark agreement and those that do not (because English also makes this distinction) than at choosing which argument of the verb will control agreement (a pattern with no English correlate). The Consistent Patterns Hypothesis predicts greater ease in learning more systematic, internally consistent, easily discernible L2 patterns. Under this hypothesis, L2 learners are predicted to be unable to correctly systematize which verbs are agreeing, and also unable to correctly determine which noun is the controller of agreement (two crucial features needed to master eye gaze agreement patterns). Thus under the Consistent Patterns Hypothesis, L2 learners are predicted to produce incomplete or divergent patterns across all levels of eye gaze agreement. Alternately, the Language Universals Hypothesis suggests that it is the universality of L2 patterns that affects the success of L2 learners. Under this view, the universal pattern of the agreement hierarchy will be relatively easier to learn than the cross-linguistically rare, ASL-specific pattern of agreement with agreeing and spatial verbs, but not with plain verbs.

Table 3.1. Hypotheses and predictions for eye gaze behavior

Hypotheses	**Predicted Eye Gaze Patterns**
L1 Transfer	a) *Correctly* categorize verbs into those that mark agreement and those that do not b) *Incomplete* or *Divergent* pattern in determining which argument of the verb controls agreement
Consistent Patterns	a) *Incomplete* or *Divergent* pattern in categorizing verbs into those that mark agreement and those that do not b) *Incomplete* or *Divergent* pattern in determining which argument of the verb controls agreement
Language Universals	a) *Incomplete* or *Divergent* pattern in categorizing verbs into those that mark agreement and those that do not b) *Correctly* determine which argument of the verb controls agreement

In section 3.2.2 we stated that we would analyze the eye gaze behaviors of L2 learners during the production of backwards, ditransitive and spatial verbs (along with regular agreeing and plain verbs) to determine the exact nature of eye gaze for L2 learners. Specifically, there are three divergent patterns of eye gaze that can be discovered with an analysis of eye gaze during the production of these verb types: (1) L2 learners may produce a divergent pattern in which gaze marks the end point of a verb in space (the evidence for this would be incorrect gaze directed toward the final location rather than the first location of backwards verbs), (2) L2 learners' gaze could mark agreement, but with the semantic goal (the evidence for this would be incorrect gaze patterns toward the goal rather than the source of backwards verbs) and, (3) L2 learners might mark agreement with the direct object only, and not according to the agreement hierarchy (the evidence

for this would be incorrect gaze patterns toward the direct object of ditransitive and spatial verbs).

Finally, within the ASL eye gaze agreement paradigm, a difference exists in the height of directed gaze produced with agreeing verbs and that produced with spatial verbs. The difference in gaze when producing spatial verbs (relatively low in space) vs. gaze during the production of agreeing verbs (relatively high in space) represents a subtle difference that could easily be overlooked by L2 learners. We will therefore examine gaze height data from L2 learners as a further measure of their level of attainment.

3.5 Methods

3.5.1 Participants

A total of ten non-native proficient signers (8 women, 2 men), 9 novice signers (7 women, 2 men) and 5 non-signing monolingual English speakers (3 women, 2 men) participated in the study (mean age = 38.5, 20.7, and 28.8 years respectively). Proficient signers all began signing after the age of 16 (mean age 19.33; range 16-24) and had been signing for over 11 years at the time of testing (mean number of years 18.8; range 11-30 years). All proficient signers were currently working as interpreters and reported signing between 15-50% of the time during the day (as stated on a background questionnaire). Additionally, proficient signers all reported being involved in the Deaf community. Novice signers all began signing after the age of 16 (mean age 18.3; range 16-19) and had completed between 9 and 15 months of ASL instruction (6 hours of in-class time per week) at

the time of testing. Non-signing participants were all monolingual English speakers with no knowledge of ASL other than the fingerspelled alphabet. All participants were hearing.

3.5.2 Materials

Using the same methodology as Thompson et al. (2006), participants were asked to make up a story about two characters (Jack and Jill) using specific verbs (12 plain, 7 agreeing, and 7 spatial verbs). The 'Jack and Jill Story' task was one of three tasks from Thompson et al's original study (no significant difference was found for eye gaze across tasks in this original study). The verbs were given to participants one at a time (signed by their interlocutor) as they progressed through their created stories. Participants were allowed to use as many sentences as needed with each verb to make the story coherent. Thus, not only were the specified verbs produced, but many speaker-generated verbs were elicited as well. English translations of the ASL verbs were used for the non-signers.

3.5.3 Procedure

Participants' 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, filmed the participant's field of view, and the second, the eye camera, tracked the participant's eye movements. In the resulting video, a cursor indicating the participant's eye position was superimposed onto the image of the participant's field of view. Another camera recorded the participant's signing or speaking and was time-

locked to the eye position video via a digital mixer. The composite video also contained an image of the participants's eye, which was used to identify eye blinks and to corroborate eye gaze direction (see Figure 3.2).

3.5.4 Coding and Analysis for Signing Participants

For each task, the full screen videotape of the participant signing was time-coded and transcribed. The transcription was used to determine (a) the exact start and end times for each verb, and (b) where participants placed referents in signing space. 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.) Gaze coordinates allowed us to pinpoint the exact location of gaze in order to make direct comparisons (e.g., to determine if there was a difference in the height of gaze between agreeing and spatial verbs, as was found for native signers).

Figure 3.2. A video-frame 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 signer.

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 either toward 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 was directed at the signer's hand (recall that the object is encoded in spatial verbs by the shape of the hand) and toward the locative if gaze was directed toward the location associated with that locative (usually the end point of the sign). Finally, eye gaze was coded as 'other' when gaze was directed above the addressee's head, toward the addressee's body, or toward an unassigned location in signing space. Approximately 25% 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 participant blinked during the production of a verb). Data were also excluded when there was a first person object, or when a plain verb was produced with no established object location (i.e., a signer might produce the sentence BOB $LIKE_{plain}$ BILL 'Bob likes Bill', without providing a location for BILL). Finally, data were excluded when a manual agreement error made it impossible to determine the intended location of referents. Agreement errors included either an error of omission (i.e., failure to show agreement when producing an agreeing verb), or an error in referent placement (i.e., marking agreement in one location in space for a referent already established in another spatial location). Referent placement errors were counted only once per incorrect location shift. For example, if 'Bob' were placed on the right in signing space, followed by an agreeing verb meant to reference Bob as the object directed to the left, this was counted as a placement error and the data from this verb were excluded. However, if the next verb indicating agreement with Bob was again on the left, this was not coded as a second error. If, on the other hand, Bob was placed on the right, and a verb was directed to the left in signing space to refer to him, followed by another verb directed to the right to again refer to Bob, this would count as two unique placement errors, and both verbs would be eliminated. Referent placement errors were coded as such when there was no clear reason for a shift in referent location (e.g., signing 'BOB $_{a}MOVE_{b}$ 'Bob moved from 'a' to 'b', and then referring to Bob in location 'b' is not a placement error). Using this

coding system, inter-rater reliability for gaze position was 89% (based on two coders analyzing a subset of the data).

3.5.5 Use of previous data

The availability of native signer data from Thompson et al. (2006) allowed for direct comparisons of data from the current L2 study with native signer data from the previous study. Data from Thompson et al. (2006) comprises an analysis of ten native signers' eye gaze behaviors (six women and four men; mean age = 28.6 years) who are all from Deaf families and were all exposed to ASL from birth (nine Deaf, one hearing native signer). In this previous study, three tasks were performed with no significant difference in gaze across tasks. However, in the current analysis we use only data from the story completion task, the Jack and Jill story, to be consistent with data from the proficient, novice and non-signing participants (these groups only performed the story completion task).

3.6 Results

Monolingual English Speakers*:* Five non-signing English-speaking participants in our study produced a total of 207 verbs with clear eye gaze data. These participants gazed toward their addressee 93% of the time when producing English verbs. An analysis of gaze throughout the entire production of the Jack and Jill story (not just during verb production) showed that non-signing English speakers looked at the addressee 92% of the time across the entire narrative. In comparison, all three signing groups looked at their addressee less than 20%

across all verb types (native signers 19.4%, proficient signers 8.8% and novice signers 16.3%).

ASL learners: Proficient signers produced 167 agreeing verbs, 207 plain verbs, and 170 spatial verbs with clear gaze direction, and novice signers produced 122 agreeing verbs, 105 plain verbs, and 140 spatial verbs. For each participant, we calculated the mean percentage of eye gaze toward each location for all three verb types. For agreeing and plain verbs, we calculated the mean percentage of eye gaze directed toward the subject, object, addressee, and other. For spatial verbs we calculated the mean percentage of gaze toward the subject, object, addressee and locative (see Figure 3.5). Following Thompson et al. (2006), 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. The native signer data from the story completion task (Thompson et al., 2006) was entered into each analysis as appropriate. Below we compare novice and proficient signer data with the native signer data for the three verbs types (agreeing, plain, and spatial).

Agreeing and plain verbs: To determine whether eye gaze differed significantly for native, proficient, and novice signers, we conducted a repeated measures analysis of variance (ANOVA) with a 2 (verb type: agreeing, plain) X 3 (participant group: native, proficient, novice) X 4 (gaze direction: subject, object, addressee, other) experimental design. The dependent variable was the mean

percentage of eye gaze toward each location. There was no main effect of group ($F(2, 181) = .116$, n.s.), but a main effect of eye gaze direction, indicating that the direction of gaze was not random ($F(3, 181) = 84.98$ $p < .0001$). Crucially, there was a three-way interaction between verb type, gaze direction and participant group ($F(6, 181) = 11.74$ $p < .0001$). As shown in Figure 3.3, for agreeing verbs, both native and proficient signers directed their gaze toward the location associated with the object (74.8% and 74.6%, respectively). In contrast, novice signers directed their gaze toward the location associated with the object only 30.9% of the time, differing significantly from both native signers ($t(17) = 7.3$, $p < .0001$), and proficient signers ($t(17) = 7.89$, $p < .0001$).

