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Referential Cohesion in American Sign Language: Modality-Specific and Modality-General Influences

A dissertation submitted in partial satisfaction of the

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by

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TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1:

CHAPTER 2:

CHAPTER 3:

CHAPTER 4:

LIST OF TABLES

CHAPTER 2:

CHAPTER 3:

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ABSTRACT OF THE DISSERTATION

Referential Cohesion in American Sign Language:
Modality-Specific and Modality-General Influences

by

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Doctor of Philosophy in Linguistics and Cognitive Science

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Understanding how producers and comprehenders converge on the same discourse entities is a central task in psycholinguistics. For example, how does a language producer decide to use a pronoun (‘she’) instead of a noun in a sentence such as ‘the cook hates the teacher, because she is grumpy’? Similarly, how does the comprehender determine which of the previously mentioned entities such an ambiguous pronoun refers to? Previous work on spoken

language referential cohesion has been concerned with questions such as how the accessibility of the referent in the discourse context influences choice of referring expression, whether pronouns prefer antecedents with a particular grammatical role, and how verb semantics influences pronoun resolution. Research on sign language cohesion, however, has focused on areas where the signed modality differs from the spoken one. This is primarily the use of space and spatial co-reference, which leads to the existence of partially iconic referring expressions and to the ability for pronouns to unambiguously indicate their referents.

This dissertation investigates how factors specific to and independent of the articulatory modality jointly influence referential cohesion in American Sign Language (ASL). The first study (Chapter 2) examines whether ASL signers systematically vary their choice of referring expression as a function of discourse context. The results show this to be the case and that, consequently, the referential hierarchy proposed for spoken languages largely applies to reference tracking in ASL. The second study (Chapter 3) focuses on whether the articulatory modality influences how a specific kind of verb semantics, known as implicit causality, is distributed across verbs in ASL. Results indicate a distribution that is language-specific rather than modality-specific. Finally, the third study (Chapter 4) examines how spatial co-reference, grammatical role, and implicit causality biases influence pronoun production and interpretation in ASL. The results show modality-independent factors to exert much greater influence on ASL pronouns than previously assumed.

Together, the studies in this dissertation indicate that referential cohesion is remarkably similar across modalities. This has important theoretical implications in the domains of psycholinguistic theory and sign language linguistics, as well as practical implications for the education of Deaf, signing children.

CHAPTER 1

Introduction

1 Studying Referential Cohesion in Sign Languages

For communication to work, it is essential that the producer and the comprehender both know who is being talked about. In linguistics and psycholinguistics, the process of describing and understanding *who is doing what to whom* throughout the discourse is known as referential cohesion. While referential cohesion might appear straightforward, understanding its underlying processes in fact involves answering numerous questions. For example, to what extent does the producer modify how they talk about an entity based on what they think the comprehender knows? What makes the producer choose a more specific form of reference ('the man') instead of a less specific one (e.g. an overt pronoun, 'he') to talk about a referent? How does the comprehender determine whom the producer meant when they used a less specific referring expression, particularly when there is more than one option (e.g. 'Lisa loves Mary, because she is kind')? A growing body of research is seeking to answer these questions by investigating typologically diverse languages, but little is known about referential cohesion beyond the spoken modality. This dissertation investigates American Sign Language (ASL) to determine whether the same or different principles govern production and understanding of referential cohesion when the language is signed rather than spoken.

Referential cohesion causes few issues for mature languages users, despite its complexity. Yet, it remains a challenge for psycholinguists to determine its underlying processes. Understanding how language users converge on who is being talked about has implications not just for theories of linguistics and cognition, but also for education. It takes children years to

become fully adult-like in referential cohesion in their first language (Hickmann, 1996), and adults struggle to achieve native-like competence in their second language (Hendriks, 2003). Moreover, being able to resolve reference appropriately, particularly anaphora, is crucial for reading comprehension. Anaphora are expressions that refer back to previously mentioned entities. Children's reading comprehension is correlated with their ability to resolve anaphora in an adult-like manner (Megherbi and Ehrlich, 2005). Similarly, pronoun knowledge and anaphor resolution predict how well children comprehend text beyond the word and sentence levels (Elbro et al., 2017). After grade 4 or 5 of elementary school, instructional focus shifts from students learning to read to instead reading to learn about a variety of subjects. It is therefore not surprising that studies have found links between reading comprehension and educational attainment at different time points in children (Cain & Oakhill, 2006) and adolescents (Ricketts et al., 2014). Mastering referential cohesion is crucial for ultimate educational attainment.

Research from the past decades has discovered a number of principles involved in referential cohesion. The choice between a lexical noun phrase (e.g. 'the man') and a less specific expression (e.g. 'he'), for example, involves the discourse-pragmatic principle of *accessibility* (also sometimes referred to as *givenness*, Gundel et al., 1993; or *salience*, Arnold, 2010). Essentially, this principle captures the fact that more specific expressions are used for referents that are new and being introduced into the discourse for the first time, while less specific expressions are used for referents that are discourse-old and therefore more accessible (Chafe, 1976; Givon, 1983, Marslen-Wilson et al. 1982; Ariel, 1990, Gundel, Hedberg & Zacharski, 1993).

The focus on accessibility means that referential cohesion has often been cast as a primarily pragmatic issue in past work. Pragmatics is the branch of linguistics studying how

context contributes to meaning. Since context is not language specific, pragmatics has generally been assumed to be universal. Universality is assumed for discourse-pragmatic organization as well (Givon 1983a 1983b, 1984; Gundel et al., 1993). Nevertheless, it was clear from early on that even if pragmatic principles are the same across languages, there are countless areas, including referential cohesion, where pragmatics interfaces with other linguistic areas such as morpho-syntax and semantics, which exhibit clear cross-linguistic variation (Givon, 1983a).

The importance of taking variation across languages into account becomes particularly clear when we move beyond the global discourse-level to look at how less specific referring expressions are used and understood in situations when more than one referent is discourse-old. A common assumption is that producers use pronouns for the referent that is the most accessible, and that comprehenders similarly resolve pronouns to such entities. However, many of the factors proposed to influence accessibility for the purposes of pronominal reference are not in themselves pragmatic. These factors include grammatical role of anaphor and antecedent, and the verb's thematic roles (Smyth 1994; Chambers & Smyth 1998, Grober, Beardsley & Caramazza, 1978; Stevenson, Crawley, & Kleinman, 1994). These should be expected to vary cross-linguistically. For instance, the lexicalization of thematic roles varies across languages (compare for example psychological verbs in Levin, 1993 and Cheng, 1996), which may influence the reliance of producers and comprehenders on thematic role cues in referential cohesion in different languages. As another example, the least specific referring expression is not the same across all languages. Some languages allow subject and/or object arguments to be dropped (many Romance and East-Asian languages), resulting in null pronouns; some languages generally do not allow null pronouns and instead make frequent use of overt pronouns (many Germanic languages); and others have overt pronouns but use them only infrequently for the

purposes of referent tracking (e.g. Japanese). Still others have several different types of expressions that fall under the category of less specific. Greek, for example, has null pronouns and clitics, as well as demonstrative pronouns (Miltsakaki, 2001). Such differences highlight the need for cross-linguistic research in areas such a referential cohesion, even when underlying principles are assumed to depend on general cognition and should therefore be universal.

Despite recent advances in our understanding of how different morpho-syntactic, semantic and pragmatic factors contribute to referential cohesion, there is still a great need for expanding the variety of languages that are investigated. The majority of psycholinguistic work has been done on English. It has been pointed out that more cross-linguistic work is needed if we are to create a truly universal model that encompasses all languages (Kaiser, 2013). An increasing number of studies examine referential cohesion in languages that are typologically different from than English (see papers in Givon, 1983; Ariel, 1990; Huang, 2000; Miltsakaki, 2007; Yoshioka, 2008; Azar & Özyürek, 2015; Zhan, Levy & Kehler, 2016), but the vast majority of the work has focused on spoken languages, and often on the written form of spoken language. Studies of sign language and co-speech gesture remain comparatively rare.