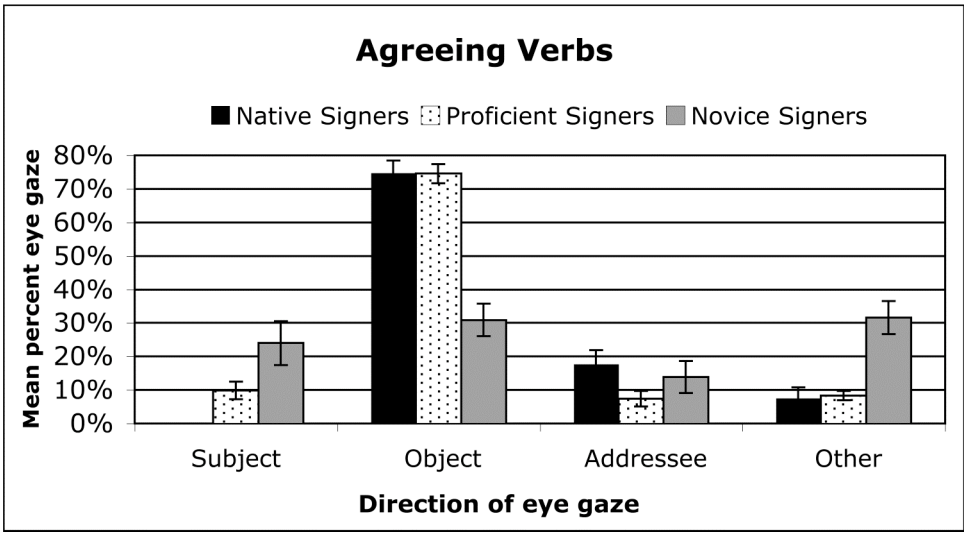


Figure 3.3. Mean percent of native signer, proficient and novice L2 learner eye gaze for agreeing verbs.

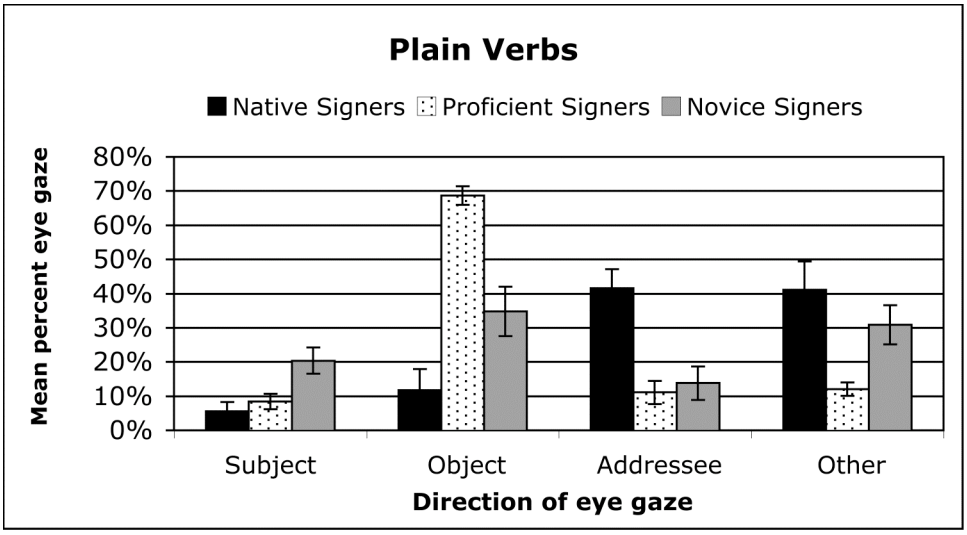


Figure 3.4. Mean percent of native signer, proficient and novice L2 learner eye gaze for plain verbs.

For plain verbs, native and proficient signers differed in the percent of eye gaze directed toward the object location ($t(18) = 7.4$, $p < .0001$). Proficient signer gaze was most often directed toward the location associated with the object (68.7%), whereas native signer gaze was distributed across the different categories (see Figure 3.4). Novice signer gaze was once again distributed across locations in space. Thus for plain verbs, novice signer gaze mirrored the native data. A post hoc analysis using Tukey's HSD with an alpha value of .05 showed no significant difference of gaze direction for either native or novice signers during the production of plain verbs, but revealed a main effect of gaze for non-native proficient signers. For proficient signers, gaze toward the object was more frequent than gaze toward the subject, addressee or other categories.

This pattern of results for plain and agreeing verbs suggests that proficient signers treat these verb types similarly. For proficient late-learners, there was no

difference between gaze directed toward the object during the production of plain verbs and gaze directed toward the object during the production of agreeing verbs ($t(18) = 1.51$, n.s.). However, there was a significant difference for native signers' gaze directed toward the location associated with the object for agreeing verbs and the object location for plain verbs ($t(18) = 7.83$, $p < .0001$). Novice signers exhibited yet a third pattern. As with proficient signers, there was no significant difference between gaze toward the object during the production of agreeing verbs and during the production of plain verbs ($t(16) = .49$, n.s.). However, unlike proficient signers, the gaze of novice signers toward the object was not significantly different from gaze toward the subject, addressee, or other locations for either agreeing verbs or plain verbs (Tukey's HSD $p = .05$, $Q = 3.694$). This result indicates that novice signer gaze was undifferentiated across these verb types.

Backwards agreeing verbs: As described in section 3.2.2, most agreeing verbs mark the subject first and the object second, but a sub-class of agreeing verbs called 'backwards verbs' instead mark the object first and the subject second. We examined eye gaze data from backwards verbs to determine whether gaze was toward the first location associated with the syntactic object, or toward the second location, the end point of the sign associated with the semantic goal. For proficient signers, gaze was directed more often toward the syntactic object, the beginning of the sign (88%), than toward the final location of the sign, the semantic goal (9%; $t(9) = 7.32$, $p < .0001$), mirroring the gaze pattern for native

signers (82.5% toward the syntactic object). Thus, proficient late-learners also treat eye gaze as a syntactic marker, not a marker of semantic roles. Novice signers' gaze during the production of backwards verbs was undifferentiated, with similar gaze toward the syntactic object (27%) and the semantic goal subject (30%; t(8) = .644, n.s.).

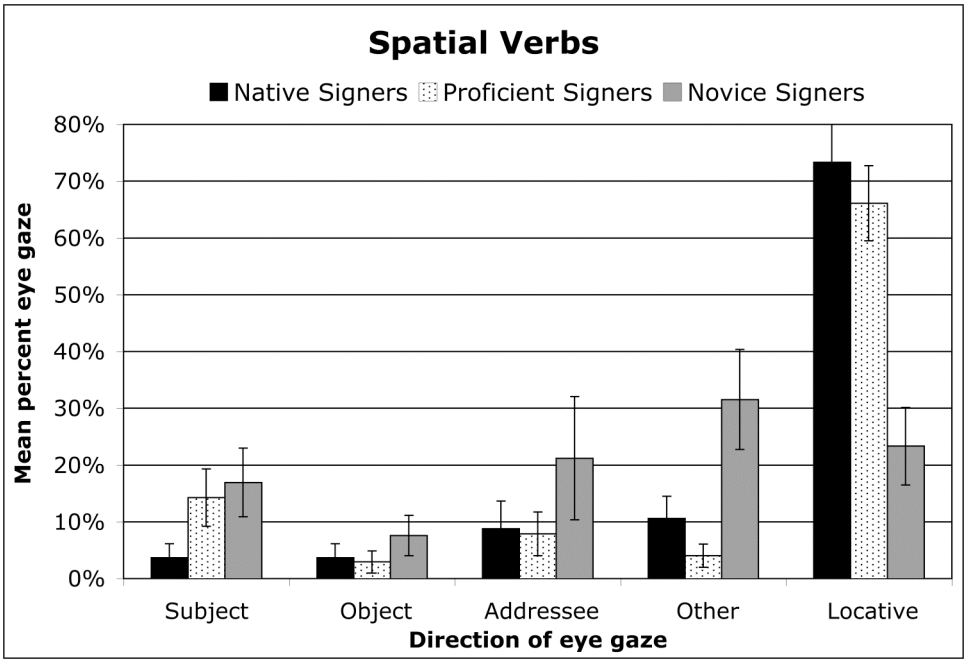


Figure 3.5. Mean percent of native signer, proficient and novice L2 learner eye gaze for spatial verbs.

Spatial verbs: The spatial verb data were analyzed using a 5 (gaze direction: subject, object, addressee, other, locative) X 3 (level of fluency: native, proficient, novice) repeated measures ANOVA. There was a main effect of gaze direction, indicating that the direction of eye gaze was not random ($F(4, 103) = 28.83$ $p < .0001$). Further, a significant interaction between gaze direction and participant group was found ($F(8, 103) = 6.26$ $p < .0001$). As shown in Figure 3.5,

for transitive spatial verbs, both native and proficient signers directed their gaze toward the location associated with the locative (73.1% and 66.1%, respectively). In contrast, novice signers directed their gaze toward the location associated with the locative only 23.4% of the time, differing significantly from both native signers ($t(9) = 4.14$, $p = .002$) and proficient signers ($t(9) = 4.29$, $p = .002$).

Finally, native signers' eye gaze fixations were significantly lower in signing space for locative agreement than for object agreement ($t(9) = 8.06$, $p < .0001$). Unlike native signers, proficient late-learners did not differ in the relative height of eye gaze during the production of agreeing and spatial verbs for ($t(9) = -.267$, n.s.).