Sign languages are produced and perceived in the visual-manual rather than the oral-aural modality. This means that the hands, the face and the body are used as articulators, and that the eyes are used to perceive language transmissions. On the surface, this introduces a number of potential differences from spoken languages that are perceived with the ears and produced with the mouth. Nevertheless, research has shown that when looking past surface-level differences, we find linguistic equivalence between spoken and signed languages on the levels of phonology, morphology, syntax, semantics, and pragmatics (see Sandler & Lillo-Martin, 2006 for an overview).

However, some questions regarding differences in language medium and properties of the modalities remain unresolved. The domains of discourse-pragmatics and referential cohesion in particular involve phenomena that seem to be drastically different between sign and speech. Broadly speaking, sign language referential cohesion relies in large part on the meaning imbued in the articulatory space surrounding the signer. Notably, referents can be associated with areas of space, and subsequent referring expressions can make use of that space. This creates drastically different referential forms, and also potentially a different process for retrieving intended referents compared to spoken language. While referents also can be associated with space in the gestures that hearing individuals make while speaking (McNeill, 1992; Kendon & Versante, 2003), sign languages have conventionalized these processes.[1]

Advances in sign language discourse-pragmatics have shown that accessibility plays a role in referent tracking, as it does in spoken languages. However, the visual-manual modality additionally offers semiotically diverse devices, such as the use of space and various (partly) visually iconic signs. These devices play a role in referent tracking as do the conventionally studied referring expressions, such as nouns and pronouns (Bel, Ortels & Morgan, 2013; Perniss & Özyürek, 2015; Hodge, Ferrara & Anible, 2019). Models of referential cohesion need to be able to account for such referential devices in addition to those familiar from spoken languages. Including sign language work in the study of referential cohesion means considering the full semiotic potential of human language and is therefore important for achieving a full understanding of the principles underlying referential cohesion.

Relatedly, studying sign languages invites the researcher to consider the consequences of writing systems in language. Sign languages do not have conventionalized written forms.

[1] Although note that the use of space, and particularly abstract space, differs between sign languages (see for example de Vos and Pfau, 2015).

Therefore, the majority of communication between signers is face-to-face. Psycholinguistic studies of sign language referential cohesion in general, and of pronouns in particular, differ from many similar studies of spoken language, where reading and writing are used as proxies for listening and speaking. Such proxies, however, do not exist for sign languages. Consequently, comparisons of results between signed and spoken languages often involve comparing online, face-to-face communication with the more offline processes of reading and writing. Such comparisons are potentially problematic, because they leave out the contributions of speech-adjacent behavior, such as gesture, to spoken language referent tracking. Consequently, we know only little about how gesture and speech interact in referential cohesion (but see Azar et al., 2018; Debreslioska & Gullberg, 2018; Debreslioska et al., 2013; Yoshioka, 2008; Gullberg, 2006; Levy & McNeill, 1992; McNeill, 1992; Marslen-Wilson, Levy & Tyler, 1982). Currently, only a handful of studies have attempted to directly compare narrative and referential strategies in co-speech gesture and sign language (Rayman, 1999; Earis & Cormier, 2012; Perniss & Özyurek, 2015; Quinto-Pozos & Parrill, 2015).

This dissertation extends the study of referential cohesion to ASL. The overarching goal of this work is to investigate whether or not modality is the primary factor in shaping referential cohesion at various levels of linguistic structure. To answer this question, we study the performance of Deaf, native signers of ASL on a set of experimental tasks. These tasks are designed to examine how modality-general and modality-specific influences affect choice of referring expression, resolution of pronouns, and the type of verbs affecting which referent is likely to be re-mentioned in the discourse. We ask if and where the processes of referential cohesion in sign languages differ from spoken languages. We also ask whether we can satisfactorily account for a language like ASL by applying principles and models developed for

spoken language reference, and how the attempt to do so can inform existing psycholinguistic accounts of referential cohesion.