3.6 Discussion

Given the unique nature of eye gaze agreement (i.e., it is produced with the eyes), the present experiment provides a somewhat surprising pattern of SLA acquisition that is nonetheless consistent with acquisition patterns across all languages. From a common-sense perspective, the findings are striking. It seems counter-intuitive that hearing adults learning ASL would somehow be able to notice that eye gaze has a grammatical function—let alone determine its exact function and approximate native signers in its use—when it is never taught and is so dissimilar to any other function of gaze. Yet this is exactly what the data show. While English-speaking participants (with no knowledge of ASL) showed no evidence of directed eye gaze toward locations in space, novice signers exhibited the expected profile of beginning language learners, producing gaze that was

directed, but full of errors. On the other end of the proficiency spectrum, proficient late-learners exhibited an eye gaze pattern that approximated the native pattern. However, proficient late-learners diverged from native signers by overgeneralizing eye gaze agreement, marking it with plain verbs, thus demonstrating a clear difference between L1 and L2 ASL acquisition.

Non-signing English speakers did not make use of eye gaze to indicate discourse referents, and only rarely varied their gaze during the production of English verbs, (or during any part of a sentence). English speakers may use eye gaze to indicate discourse referents under other circumstances (see Clark, 1996), but evidently the story continuation task used in our study did not lend itself to this type of eye gaze behavior, or for that matter to manual gesturing. English-speaking participants produced very few gestures overall, with only one gesture (across all participants) indicating the location of a character in space (i.e., getting into a car). The fact that the story continuation task consistently elicited directed gaze from proficient and native signers thus provides one piece of evidence that directed gaze for signers is not a gestural phenomenon driven by attentional focus.

An additional piece of evidence that bears on whether eye gaze behavior is cognitively or gesturally based comes from the novice signers. Unlike the participants in McNeill's (1992) studies, the non-signers in our study did not have a visual aid such as a cartoon to help them form a mental image of characters in space. In contrast, the novice signers were forced by the grammar of ASL to locate characters at particular locations in space. Specifically, in the ASL task the

experimenter began a story by introducing the characters, 'Jack' and 'Jill,' and, as is frequently the case with the first mention of characters, assigned them to locations in space (i.e., Jack was located on the left in signing space and Jill was located on the right). Participants then continued the story, adopting the already established locations when referring to Jack and Jill and, as required by ASL grammar, making frequent reference to these locations with pronominals and manual verb agreement. If having an established location in space for discourse-salient referents is what controls directed eye gaze, then novice signers should preferentially look at the spatial locations of salient discourse referents. However, while novice signers frequently produced directed gaze, their gaze was dispersed across all possible spatial locations, including the spatial locations of discourse referents, but also toward the addressee, to non-associated locations in space, to locations above the addressee, etc. The eye-tracking results from novice signers thus indicate that the use of eye gaze to mark locations in space does not arise 'naturally' as a property of attentional focus in sign language, but rather that it must be learned.

The fact that the gaze of novice signers was directed but undifferentiated indicates that these beginning signers recognized that they were supposed to be doing something with their gaze during the production of ASL verbs. While the novice signers had only recently begun learning ASL and had not yet mastered its grammar, their eye gaze patterns were not equivalent to those of the English-speaking non-signers. This finding suggests that implicit learning *is already* taking

place in this L2 population: even beginning signers are attending to eye gaze as an aspect of ASL grammar. Taken together, the eye-tracking data from both novice and proficient L2 signers provide evidence for implicit stages of learning in SLA. While eye gaze agreement may be something that exists below the level of conscious awareness (even for native signers and ASL instructors), L2 learners apparently start out using directed gaze that is undifferentiated, but end up with a pattern of agreement that is similar to (but still divergent from) that of native signers.

In particular, the results show that proficient non-native signers erroneously marked eye gaze agreement when producing plain verbs. Interestingly, proficient signers made no manual agreement errors with plain verbs. Manual agreement is overtly taught in the classroom within the first few months of instruction. Thus, proficient L2 learners correctly avoid marking *manual* agreement on plain verbs, but they incorrectly mark *eye gaze* agreement. One possible explanation for the difference between manual and eye gaze agreement is in the relative success of implicit learning alone (i.e. eye gaze agreement), versus implicit learning combined with explicit learning (i.e. manual agreement). That is, while explicit learning appears to be a rather ineffective tool in first language acquisition (e.g., children often insist on using an incorrect form even when corrected by an adult), adult learners are able to use both explicit and implicit learning strategies in acquiring a second language (see also Ioup, 1995).

Another possible explanation for the difference in ultimate attainment in manual vs. non-manual (i.e., eye gaze) agreement is perceptual salience. Specifically, large articulators (the hands) that produce large movements may be more perceptually salient (and thus easier to learn) than smaller articulators (the eyes) with relatively smaller movements. However, this is only one possible interpretation of 'salience.' In Thompson & Emmorey (in prep.), we find that sign perceivers (both native and novice) overwhelmingly look at the area around the signer's eyes when viewing signed narrations. This finding suggests that the majority of manual signs are perceived through peripheral vision while the eye gaze of the narrator is seen through foveal vision. Thus another possible interpretation of salience is attentionally based: the focus of attention might provide the most salient information. It is well known that both humans and apes are sensitive to the direction of eye gaze, and some theorists have even proposed that the increased exposure of the sclera in humans is an evolutionary development favoring detection of eye gaze (Emery, 2000). Therefore, while salience may well be a factor in the ultimate attainment of ASL agreement, it is unclear how 'salience' should be most appropriately defined in this context, and therefore the relative salience of manual vs. eye gaze agreement markers is also unclear.

Finally, native signers gazed toward a relatively low location in space for spatial verbs compared to agreeing verbs. However, proficient L2 learners made no such distinction. This finding suggests that some aspects of language may be

extremely difficult for late learners to acquire. One possible reason for the failure to acquire this aspect of eye gaze agreement is that such a slight variation in relative height on a vertical plane may be too subtle for adult L2 learners to acquire (implicitly). Another possibility is that the variation in gaze height occurring during verb production may not have a communicative function. In other words, native signers may not attend to the differing heights in the production of eye gaze by their interlocutors. Rather, differences in eye gaze direction (high or low) during the production of ASL verbs may arise from a signer's awareness of the canonical location for locative and object referents. Locatives usually encode the meaning of a location associated with the ground (low in space) and grammatical objects usually encode the meaning of things/objects that are above the ground (higher in space).

This conceptual difference may cause signers to produce different gaze patterns for locatives and objects as an outward manifestation of the way in which they are envisioned, rather than as a grammatical or discourse marker. This possibility is supported by Liddell (1990, 2003), who observed that agreeing verbs are produced at variable heights that change in relation to the nature of the referent. For example, the verb ASK-TO, which is normally directed toward the chin of a present referent, can be directed relatively high in space to refer to an imagined tall person and relatively low in space toward the chin of an imagined seated or short person. Currently we are conducting a study to examine whether native signers attend to the difference in gaze height produced by another signer in

order to tease apart whether gaze is used for communicative functions or whether gaze is an outward manifestation of visualization during discourse.

In addition to the types of errors that proficient L2 learners made, the types of errors that these L2 learners did *not* make are informative. There are several patterns of eye gaze that L2 learners might produce which would be almost identical to native signers' patterns, but that would nonetheless be indicative of divergent underlying representations of eye gaze agreement. One possible pattern would be directing gaze toward the semantic goal, rather than the syntactic object during the production of backwards verbs. However, proficient L2 learners correctly directed their gaze toward the location associated with the grammatical object, regardless of whether the object was associated with the first location of the verb (backwards agreeing verbs) or the second location (regular agreeing verbs). Thus, proficient L2 learners did not acquire a divergent eye gaze agreement system based on semantic roles. Nor did they acquire a system in which eye gaze simply follows the hands in space.

We next looked for errors during the production of spatial transitive verbs to determine if proficient L2 learners have an underlying representation of eye gaze agreement as always directed toward the object. No evidence for such a system was found. Proficient L2 learners, like native signers, consistently directed their gaze toward the location associated with the locative argument of the verb, and not toward the object location. Further, proficient L2 learners and native signers looked toward the location associated with the indirect object, not the

direct object during the production of ditransitive verbs. These two facts taken together provide strong evidence that proficient L2 learners adhere to the eye gaze agreement hierarchy in marking the lowest ranked argument with their directed gaze.

The crucial difference found in the data between proficient non-native and native signers was seen in the production of plain verbs. While native signers did not produce directed gaze toward the location of the object for plain verbs, proficient signers consistently directed their gaze toward the object location. In other words, the mental representation of the ASL grammar for eye gaze agreement in proficient non-native signers diverged from that of native signers in this one crucial area. Proficient non-native signers systematized the input they received, but in a way that caused their output to differ systematically from that of native signers.

We are thus left with the question of why some patterns of native eye gaze agreement are acquired better than others. We proposed three hypotheses that could account for differential learning of specific patterns within the eye gaze agreement paradigm (see Table 3.1). The L1 Transfer Hypothesis predicted a strong influence of L1 patterns on L2 learning. In the case of ASL agreement, which argument of the verb controls agreement is determined by an eye gaze agreement hierarchy that has no English agreement correlate. However, as evidenced by the data from spatial verbs, native English-speaking learners of ASL were nonetheless able to correctly acquire this ASL pattern.

The data also indicate that proficient L2 learners incorrectly determine which verb classes are marked with eye gaze agreement. Proficient late learners overgeneralized the eye gaze agreement rule, marking plain verbs as well as spatial and agreeing verbs. Under the L1 Transfer Hypothesis, a pattern of agreement with some verb types and not with others should have been easier to acquire because an English language correlate exists (modal verbs don't show agreement). However, it is possible that this idiosyncratic feature of English would not carry over in a straightforward way into mastering the bifurcation of the ASL lexicon into agreeing and non-agreeing verbs. A stronger L1 correlate may be needed in order to translate into successful implicit learning of the ASL pattern. Nonetheless, the fact that proficient L2 learners acquired the pattern of eye gaze agreement that had no L1 correlate (i.e., marking agreement according to an agreement hierarchy) suggests that the L1 Transfer Hypothesis did not play a major role in the acquisition of ASL eye gaze agreement.

Both the Consistent Patterns Hypothesis and the Language Universals Hypothesis draw on the nature of the L2 patterns themselves as a strong predictor of successful SLA. The difference is that while the Consistent Patterns Hypothesis emphasizes systematic, easily discernible L2 patterns, the Language Universals Hypothesis emphasizes universal (but perhaps not easily identified) language patterns as instrumental in successful L2 acquisition. In terms of ASL eye gaze agreement, L2 learners were predicted to do poorly across the board under the Consistent Patterns Hypothesis because of the lack of easily discernible

patterns in this system. However, proficient non-native signers generally performed well during the production of eye gaze agreement.

The one feature of ASL agreement where overgeneralization was in evidence was predicted under the Language Universals Hypothesis. L2 learners were predicted to correctly acquire the cross-linguistically universal language pattern (the agreement hierarchy), while doing relatively worse at mastering the idiosyncratic, ASL-specific pattern of showing agreement with only a subset of verbs. The results obtained in our study support this prediction.

In the introduction, we stated that some of the motivation for studying language acquisition is based on the assumption that understanding how specific languages are acquired will inform us about the general principles that underlie all languages. Our results show that even adults can implicitly learn certain features of a language. However, the fact that proficient L2 learners (all of whom were skilled interpreters) overgeneralized the eye gaze agreement pattern even after extensive time and exposure to the language suggests that some aspects of L2 grammar may never be fully acquired (Oshita, 1998).

Crucially, the results here provide support for ease of learning associated with language universals. Recall that eye gaze agreement occurs about 70% of the time with agreeing and spatial verbs. The fact that eye gaze agreement marking is not available to the language learner 100% of the time, and is still acquired by late L2 learners, is evidence for the strength of implicit learning of language universal

patterns. Even with unreliable input, proficient signers proved adept at internalizing language patterns that hold cross-linguistically.

What makes particular language features more prevalent cross-linguistically is unclear. This raises the interesting question of the exact nature of Keenan and Comrie's (1979) accessibility hierarchy. While the applicability of the accessibility hierarchy to relative clause formation and other phenomena seems quite robust cross-linguistically, why this generalization should hold up so consistently has never been adequately demonstrated. Keenan and Comrie (1979) initially suggested that the ordering of the accessibility hierarchy could be related to ease of processing. However, this explanation is not particularly helpful if processing studies in turn appeal to the accessibility hierarchy to help explain ease of processing (Miyamoto & Nakamura, 2003; Kwon, Polinsky & Kluender, 2004). We find ourselves in a similar circular dilemma here if we claim that language universals are easier to acquire in order to explain ease of learning associated with language universals. Nonetheless, the results here provide evidence that language universal patterns can be acquired successfully even by those in a disadvantaged language learning position (i.e. late L2 learners).

Finally, by and large, the findings presented here crucially suggest that language learners do not come to the table with pre-established notions of what forms language might take (i.e., speech stream or directed eye gaze). Rather, the ability to acquire a language appears dependent on the human capacity to pick out

patterns related to grammar, no matter what modality or form these patterns appear in.

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4

Eye Gaze During the Production of ASL Pronouns

Abstract

In American Sign Language (ASL), both eye gaze and manual signs are directed toward locations in space to mark verbal agreement (Thompson, Emmorey & Kluender, 2006). Pronouns are also directed to locations in space to indicate referents; however, it is unknown whether directed eye gaze likewise occurs during the production of pronouns. If eye gaze has an indicating function (which is gesturally and not grammatically based), as Liddell (2000a, 2000b) has proposed for the directionality of indicating (agreeing) verbs, then signers should consistently look toward locations associated with referents during the production of pronouns, because the direction of gaze and of signs (both verbs & pronouns) is driven by our general cognitive ability to point at things (either with the eyes or the hands). Alternatively, Meier (1990) provided evidence that in ASL the grammatical category of person contains only two members, first person and non-first person (a category which subsumes 2nd and 3rd person referents). Under Meier's analysis, there should be no systematic difference between gaze occurring with second and third person referents.

To test these hypotheses, we measured eye gaze using head-mounted eye tracking technology. For pronouns with second person referents (i.e., the addressee), gaze was not directed significantly more often toward the addressee

than toward other locations. Likewise, for third person referents, gaze was not directed toward the location associated with third person significantly more often than toward other locations. This pattern of results indicates that directed gaze does not occur in all places where gestural pointing is predicted to occur (i.e. with both verbs that use space to show agreement, and pronouns that use space to indicate referents), contra Liddell (2000a, 2000b). Further, the data show no systematic gaze distinction between second and third person referents, providing support for Meier's (1990) analysis. Although not systematic, signers often gazed toward the spatial location associated with the pronominal referent. Gaze to locations associated with pronominal referents was found to be more frequent relative to our estimates of chance. We hypothesize that discourse factors (e.g., emphatic stress, topic, first mention, etc.) influence the occurrence of directed gaze accompanying pronouns.

4.1 Introduction

Research has highlighted the ways in which signed languages conform to the same grammatical constraints and exhibit the same linguistic principles found in spoken languages (for reviews see Emmorey, 2002; Sandler & Lillo-Martin, 2006). Nonetheless, some observed universal properties of spoken languages do not appear to be fully mirrored by signed languages. One potential difference between signed and spoken languages is how the category of 'person' is grammatically encoded. Spoken languages consist of three person distinctions (first, second and third person) while the majority of evidence indicates that in signed languages two person systems (first and non-first person) predominate (Meier, 1990; Engberg-Pederson, 1993). However, this view is not uncontroversial and several researchers have claimed that three person systems are also grammatically encoded in signed languages through the use of eye gaze (Bellugi & Fischer, 1972; Baker & Cokely, 1980). This chapter therefore examines the nature of eye gaze occurring with pronominal reference in order to investigate possible differences in person marking between signed and spoken languages.

In Thompson, Emmorey and Kluender (2006) we examined eye-gaze occurring with ASL verbs and found that they are marked with both eye gaze and manual agreement morphology. The co-occurrence of eye gaze and manual marking with verb agreement suggests an integral relationship between the two that may also be present during the production of pronouns. Like verbs, ASL pronouns are manually directed toward locations in space associated with referents

in order to mark pronominal reference. However, it is unknown if pronouns additionally use eye gaze to mark locations associated with these referents. The presence or absence of directed eye gaze to mark pronominal referents in a fashion similar to verb agreement marking is predicted by some analyses of ASL pronominals. Thus, whether or not pronominal referents are marked with eye gaze will also have implications for these analyses and offer clues about the relationship between pronouns and verbal agreement in ASL. These issues are outlined in the following paragraphs.

4.2 Background

4.2.1 Pronominal Reference in ASL

Pronominal reference in ASL is accomplished in much the same way as verb agreement—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 in order to refer. Pronominal reference in ASL is indexical in that pronouns point to physically present referents, or to the locations in space that have been associated with non-present referents.

While pointing behaviors in ASL serve to call attention to particular entities, this behavior alone is not sufficient evidence for a linguistic category of pronouns or for how many formal person distinctions exist. In fact, while the meaning of first, second and third person can be clearly understood within the discourse for both present and non-present referents, Meier (1990) argues that

ASL only distinguishes between first and non-first person in the grammar. Meier's argument hinges on the difference in how location (one of four phonological parameters for ASL, the other three being handshape, movement and orientation) is determined for the three possible pronominal forms. Specifically, the location for second and third person pronouns is simply toward the position of the referent, or towards the established location of non-present referents, and these locations cannot be phonologically specified. Alternatively, the location for first person plural pronouns is at best only partially motivated (it does not change according to the location of the referents) and therefore, for first person pronouns location must be phonologically specified. ASL pronouns for 1st, 2nd and 3rd person share the same handshape and movement features (e.g., all plural pronouns incorporate an arc movement, and all possessive pronouns have an 'open-b' handshape; see Figure 4.1 for first person forms, including a plural possessive), and the surface forms differ only in location. First person pronouns make contact with the signer's chest and therefore the location, or place of articulation, can be easily specified. However, since 'position of the addressee' cannot be entered into the lexicon as a specified location for the phonological form, second and third person forms cannot be distinguished from each other underlyingly in the grammar. In other words, even though the spatial loci of the non-first person forms vary according to the referent, these variations are analogically determined and do not represent linguistically distinct forms.

Figure 4.1. Illustration of first person pronouns in ASL (from Emmorey, 2002)

If Meier's analysis is correct, it raises an important potential difference between a signed language and accepted typological universals proposed for spoken languages. In Greenberg's (1963) discussion of language universals he states that: "all languages have pronominal categories involving at least three persons and two numbers" (p. 96). Later he shows that various phenomena do not fit in the three-person analysis (such as the same form used for both second and third persons; Greenberg, 1993). However, because of the prevalence of three-person systems across the languages of the world he still claims their universality.

Similarly, in a cross-linguistic typology of person marking in spoken languages, Cysouw (2003) finds evidence that some spoken languages share the ASL-type of homophony (i.e., second and third person that have the same form), but concludes that not only is this type of homophony too rare to show up in the average typological study, but that of all languages included in his study, the first/non-first type of homophony is never a characteristic of all pronominal

paradigms in the language (2003: 52). In other words, homophony may exist in the agreement system, the singular pronominal paradigm, or the plural paradigm, but crucially not in all three, as is proposed for the ASL system. Thus, if Meier's (1990) analysis of ASL person is correct, it suggests a major difference between spoken and signed languages.

When compared to spoken languages, the rarity of the person marking paradigm in the ASL case is even more surprising when one considers that it is also attested in other signed languages (e.g., see Engberg-Pederson, 1993 for Danish Sign Language, Cormier, 2004 for British Sign Language, & Meir, 1998 for Israeli Sign Language). For example, Engberg-Pedersen (1993) argues for a distinction between first and non-first person in Danish Sign Language (DSL). She argues that the first person pronoun is the only pronoun in which the hand makes contact with something (namely, the signer's body), and that the first person pronoun is the only pronoun that is not always articulated with an index handshape.