The remainder of this introduction (Chapter 1) provides a review of relevant theoretical literature and results of past experimental studies. It begins with studies of referential cohesion (section 1.1), and continues to consider how factors like implicit causality verbs contribute to so-called *next-mention biases* and referential cohesion (section 1.2). The review ends with a discussion of past work in ASL (section 1.3). The final parts of the introduction offer an overview of why modality should matter for referential cohesion, and discusses the specific hypotheses tested in this dissertation (section 2). This Chapter concludes with an overview of the structure of the remainder of the dissertation (section 3).

1.1 Referential Cohesion and its Influences

Much work on referential cohesion has focused on the effects of discourse-pragmatics on the producer's choice of referring expression. Typically, speakers mark which information is new and which information is old (often termed given) in the discourse (Chafe, 1976; Givon, 1983; Ariel, 1990; Gundel et al., 1993). Researchers have assumed that producers vary referential explicitness to enable the comprehender to identify the referent in question (see review in Arnold, 2010). Thus, referring expressions, such as names and definite noun phrases, that specifically indicate their referent ('Robert Mueller', 'the man'), are used when more information is needed to determine who or what is being discussed. Conversely, referents that are easily retrievable can be referred to with a less specific expression, such as a pronoun. Pronouns are often (at least potentially) ambiguous and might cause communicative breakdowns if used in contexts where the reference is unclear or where they could indicate an unintended referent.

A related discovery is that more specific referring expressions tend to involve a larger quantity of marking material compared to less specific ones (Givon, 1983a, 1984). In general, noun phrases (e.g. 'the old man') contain more phonological material than pronouns (e.g. 'he'), which in turn contain more material than null references (e.g. 'Ø' in 'he became tired, and Ø went home')[2].

Cross-linguistic research has provided additional support for the claims that specificity and quantity of marking material vary as a function of accessibility in different languages. For example, a number of European languages use nouns for new and less accessible referents, and pronouns for the most accessible ones (French, Leclercq & Lenart, 2013; Dutch, Yoshioka, 2008). Others use null pronouns for the most accessible referents in narratives, and nouns (and pronouns) for less accessible ones (German: Debreslioska et al, 2013; Japanese: Clancy, 1980). These findings pertain to how referring expressions are produced, but other work has shown that matching referring expressions to accessibility of the referent has impacts for the comprehender as well. For example, repeating the name of the previous sentential subject can introduce processing delays for the comprehender (Cloitre & Bever, 1988, Gordon, Grosz & Gilliom, 1993). Thus, with respect to using different referring expressions as anaphora, there is some symmetry between what producers do and what comprehenders prefer.

Based on such findings, it is expected that producers will use pronouns for the referents that are the most accessible to the comprehender. As more accessible referents can be reactivated and retrieved by the comprehender with less information than can less accessible ones, the comprehender is assumed to resolve pronouns to those same referents. The task for psycholinguistics, then, is to identify what makes a referent accessible. Many studies have

[2] Note that English does not have actual null pronouns and only permits leaving out repetition of the overt subject specific syntactic constructions such as conjoined verb phrases. Other languages have free null pronouns.

attempted to do this, and a variety of factors have been proposed to influence accessibility. Among these are the subject preference (Frederiksen, 1982; Crawley, Stevenson & Kleinman, 1990), which holds that pronouns are preferentially linked to grammatical subject antecedents; the parallel grammatical role strategy (Smyth 1994; Chambers & Smyth 1998, Grober, Beardsley & Caramazza, 1978), which holds that pronouns prefer antecedents that occupy the same grammatical role; the first-mention advantage (Gernsbacher & Hargreaves 1988; Gernsbacher, Hargreaves & Beeman 1989), where first-mentioned entities are preferred antecedents regardless of their other linguistic properties; and thematic role prominence (Stevenson, Crawley, & Kleinman, 1994), which holds that entities with certain thematic roles are more prominent than others and will therefore be preferred as pronoun antecedents. While not always explicitly stated, many approaches assume that pronoun interpretation is a step-wise process triggered by encountering a pronoun (see Kehler, 2008), as shown in 1-3) below.

1) The comprehender first searches for possible referents from the discourse
2) The referents that match the pronouns on morphosyntactic features such as number, gender, person, and binding contraints are retained, while mismatches are filtered out
3) The referent of the pronoun is found among remaining options by assessing which entity is the most accessible, using one of, or a combination of, the strategies discussed above.

Counter to the traditional assumption that pronoun production and comprehension mirror each other, another line of work has argued for a dissociation between these two processes. This work has found evidence that pronoun resolution can be understood as a partly predictive process, rather than a step-wise reaction to encountering a pronoun. A study of English by

Stevenson, Crawley and Kleinman (1994) discovered that the thematic roles of the verb in the clause preceding the anaphor exert influence over which referent will be re-mentioned, regardless of how it is mentioned. Stevenson et al. argue that thematic role influences how a pronoun will be interpreted because the comprehender has formed an expectation about which referent will be mentioned, before the pronoun is encountered. They also found evidence that this predictive process does not affect whether a pronoun will be used by the producer. While semantic factors, such as thematic role, affect which referent will be re-mentioned, grammatical role appears to determine the producer's choice of referring expression for that referent.

Findings from other studies have supported the claims by Stevenson and colleagues. In English, if the antecedent is the subject referent, it is likely to be pronominalized. However, if it is a non-subject referent, noun reference is preferred. Moreover, when the comprehender encounters a pronoun, the likelihood increases that they will interpret the sentence as being about the previous grammatical subject. This suggests that comprehenders rely jointly on semantic biases and pronoun production biases in their interpretation of pronouns (Kehler, Kertz, Rohde & Elman, 2008). On the other hand, because the rate of pronominalization stays constant across different semantic contexts (Miltsakaki, 2007; Kehler et al., 2008; Fukumura and Van Gompel, 2010), producers do not appear to take referent accessibility or the activation of the referent in the comprehender's mind into account when choosing a referring expression.

These findings led to the proposal of the Bayesian model of pronoun interpretation by Kehler and colleagues (Kehler et al., 2008; Kehler & Rohde, 2013; Rohde & Kehler, 2014; Kehler & Rohde, 2018). The model holds that "pronoun production is insensitive to a class of semantically- and pragmatically-driven contextual biases that have been shown to influence pronoun interpretation" (Kehler & Rohde, 2018:1). Instead of treating pronoun comprehension

and production as mirror images of each other, Kehler and colleagues propose that the two processes are linked by the probability that a referent will be re-mentioned, which they refer to as the next-mention bias. In production, the next-mention bias affects whom the producer mentions in the upcoming discourse; in comprehension, it guides the comprehender's expectation about who will be talked about. In resolving a pronoun, then, the comprehender uses this expectation together with their knowledge that the producer prefers to pronominalize previous subjects to determine whom that pronoun refers to.

The next section discusses a few of the factors that help shape next-mention biases.

1.2 Next-Mention Biases and their Sources

One source for next-mention biases is semantics. This dissertation focuses on implicit causality (IC) verbs as one possible semantic contributor to next-mention biases. IC verbs are interpersonal verbs such as 'annoy', 'like', and 'surprise'. They get their name from the fact that they implicitly attribute the cause of the event described by the verb to either the subject or the object (Au, 1986; Brown & Fish, 1983a, 1983b; Caramazza, Grober, Garvey & Yates, 1977; Garvey & Caramazza, 1974). Consequently, they elicit re-mention of the causally implicated referent. This means that verbs like 'annoy', which implicitly attribute causality to the subject, elicit proportionally more re-mentions of the subject referent than of non-subject referents; they are referred to as NP1-biased or subject-biased verbs. Conversely, verbs such as 'like' elicit more re-mentions of the object (or non-subject) referent and are referred to as NP2-biased or object-biased verbs. This dichotomy has been of great interest to psycholinguists, because it not only leads to more re-mentions of the causally implicated referent on the part of the producer, but also to the comprehender resolving ambiguous pronouns in line with the bias.