Alternatively, the key morphological component that distinguishes between second and third person in ASL (and other signed languages) may as yet be unrecognized. Several researchers have claimed that there is in fact second and third person in ASL, and that eye gaze is the distinguishing factor (Bellugi & Fischer, 1972; Baker & Cokely, 1980). For second person, gaze is toward the addressee, while for third person it is toward the location associated with the third-person referent. This analysis has been criticized for the same reason that analyses

of manual pointing using loci in space have been rejected—the direction of both manual points and eye gaze using a potentially infinite number of loci in space is not phonologically describable and cannot be entered into the lexicon.

However, Berenz's (1996) analysis of pronouns and eye gaze appears to address this issue. She claims that there is a three-way person distinction for Brazilian Sign Language (LSB). Under her analysis, first person reference is distinguished from second and third person reference by the orientation of the hand (with index finger pointed toward signer and palm facing the signer's body for first person, and the extended index finger pointed away from the signer for second and third person), and second person reference is distinguished from third person reference by the orientation of eye gaze. According to Berenz, for second person referents, the signer holds the gaze of the addressee, while for third person referents, the signer shifts gaze from the addressee to the actual location of the present referent, or toward the location associated with the non-present referent and then back to the addressee (1996).

While not explicitly stated, one possible interpretation of Berenz's analysis is that the phonologically specifiable feature that distinguishes second- versus third-person eye gaze is movement. Gaze for second person referents is said to be a steady state gaze toward the addressee (i.e. no movement) whereas gaze for third-person referents is said to be eye movement from the addressee to the third-person referent and then back (i.e. a single back and forth movement). As with pronouns and verb agreement, the actual direction to which gaze is directed could

be determined by a gestural component. If true, this analysis suggests the same tight relationship between eye gaze and pronominal reference that was found for verb agreement and eye gaze.

Finally, empirical data on the nature of eye gaze with pronominals is practically non-existent. One study by Metzger (1998) analyzed eye gaze data for a small number of ASL pronouns using videotaped data (there were 7 usable second person pronouns and 12 usable third person pronouns). The data revealed eye gaze that was consistently directed toward the addressee during the production of both second person pronouns (100%) and third-person pronouns (91.7%). Gaze for third-person pronouns was only toward the third-person referent 8.3% of the time. Thus, no distinction was found between second and third person gaze.

4.2.2 The Relationship between Pronominal Reference and Verb Agreement

In sections 4.2.2.1 and 4.2.2.2, I discuss different claims about ASL grammar that share as a common theme a suggested relationship between verb agreement and pronominal reference. Because eye gaze occurs during the production of verb agreement, by extension these analyses also make predictions about whether and how eye gaze will occur with pronouns. Thus, examining the nature of eye gaze during the production of pronouns and comparing it to that of verb agreement can inform us about the nature of the relationship between the two.

4.2.2.1 Directionality of Pronominal Reference and Verbs that Mark Agreement

Both verb agreement and pronominal reference in ASL make use of locations in signing space to indicate referents. Like verb agreement, pronominal reference is accomplished by directing (phonologically specified) signs toward spatial locations associated with discourse referents (which cannot be phonologically specified). Because directionality for verb agreement and pronominal reference cannot be determined completely with a phonological specification, different analyses have arisen to account for how directionality is determined.

Liddell (2000a, 2000b) claims that directionality is wholly gestural and that the directed movement of signs to locations in space is driven by our general cognitive ability to point at things (either with the eyes or the hands). Under this view, directionality is a function of general cognition and is not constrained by the grammar. Therefore, Liddell's analysis predicts that the directed eye gaze occurring with the directionality of verb agreement should also occur with pronouns, consistently "pointing" toward spatial locations associated with pronominal referents.

Alternatively, in Thompson et al. (2006) we adopt a type of dual representation for both eye gaze and manual agreement that contains both gestural and grammatical elements (Askins and Perlmutter, 1995; Mathur, 2000; Lillo-Martin, 2002; Rathmann and Mathur, 2002). We assume that both verb agreement and

pronominal reference in ASL involve a lexically specified direction morpheme, but that spatial locations are unspecified in the phonological and morphological representation of these signs. Under this analysis we conclude that eye gaze is part of a directional morpheme occurring with verb agreement (Thompson et al. 2006) and may or may not occur during the production of pronouns.

4.2.2.2 Grammatical Relationship Between Verb Agreement and Pronominal Reference

Like Liddell, some researchers have also claimed a direct relationship between pronouns and verb agreement in ASL, but one that is grammatically, not gesturally based. Kegl (1986, 1990) claims that pronoun clitics, which she terms 'role prominence markers,' mark NP arguments on the verb. This analysis is similar to diachronic accounts of spoken language agreement that have suggested an historical link between verb agreement and incorporation of pronominal elements in the verbal complex (Lehmann, 1985). The crucial difference is that, in Kegl's analysis, pronoun clitics exist currently in ASL and have not been reduced to agreement morphemes. Kegl's analysis points to a direct relationship between verb agreement and pronominals, suggesting that full pronominal forms will be produced with directed eye gaze in the same way as pronoun clitics marking agreement.

Padden (1990) also claims that pronoun clitics can occur with verbs—but only with a small subset of plain verbs that show optional agreement. For the most part, these 'optionally' agreeing verbs behave like plain verbs, with no agreement

marking. However, they can optionally indicate subject or object, and as (4.1) and (4.2) demonstrate, they are ambiguous as to whether it is the subject or object that is marked. As (4.1) and (4.2) indicate, the verb WANT can be produced at the locus of the subject to indicate who wants something or at the locus of the object to indicate what is wanted. The subscript letters in the examples below represent distinct locations in space.

4.1 WOMAN $_a$WANT; MAN $_b$WANT
'The woman$_a$ is wanting and the man$_b$ is wanting too' (interpretation A)
(i.e., 'the woman in one location wants an unspecified thing and the man in another location wants it too')

'The woman wants it$_a$ and the man wants it$_b$' (interpretation B)
(i.e., 'the woman wants the thing in location a, and the man wants the thing in location b')

4.2 WOMAN $_a$WANT $_b$WANT $_c$WANT
'The women$_{a,b,c}$ are each wanting (interpretation A)
(i.e., ' the three women each want something')

'The woman wants this$_a$ that$_b$ and that one$_c$ too' (interpretation B)
(i.e., the woman wants 3 different unspecified things) (pp.121)

In support of her pronoun clitic analysis, Padden demonstrates that nouns (4.3) and adjectives (4.4) can also be articulated at loci of associated referents.

4.3 1PS SEE $_a$DOG $_b$DOG $_c$DOG.
'I saw a dog here, there and there, too.'

4.4 HAVE CAR LINE-OF $_a$BLUE $_b$BLUE $_c$BLUE.
'There's a line of blue cars.'

(Padden 1990: 122)

This evidence is in line with Zwicky and Pullum's (1983) claim that clitics exhibit a low degree of selection in spoken language, and thus suggests that spatial displacement of a sign in these examples is not agreement, but rather cliticization.

In Thompson et al. (2006), we compared plain verbs that can show optional agreement (i.e. plain verbs that according to Padden can occur with pronoun clitics) with those that can't, and found no significant difference in eye gaze between the verb types ($F(3, 27) = .195$, $p < .89$). Thus, both plain verb types (those that can and those that can't host pronominal clitics) were not shown to mark agreement with eye gaze as is the case for regularly agreeing verbs marked with an agreement morpheme. This supports Padden's claim that regular agreement (which marks arguments of the verb with eye gaze) and optional agreement (which does not mark eye gaze agreement) are different processes. Further, the fact that we found no directed eye gaze occurring with plain verbs marked with pronoun clitics suggests that directed eye gaze may likewise not occur with full pronominal forms.

4.3 Goals and Predictions

To summarize the discussion so far, a difference between second and third person referents may be grammatically encoded with eye gaze in ASL. Specifically, we may find steady gaze toward the addressee for a second person referent and a single back and forth movement from the addressee to the location associated with the third person referent to mark that referent. Alternatively, there may be no difference in eye gaze between second and third person forms, thus

providing further evidence for a first/non-first person distinction in ASL, as claimed by Meier (1990). Thus, whether and how directed eye gaze occurs with ASL pronouns will have implications for the putative language universal of a three-person system across spoken languages.

We discussed analyses of ASL that predict a relationship between eye gaze used for verb agreement and eye gaze used for pronominal reference. First, Liddell (2000a, 2000b) claims that verb agreement and pronominal reference are gesturally based (with no grammatical component). This analysis predicts that the directed gaze that occurs during the production of verb agreement should also occur during the production of pronouns, because gesturally encoded directionality should not distinguish among different grammatical categories (i.e. verb agreement and pronouns). From another perspective, Kegl (1986, 1990) claims that verb agreement markers are pronoun clitics. Under her analysis, eye gaze during pronoun production should likewise pattern with eye gaze during verb production, however in this case because both are pronominal forms. Thus, both Liddell (2000a, 2000b), who claims that verb agreement and pronominal reference is gesturally based (with no grammatical component), and Kegl (1986, 1990), who claims that verb agreement markers are pronoun clitics, have analyses that predict directed gaze during the production of pronouns.

Under other analyses, there is no prediction that eye gaze will be similar for verb agreement and pronouns. For some, the directionality of pointing for both pronominal reference and verb agreement is made up of a combination of gestural

and grammatical (i.e. directional morpheme) components (Askins and Perlmutter, 1995; Mathur, 2000). Under these analyses, there is no prediction that eye gaze occurring with verb agreement will also occur with pronouns, because while both make use of a (shared) gestural component, there is not necessarily a direct relationship between a verb agreement directional morpheme and a pronominal directional morpheme. Thus eye gaze, a feature of a grammatical verb agreement morpheme, may or may not occur as a feature of a pronominal morpheme.

Finally, Padden's analysis (1990) actually predicts a difference between eye gaze patterns for agreeing verbs and pronouns. Under her claim, only a subset of plain verbs occurs with pronoun clitics, and it is these verbs (not agreeing verbs) that should pattern with full pronominal forms. Thus, the results of our pronominal eye gaze experiment will provide insight into ASL-specific issues, such as the relationship between verbal agreement and pronouns, as well as the basic nature of eye gaze in ASL (e.g., grammatically or gesturally based). We make use of head-mounted eye-tracking technology to investigate the use of eye gaze agreement occurring with pronouns.

4.4 Methods

4.4.1 Subjects

Ten native signers (four men and six women) participated in the study (mean age = 29.6 years). All subjects were Deaf from Deaf families and exposed to ASL from birth and were compensated for their time.

4.4.2 Tasks

Subjects performed two language production tasks. The first task was designed to elicit pronouns with third person referents while the second task elicited pronouns with second person referents. In the first task, participants were asked to compare and contrast groups such as men and women, Deaf and hearing, Europeans and Americans, and Asians and Americans. In addition to these categories, their Deaf interlocutor frequently questioned participants further about not only how, but also why they thought the groups were different (e.g., nature or nurture). Since the length of discussion for each topic differed from participant to participant, not every participant finished discussing every topic. The Deaf interlocutor ended the task at a natural break occurring after ten minutes of data collection, with subjects generally discussing three or four of the possible topics.

The second task was to find out ten things about the Deaf interlocuter that the subject didn't know. This required questions to be directed at the Deaf interlocuter, the addressee, and thus elicited pronouns with a second-person referent. The overall experimental design attempted to elicit personal pronouns. However, possessive and reflexive pronouns were also included in the data when they occurred.

4.4.3 Pronoun Study: Procedure

The procedure for this experiment mirrors previous work. For details see Chapter 2 (p. 28) and Chapter 3 (p. 81).

4.4.4 Analysis

For each task, the full screen videotape of the subject signing was time-coded and sentences containing overt pronouns were transcribed. The transcription was used to determine a) the exact start and end times for each pronoun and b) where subjects placed referents in signing space. The videotape with the eye-position cursor was used to determine gaze position. For both pronoun types (i.e., pronouns with a second person referent and pronouns with a third person referent) gaze was categorized as 'toward the location associated with the referent' or 'away from the location associated with the referent.' Approximately 12% of the pronouns collected were not used in the study. Pronoun 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 92% (based on two coders analyzing a subset of the data).

4.5 Results

A total of 119 pronouns with a second person referent and 416 pronouns with a third person referent were produced with clear gaze direction. For pronouns with second person referents, gaze toward the referent (i.e., the addressee) did not differ significantly from gaze away from the referent (58% vs. 42%; $t(9) = .50$, $p = .63$). Thus, gaze was not systematically directed toward the addressee (the referent) for second person pronouns. For pronouns with third person referents, gaze toward the location associated with the third person referent was not more

frequent than gaze away from that location (46.5% vs. 53.5%; t(9) = .76, p = .47). This pattern of results indicates that for both pronoun types, gaze was not systematically directed toward the location associated with the referent (see Figure 4.2).

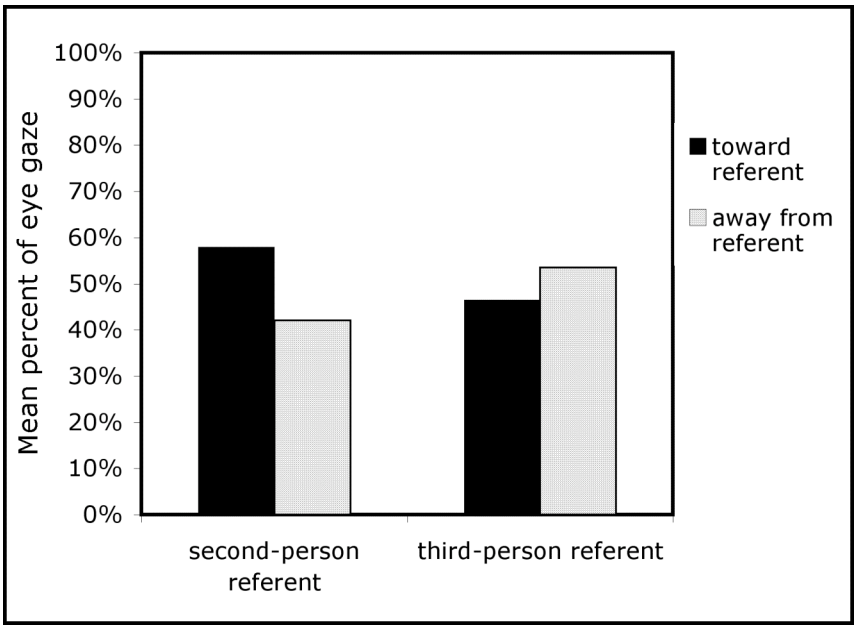

Figure 4.2. Mean percent of eye gaze toward referent locations and away from referent locations.

4.6 Discussion

The data during the production of ASL pronominals show no evidence that eye gaze marks a grammatical distinction or that there is a systematic distinction between gaze directed toward second or third person referents in ASL. This finding thus provides further support for Meier's (1990) analysis of ASL as having only a first and non-first person distinction. Overall, gaze occurring with pronouns

was relatively inconsistent, did not vary dramatically across pronoun types, and exhibited a large degree of individual variation. In contrast, directed gaze occurring with verb agreement was consistent, differed systematically across verb types, and exhibited little individual variation in our previous verb production studies for both L1 and highly proficient L2 signers (Thompson et al., 2006; Thompson, Emmorey, Kluender, under review).

While signers' gaze during the production of pronouns does not provide support for a grammatical distinction between second and third person, signers do appear to exhibit different preferences for directed gaze when producing pronouns with different referents. This preference is better illustrated by considering the nature of the data. In order to test the hypothesis that second and third person are grammatically encoded with eye gaze in ASL, we divided gaze into two groups: toward the referent, or away from the referent. However, in order to determine if there is any relationship between pronoun production and eye gaze, a further separation is required. This is because the first category, toward the referent, represents only one location in space, while the second category, away from the referent, represents a potentially unlimited number of possible locations (i.e., gaze toward the right, left, etc. was all classified as 'away from the referent' if the location did not match the location of the referent). The question then is how best to divide this space up for analysis.

In Thompson et al. (2006) we recorded 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.) A careful analysis using these coordinates showed that signers' gaze accuracy (i.e., the exact position of gaze across different verb tokens to a single referent) was not exact. Gaze to a single referent to mark agreement across multiple tokens did not fall within a one-inch cell from our graph. Rather, signers tended to divide space into much larger quadrants consisting of three horizontal areas (i.e., right, left or center) and two vertical areas (i.e., above or below midpoint) with the addressee as a special category in the center (the addressee was coded as anywhere on the addressee's face, or falling within one inch around the addressee's head). This made for seven likely areas where gaze could fall (addressee, above addressee, below addressee, right above mid-point, right below mid-point, left above mid-point and left below mid-point), with repeated gaze to a single referent across multiple tokens tending to fall within the same quadrant (see Figure 4.3).

Therefore, one possible division of space for directed eye gaze on the data from our verb production study would be into these seven quadrants. Under this system, gaze toward the location associated with the referent would be predicted by chance about one in seven times, or only 14.3% of the time. Thus, during the production of ASL pronouns, gaze toward the addressee for second person referents (54.2%) and gaze toward the third person referent for third person (46.5%) were found considerably more often than is predicted by chance. This means that signers show eye gaze preferences for pronominal reference that differ

however from the eye gaze behavior during the production of verb agreement shown in Thompson et al. (2006).

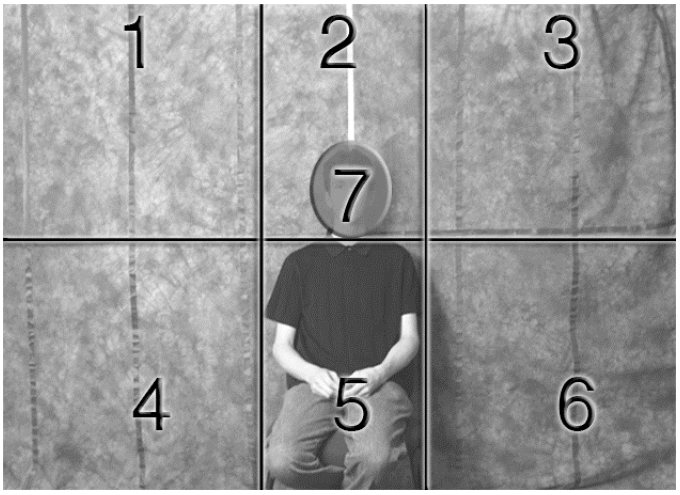

Figure 4.3. Possible division of gaze into seven quadrants including 'left above mid-point' (1), 'above addressee' (2), 'right above mid-point' (3), 'left below mid-point' (4), 'below addressee' (5), 'right below mid-point' (6), and 'addressee' (7). The chance of gazing toward any one of these quadrants is one in seven, or 14.3%.

Currently, we are investigating the mechanism(s) that drive preferential gaze toward referent locations. Several researchers have pointed to the use of eye gaze to assume the role and perspective of a given character in the discourse, to mark shifts in discourse focus, or to indicate emphasis (Baker and Padden, 1978; Bahan & Petitto, 1980; Engberg-Pedersen, 1993). Therefore directed gaze during the production of pronouns in ASL may be controlled at the level of discourse. A preliminary analysis of our gaze data suggests that directed eye gaze during pronoun production might serve to add more emphatic stress. For example, when adding discourse emphasis, or when an NP is syntactically stressed through the use of topicalization, a signer appears likely to gaze toward the location associated with the referent to mark that stress. Such a function for eye gaze differs

dramatically from the grammatical function of marking agreement as found for eye gaze during the production of verbs.