Much work has focused on discovering the sources of the IC biases. A proposal that has spurred much subsequent work is the *revised action-state taxonomy* (Rudolph & Försterling's 1997). Building on the work of Brown and Fish (1983), this taxonomy suggests that IC biases results from the thematic roles of the arguments occupying subject and object positions in the verb. Stimulus-experiencer verbs, such as 'annoy', have a stimulus-subject and an experiencer-object, and are biased towards re-mentioning the subject. Experiencer-stimulus verbs, such as 'like', have an experiencer-subject and a stimulus-object and are biased towards re-mentioning the object. These patterns have been confirmed for a large number of verbs in English (Ferstl et al., 2011), and Spanish (Goikotexea et al., 2008). While subsequent work has argued that thematic roles do not offer a sufficiently fine-grained distinction to reliably capture biases (Hartshorne & Snedeker, 2012), alternative classifications nevertheless predict verbs with experiencer-stimulus structure to elicit NP2-biases and those with stimulus-experiencer structure to elicit NP1-biases.

While it has been assumed that IC-biases are the result of a universal cognitive phenomenon (see Hartshorne, 2013 for discussion), it is also clear that verb semantics and verb argument structure can differ cross-linguistically. The realization of thematic roles across languages is linked to how causatives are lexicalized. While English boasts a large number of lexical causatives of both the stimulus-experiencer and the experiencer-stimulus type, other languages exhibit asymmetries in the area of causatives. Mandarin Chinese, for example, appears to prefer periphrastic causatives (e.g. 'John made Lisa embarrassed') for events that would typically be expressed using a lexical verb with stimulus-experiencer structure in English (e.g. 'John embarrassed Lisa'). While a number of lexical causatives with experiencer-stimulus structure exist in Mandarin, there are very few ones with stimulus-experiencer structure (Chen,

1996). Similarly, Korean realizes many IC constructions as periphrasic causatives or light verb constructions (see overview in Kim & Grüter, 2018). However, research has primarily focused on discovering whether similar verb semantics or even translation equivalents of individual verbs lead to similar IC-biases across languages. Not much is known about potential differences between periphrastic and lexical constructions in contributing to the next-mention bias (but see Cheng and Almor, 2017; and Kim & Grüter, 2018).

Another source of next-mention biases is pragmatic and includes factors such as coherence relations. Coherence relations are explicit or implicit links between clauses or sentences. Consider the sentences in 4):

4) The domestic pharmaceutical industry fears the institution of a Medicare drug benefit. They do not want to reveal the true costs of their proprietary medicines. (Kehler, 2002: 12)

Although this example consists of two separate statements, readers will generally not treat them as separate but rather infer a relationship between them. In the case of 4), the relation that is inferred is an *explanation relation*. That is, readers will take the second statement (not wanting to reveal the cost of medicines) to be an explanation for the first statement (fearing a Medicare drug benefit). Such a relation can be made explicit by using a conjunction (e.g. 'because'), as in 5):

5) The domestic pharmaceutical industry fears the institution of a Medicare drug benefit, because they do not want to reveal the true costs of their proprietary medicines. (Kehler 2002: 12)

Kehler proposes a number of different coherence relations. This dissertation discusses the explanation relation and two additional relations, namely *result* and *elaboration relations.*

In result relations, addressees infer that the second statement is a result of the first statement, as in 6):

6) George is a politician, and therefore he is dishonest. (Kehler 2002: 20)

Elaboration relations are generally restatements providing a different level of detail or presenting a different perspective on the event, as in 7):

7) A young aspiring politician was arrested in Texas today. John Smith (34) was nabbed in a Houston law firm while attempting to embezzle funds for his campaign. (Kehler 2002: 18)

The coherence relation that is inferred influences the next-mention bias, that is, which referent is likely to be re-mentioned. In the context of IC verbs, explanation relations mostly elicit mention of the causally implicated referent, that is, the subject in NP1-biased verbs, and the object in NP2-biased verbs.