This difference between directed gaze with verbs and directed gaze with pronouns has implications for theories claiming that the use of space to indicate referents (either through manual movement or eye gaze) is driven by the same process for both verbs and pronouns. In particular, analyses that treat both verbal agreement and pronominal reference as forms of gestural pointing would need to account for the difference in gaze between verbs and pronouns. In section 4.2 we discussed different analyses of the relationship between verb agreement and pronouns. First, we proposed that the tenets of Liddell's (2000a, 2000b) analysis predict similar eye gaze behavior during the production of verb agreement and pronouns. This is because, according to Liddell, indicating is based on the same gesturally-based process for both verb agreement (Liddell's indicating verbs) and pronominal reference. If this analysis is correct, then eye gaze behavior for verbs and pronouns should pattern together. If directed eye gaze is simply another form of pointing, then we should expect to see it during the production of ASL pronouns as well as ASL verbs. Alternatively, the data from the pronoun study are not out of line with analyses that claim both gestural and grammatical components for both verb agreement and pronominal morphemes (Askins and Perlmutter, 1995; Mathur, 2000; Lillo-Martin, 2002; Rathmann and Mathur, 2002). In fact it suggest that, while the gestural component may be the same, there is not

necessarily a relationship between the grammatical components of verb agreement and pronominal reference.

Under Kegl's (1986, 1990) very different analysis of verb agreement markers as pronominal clitics, it would be hard to explain why full pronominal forms do not occur with directed eye gaze, but reduced pronominals in the form of clitics do. However, Padden's analysis predicts a difference between eye gaze patterns for agreeing verbs and pronouns. Padden (1990) claims that only a subset of plain verbs optionally occur with pronominal clitics, and it is therefore these verbs (not agreeing verbs with their own [unrelated] agreement morphemes) that should pattern with pronouns. This prediction is borne out, since neither plain verbs with optional agreement in the form of pronoun clitics nor full pronouns show any pattern of systematically directed eye gaze, while agreeing verbs on the other hand do.

From a broad viewpoint, the study of signed languages is relevant to general linguistic inquiry because it provides opportunities to examine purported language universals from a new perspective. The research here supports previous claims that in ASL only a first and non-first person distinction is grammatically encoded during the production of agreeing verbs and pronouns (singular and plural). This same grammatically encoded two-person system has been reported in all signed languages researched to date. Alternatively, spoken languages, unlike ASL and other signed languages, appear to universally encode a three-person system in the grammar. In cases where spoken and signed languages differ, such

as the case under investigation here, it is useful to entertain questions about why these differences exist.

How then do we account for this difference between signed and spoken languages? And which system should be considered the more basic, or 'universal' one? Since a two-person distinction is minimally found in both signed and spoken languages, it would be accurate to claim that it is the universally encoded distinction. At a conceptual level this makes sense, because as humans we tend to think in terms of self and other. The difference in two vs. three-person systems found in signed and spoken languages appears due to another reason not related to how humans conceptualize the world around them. Here I suggest that the difference is in the relative amount of ambiguity that exists within the two language types.

For signed languages two-person distinction appears sufficient because communication proceeds unambiguously due to the use of a required gestural interface. The gesture that occurs with pronouns and verb agreement in signed languages serves to uniquely identify the intended discourse referent, allowing signed languages to distinguish among each individual referent in the discourse, not just between second- and third-person referents. The end result is that there is no loss of clarity because of the absence of a grammatical second and third person.

Conversely, for spoken languages, there is no reliable gestural component to uniquely identify referents. Therefore we find more grammatical distinctions as a way of disambiguating referents. Not only do spoken languages encode a three-

person system, but other disambiguating information like gender is also common (Gender marking has been reported in only one sign language to date, Nippon Syuwa [Japanese Signed Language]; Fischer & Osugi. 2000).

Nonetheless, while it appears that spoken languages predominantly encode a three-person system at the core, paradigm gaps can be found in which spoken languages behave in much the same way as signed languages, with only a first and non-first distinction (Lengua, Chitimacha, Awa Pit, Wambon, etc; Cysouw, 2003). Cysouw states that, "most of the time, enough information is present in the discourse to fill the referential gaps left by a homophonous paradigm" (2003: 54). Thus, while it makes sense that the need to minimize ambiguity is what creates three-person systems in spoken languages, they are also not universally found wherever person is marked in spoken languages. Underlyingly, spoken languages appear to universally make the same two-person distinction in the grammar that signed languages do.

Overall, the data from both signed and spoken languages indicate that a grammatically encoded three-person distinction is not a language universal. However, three-person systems may be prevalent across spoken languages, because of a general pressure within the language to reduce ambiguity. What appears common to both signed and spoken languages is a two-person distinction (i.e. languages appear to minimally encode this distinction in the grammar). As with many other purported 'language universals' the reason for this is not easily explained. However, what the lack of referential ambiguity in signed languages

allows us to do is strip away all non-linguistic influences and see what system emerges. What we are left with, a grammatically encoded first/ non-first (me and other) person system, may very well be the most basic system underlying all other surface forms.

In sum, directed eye gaze during the production of ASL pronouns did not occur with enough regularity or frequency to indicate a grammatically encoded distinction. While it may seem intuitive that signers will look toward real or imagined referents in signing space while pointing at them, the data do not bear this out. That directed eye gaze is determined by grammatical environment (marking agreement with verbs but not marking referents for pronouns) and does not occur under all conditions where it might be expected if it were the product of more general human cognition (contra Liddell 2000a, 2000b) supports our previous claim that gaze behavior during verb production is in fact a grammatically specified element of ASL.

Finally, the data presented here highlight the usefulness of empirical data from signed languages. It is interesting to note the clear preference in spoken languages for three-person systems on the one hand and two-person systems for signed languages on the other. We suggest that the difference between languages in the two modalities arises directly from a general pressure in languages to minimize ambiguity. Thus we see that by examining the different environments (signed or spoken) under which different person distinctions arise, we can gain insight into how language systems might arise or how they are motivated.

However, we also note that even when ambiguous reference is stripped away (as is the case with signed languages) we are still left with a grammaticized system for person marking. Thus by examining languages in both a signed and spoken modality a more complete picture of true language universals can emerge.

4.7 References

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5

General Discussion and Conclusions

I set out in this dissertation to examine the grammatical functions of eye gaze in ASL. This desire was motivated in part by several broad questions about the nature of language and language learning. In this final chapter, I attempt to bring together the different results that bear on these questions by revisiting, from a broader perspective, the findings presented in Chapters 2-4.

When studying signed languages, one of the questions that arises is the degree to which they are governed by the same linguistic principles as spoken languages. In Chapter 2, we investigated the unique and modality-specific use of eye gaze to mark verb agreement. The data suggested that eye gaze during the production of verbs is in fact used to mark agreement and is a fully grammaticized feature of the language. In support of this claim, the data showed that gaze accompanying verb agreement is consistently directed toward the location associated with the verbal argument marked for agreement, that gaze differs systematically across verb types, and that gaze with verb agreement exhibits little individual variation.

More specifically, the results of the verb agreement study argue for a system of eye gaze agreement that marks agreement according to a universal accessibility hierarchy (Subject < Direct Object < Indirect Object < Locative). While there is existing evidence that this hierarchy captures a universal 'natural' ordering of arguments for spoken languages (e.g., as found in causativization and

case marking; Comrie 1976; Croft 1988), there has been no evidence to date that signed languages conform to these same universal principles. That eye gaze agreement in ASL can now be added to the list of spoken language phenomena that adhere to the accessibility hierarchy suggests that signed languages are in fact governed by the same linguistic principles as spoken languages. In sum, with the use of eye gaze to mark verb agreement, we can see that human languages allow sometimes surprising and varied forms with which to encode grammatical distinctions, and that these forms can be influenced by language modality. Nonetheless, an exotic form of agreement like eye gaze still follows a predictable pattern, namely an accessibility hierarchy found in natural languages.

Another question addressed in this dissertation is how language-specific properties, including modality, might influence the acquisition of a signed second language (L2). In Chapter 3, we demonstrated that modality has little if any influence on the acquisition of a signed L2. Instead, L2 learners are able to discern underlying universal features of eye gaze agreement. This finding is not only surprising given the exotic nature of eye gaze as a linguistic feature, but also given the quality of the input. The input the L2 learner receives to master eye gaze agreement is impoverished at every point. To begin with, eye gaze has many uses at almost every level within ASL. Eye gaze can be lexically specified (e.g., the sign GOAL is accompanied by gaze upward) or can be used to add information about some property of a noun (e.g., 'tall tree', where TREE is signed while the eyes gaze skyward; Baker, 1978). Signers also use eye gaze for other linguistic

functions such as setting up referents in space or marking role shift (Friedman, 1975; Baker & Padden, 1978), and for discourse functions such as regulating turn-taking, or gazing at the addressee to see if s/he is following (Baker and Cokely, 1980; Baker-Shenk, 1983). These many different functions for eye gaze in ASL are part of what makes the input signal very poor.

When eye gaze does function as a marker of agreement, it occurs with only two out of the three ASL verb types (i.e., with agreeing and spatial verbs, but not with plain verbs). Further, eye gaze agreement does not consistently mark agreement features on a single verb argument type, but rather marks agreement according to an accessibility hierarchy. Finally, for the two verbs types that are marked with eye gaze agreement (spatial and agreeing), agreement is marked only about 75% of the time.