Finally, IC verbs usually elicit an inferred explanation relation (Kehler, et al., 2008). However an explicit connective can alter this tendency. As shown in 8a) and 8b), changing the connective from ‘because’ to ‘so’ changes the coherence relation from an explanation relation to

a result relation, and this changes the next-mention bias from subject in 8a) to object in 8b) (Au, 1986; Stevenson, Crawley, & Kleinman, 1994):

8a) Lisa_i annoys Jill, because she_i …

8b) Lisa annoys Jill_i, so she_i …

In summary, next-mention biases arise as a result of (sometimes) subtle semantic and pragmatic factors. While most research has been conducted on English, there is some evidence that next-mention biases stem from similar sources and result in similar effects on pronoun resolution in other languages as well.

At this point, a picture emerges that suggest that referential cohesion is governed globally by referent accessibility, and locally by different processes for comprehension and production of pronouns, which are linked by next-mention biases. These principles are suggested to be universal, and there is some evidence from languages other than English to support this. To date, however, little is known about the extent to which these principles are attested in sign languages, and about how they affect signed referential cohesion.

1.3 American Sign Language

American Sign Language (ASL) is the primary language of the Deaf communities in the U.S. and parts of Canada. The following provides an overview of ASL structure and introduces relevant notational conventions.

Signed lexical words are articulated by the hands and will be represented by glosses

written in capitalized English letters (e.g. 'MAN')[3]. A subcategory of ASL lexical items do not consist of sign units, but rather of sequences of fingerspelled letters. ASL allows borrowing from English though spelling of English letters using the handshapes of the manual alphabet. This is often used for proper names, where no sign name exists, and for some common nouns. There is a tendency for high frequency words that are conventionally fingerspelled (e.g. #ALL, #EARLY) to lose resemblance to actual spelling and instead become more like the signs in the core lexicon (see Padden, 1998; and Thumann, 2009, for discussions of this phenomenon). In this dissertation, fingerspelled words will be indicated with a hashtag (e.g. #LISA).

In addition to lexical items, usually represented on the hands, ASL represents grammatical information non-manually, by using facial-expression and head- and body-movement. For example, polar questions are marked by eyebrow raise, while WH-questions are marked by furrowed brows (Baker & Padden, 1978). Similarly, eye-gaze serves a number of functions, including marking verb arguments (Thompson et al., 2006) and associating areas of space with referents (Lillo-Martin, 1986; Padden, 1988, Baker-Shenk & Cokely, 1980).

The basic word order in ASL is Subject-Verb-Object. However, overt subjects are frequently dropped, overt objects are sometimes dropped, and word order is sensitive to factors like discourse context and even verb type (see Sandler & Lillo-Martin, 2006 for a discussion of word order in ASL).

Most researchers recognize three types of verbs in ASL. Agreeing or indicating verbs[4], such as 'GIVE' or 'HATE' can mark their subject and object arguments though the use of space (discussed below). Spatial verbs, such as 'PUT', can indicate their subject and locative argument.

[3] It is important to note that the glosses selected in this dissertation do not necessarily reflect glosses that other researchers use, since there is no consensus among researchers regarding which English words should be used for which ASL sign, nor do Deaf signers always agree about how to translate ASL signs into English words.
[4] Whether verbs in this group exhibit grammatical agreement marking or gestural indication of referents is under debate (see for example Schembri, Cormier & Fenlon, 2018 for an overview of the discussion)

Plain verbs, such as ‘LOVE’, are often articulated on the body (Figure 1.1), and do not indicate their arguments in the verb sign itself.

Figure 1.1. The ASL verb LOVE

A group of verbs often treated apart from the lexical verbs discussed above is classifier predicates. Classifiers are handshapes which, sometimes in combination with hand movements, represent some visually salient part of the referent (Zwitserlood, 2012). ASL has different types of classifiers, including handling classifiers, which show how an entity is handled, and entity classifiers, which map a referent onto the signer’s hand(s), in its entirety. Both handling and entity classifiers handshapes can be combined with movement and palm orientation to form predicates (Supalla, 1982). For example, in ASL, an upright 1-handshape[5] (i.e. an extended index finger) represents a person. How a person moves can then be represented by adding movement to

[5] Classifiers are often identified by their handshape, and by convention these handshapes are described with the corresponding ASL numbers or letter from the manual alphabet (e.g. an S-handshape indicates a closed fist, which can be used to represent an agent holding a long, thin object in their hand).

the 1-handshape, e.g. moving the hand, palm facing out, away from the signer in a straight line shows a person walking forwards. Other classifier types, such as size-and-shape classifiers, in which the hands outline the shape of the entity in question (e.g. tracing the shape of a picture frame in the air with the index fingers), cannot be incorporated into predicates.