Given the poor quality of the input signal, it is therefore surprising that L2 learners acquire the use of eye gaze agreement at all. One explanation for how L2 learners pick up the use of eye gaze agreement is that they are making use of some innate linguistic knowledge, as evidenced by the fact that their level of attainment goes beyond what is possible given the information provided by the data. However, the ability to acquire the grammatical uses of eye gaze in ASL may also be supported by our knowledge of more general cognitive processes for gaze.

From infancy, the use of eye gaze is important in human interaction. Shared attention, or the ability to direct gaze to match another's focus is directly related to learning, and in particular to word learning in children (Baldwin, 1993;

Brooks & Meltzoff, 2002; Butler, Caron & Brooks, 2000). Interestingly, You, Deák, Jasso, Teuscher & Wood (2005) find that infants (3-5 months old) seldom follow a caregiver's gaze unless the parent also points or moves an object. Thus there is an early relationship between manual movements and eye gaze. You et al. suggest that gaze-following patterns may actually be learned as a result of infants paying attention to manual movements and consequently noticing the relationship between these movements and eye gaze.

In the adult literature there are also several areas of research that demonstrate cognitive processes reflected in eye movements. As discussed in Chapter 3, eye movements have been argued to be a behavioral expression of attention, providing a real-time measure of visual and cognitive processing (for reviews see Hayhoe & Ballard, 2005, and Henderson, 2003). For example, when viewing scenes or performing tasks, gaze is directed toward informative regions within a scene or toward task-relevant objects. Another interesting avenue of research that appears directly related to grammatical eye gaze in ASL is the study of gaze during spoken language production. During picture naming tasks, or while describing a scene from a single picture, speakers look at objects just before naming them as a part of speech planning processes (i.e., processing visual input, understanding the scene/picture and verbalizing what they see; for reviews see Meyer 2004, and Griffin 2004).

Eye gaze during speech planning is timed similarly to directed eye gaze during ASL production, in that gaze begins before language production. In spoken language production, speakers do not look at objects while saying the object's name. Instead typical gaze begins 900ms before word production and ends a full 200ms before the word's onset as speakers alter gaze to begin planning for the next word. Gaze during ASL production begins about 250ms before the onset of either the verb or pronoun and is usually completed before the onset of the sign. The shorter overall duration of gaze during signing may be the result of the different nature of the two types of gaze. Specifically, with the grammatical use of eye gaze in ASL there is no need for visual processing of the object that a signer is either referring to, or marking agreement features for, because in fact, there is no actual object present. The tighter time link between gaze and the onset of a sign (from 200ms in speech to right before or slightly after the onset of a sign) can be similarly explained. With the grammatical use of eye gaze, signers do not have to quickly move gaze from a location associated with an object to begin planning for word production of the next object, as is the case in spoken language scene descriptions. Thus, the use of eye gaze in both non-signing children and adults suggests that grammatical eye gaze in ASL may emerge from non-linguistic cognitive functions for eye gaze.

Regardless of the origins of grammatical eye gaze, the L2 data still demonstrate that acquisition of eye gaze agreement does not come for free (i.e., novice signers are unable to correctly produce eye gaze agreement). Thus, there

must still be something more in an L2 learners' ability to acquire eye gaze agreement than their knowledge of shared attention. This study examines the end result of L2 learning, not the step-by-step process that occurs during the learning of a language, and must therefore leave the question of how this learning proceeds open. However, the suggestion here is that while one interpretation of the process of learning eye gaze agreement is that L2 learners make use of some innate linguistic knowledge, another equally plausible interpretation is that the predisposition to pay attention to gaze causes L2 learners to attend to grammatical eye gaze patterns in such a way that acquisition is ultimately possible.

By and large, the findings presented here crucially suggest that language learners do not come to the table with pre-established notions of what forms language might take (i.e., speech stream or directed eye gaze). Rather, the ability to acquire a language appears dependent on the human capacity to pick out patterns related to grammar, no matter what modality or form these patterns appear in.

Chapter 4 of this dissertation examined native signer pronoun production. The data showed that eye gaze during the production of pronouns does not function as a grammaticized feature of pronominal reference, although it likely serves some discourse functions. The following evidence supports this claim: eye gaze accompanying pronouns is relatively inconsistent, does not vary dramatically between pronouns with a second and third person referent, and exhibits a large degree of individual variation. The data from the pronoun study also show that eye

gaze does not mark a grammatical distinction between second and third person in ASL. The fact that eye gaze is not used to distinguish second and third person pronouns supports the growing body of research which claims that while spoken languages invariably have a three-person system, signed languages have two-person systems (Meier, 1990; Engberg-Pederson, 1993; Cormier, 2004; Meir, 1998). The growing evidence suggests a true language dichotomy in which modality appears responsible for creating different systems of person marking. Thus the split between signed and spoken languages for grammatically encoded person offers us the opportunity to examine the factors that shape grammar.

Traditionally, language typology research seeks to identify properties of languages, as well as relationships between these language properties (e.g. implicational universals) by cross-linguistic comparison. The goal of this research is to discover language universals and, more importantly, to seek explanations for these universal properties. The cross-modality data on pronouns to date (including the data from Chapter 4) suggest an implicational universal for person marking systems that can be stated as follows:

a) If a language has no required gestural interface occurring with person marking paradigms, then a three-person system will emerge.

b) If a language has a required gestural interface, then a two-person system will be the result.

The above statements suggest that even though both signed and spoken languages make use of gesture, only when gesture has a *required* interface with language is

the need for a three-person system abrogated. Gesture interfaces in this way only with signed languages, probably because of the need for signers to be in view of their conversational partners. Thus the explanation offered here is that the difference in person marking between signed and spoken language arises directly as a result of language modality. Since the gestural component serves to disambiguate pronominal reference by directly pointing to locations in space associated with referents, ambiguity is reliably eliminated[18], and so is the need for a second and third person grammatical distinction. Crucially, while eye gaze could be used to mark person in ASL, it does not become grammaticized in this environment.

The influence of gesture (which exists outside the language domain) on the outcome of the language system is intriguing. However, we do not always find the same effect on the grammar from the required sign-gesture interface. That is, in the environment of ASL verb agreement, with the presence of a disambiguating gestural component, eye gaze can and does become grammaticized. Verb agreement is similar to pronominal reference in that it is carried out with the same symbiotic relationship between gesture and sign (see Chapter 2). However, in this case eye gaze *is* recruited into the grammar as an agreement marker. Eye gaze appears to mark the same features already marked by manual agreement, and

[18] Ambiguity of a different kind than that of spoken languages is possible for some pronouns in ASL. Ambiguity arises when a locative and a noun are established in the same location. For example, if I sign MAN_1 LIVE $NEW\text{-}YORK_1$ 'the man lives in New York' where both MAN and NEW-YORK share the same location in space (as indicated by the matching subscript number 1), a pronoun used to refer back to that same location will be ambiguous (i.e., it will not be clear whether I am referring back to MAN, or NEW-YORK).

simply functions as an additional marker of agreement, creating redundancy in the system. The question then is why does eye gaze with pronominal reference not become grammaticized, while eye gaze with verb agreement does?

It is possible that eye gaze is recruited as a grammatical marker within the agreement system—but not within the pronominal system—as a result of the distinct nature of these two systems. On the one hand, the pronominal system is built to represent reference with pronouns simply encoding this straightforward referential relationship. On the other hand, the agreement system is based on a matching of features between an agreement trigger and agreement element and the agreement morphology arises out of the combinatorics of the trigger (i.e., agreeing verb) in a syntactic relationship with its agreeing element (i.e., the verb's arguments). In the process of coupling together a verb with its arguments the language creates a more complex grammatical relationship than referential identification.

The different grammaticization patterns for eye gaze in the pronominal and verb agreement systems suggest that redundancy is more likely to arise the more abstract and complex a system becomes. Within the pronominal system, there is no need for redundancy because it represents a simple referential relationship. Within the agreement system, however, a more complex syntactic relationship exists between a verb and its arguments. With the increased complexity of the system, language recruits eye gaze as an additional redundant marker of agreement. Thus, the difference between eye gaze with pronominals and eye gaze with verb

agreement provides evidence of two different principles exerting influence on the language system. The first principle is to reduce ambiguity if possible. In an environment where pronouns are not ambiguous, a three-person paradigm does not arise, and eye gaze is not recruited into the grammar. The second principle is to alleviate the burden of complexity if possible. In an environment where complexity arises, this complexity can be compensated for with redundancy. Thus with ASL verb agreement eye gaze is recruited into the grammar as a means of offsetting language complexity.

Overall, signed languages include characteristics that are clearly shaped by the visual-spatial modality, such as a tight link between manual signs and gesture, with a required gesture-sign interface occurring with pronouns and verb agreement. At the same time, they exhibit properties found in all human languages, including complex grammatical relationships like verb agreement, which conforms to universal principles like the accessibility hierarchy. The difference in the grammaticization of eye gaze that occurs across pronominal and verb agreement systems provides evidence for two different forces responsible for determining aspects of the language system. For pronouns, gesture does the work minimizing ambiguity because of the required gesture-sign interface, and thus eye gaze is not incorporated into the grammar. For verb agreement, ambiguity is still minimized with the incorporation of gesture. However, because of the complexity of the relationship between a verb and its arguments as marked in ASL with manual

agreement morphology, eye gaze is now recruited into the grammar as a redundant agreement marker.

The goal of this dissertation was to examine the grammatical functions of eye gaze in ASL. The desire to understand how eye gaze functions within a signed language was motivated in part by larger questions regarding the nature of language in general. Specifically, I made use of eye gaze in ASL as a tool to answer questions about what is possible in human languages, how they are learned, and how language features arise. In sum, this body of research suggests that regardless of modality, languages are surprisingly similar. There is strong evidence, therefore, for the universal nature of all types of languages. However, modality-specific typological differences do arise. In this case, linguistics can look to these disparities (such as the effect of a required gesture-sign interface) to provide insight into how language tendencies come about, and what the interaction between language and other aspects of cognition may be.

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