One of the most researched topics in sign language linguistics is the use of space for linguistic purposes. When using a sign language, the signer moves her hands and body in space in meaningful ways. The articulatory space surrounding the body, primarily in front of the signer, from the waist up, is referred to as the *signing space*. This space serves a variety of functions apart from the articulation of lexical signs. For example, signers can use this space to contrast items and to create timelines (Winston, 1991). It also serves morpho-syntactic functions. As discussed, agreeing verbs can indicate their (indirect) object, and sometimes also their subject. This is accomplished by varying the spatial beginning and ending points of the verb's orientation or articulatory path, or though hand orientation. To exemplify, in the sentence 'LISA HATE-b MARY' the verb 'HATE' can be modified to end at a spatial location associated with the (non-present) object referent, MARY.[6] Verb arguments can also be indicated through body-movement or head-tilt, such that even for plain verbs, subject and object arguments can be made spatially explicit.

The pronominal system can also make use of these spatial locations. Overt pronouns in ASL are pointing signs in which the index-finger is extended. While deictic pronouns are simply directed at present referents, anaphoric pronouns are directed towards the abstract spatial location associated with the intended referent (Friedman, 1975). The spatial locations used in ASL and other sign languages are not permanently reserved for a given argument (although some

[6] Abstract spatial loci are used for non-present referents. For present referents, a locus in the direction of the person in question is used.

argue that a default spatial setup exists in which subjects are positioned on the ipsilateral side of the signer's dominant hand, e.g. the right side for right handed signers, and objects on the contralateral side. e.g. the left side for right handed signers, see for example Sandler & Lillo-Martin, 2006; Geraci, 2014; and Steinbach and Onea, 2016). Instead, loci are established on an ad-hoc basis for each discourse situation, for example by articulating a nominal denoting a given referent in a spatial location.

There is some debate about whether index-finger pointing signs are in fact personal pronouns. Some have argued that these signs are gestural, rather than linguistic in nature (Liddell, 2003), while others have categorized them as demonstrative rather than personal pronouns (McBurney, 2002; Koulidobrova & Lillo-Martin, 2016). For purposes of this dissertation, the main concern will not be the classification of these signs, but rather the fact that they are used to refer to persons and entities, similar to spoken language personal pronouns.

2 Should Modality Matter?

A number of the articulatory, lexical and grammatical phenomena described above are thought to be dissimilar to what is found in spoken languages, particularly the visually iconic properties of some signs, and the use of space. The following outlines whether and how these differences are expected to shape referential cohesion in American Sign Language (ASL) and discusses the specific hypotheses tested by the three studies in this dissertation.

2.1 Varying Form-Specificity and Quantity of Marking Material as a Function of Accessibility

When speakers of a variety of languages track referents though narratives or discourse, they vary the specificity of the referring expression as a function of the accessibility of the

referent. This means that highly informative expressions such as lexical noun phrases are used for new or otherwise less accessible referents, and less informative expressions such as pronouns or null forms are used for more accessible entities. Similarly, the quantity of marking material generally decreases with accessibility of the referent.

These findings raise a number of questions about ASL referent tracking. Nouns, overt pronouns and null pronouns in ASL are seemingly parallel to the specific and less specific referring expressions found in spoken languages. However, a closer look at ASL pronouns suggest that they might behave differently that spoken language pronouns, especially with respect to referent tracking. Because they can make use of the system of referential loci, they can unambiguously indicate their antecedent (Sandler & Lillo-Martin, 2006). No spoken language comes to mind where pronouns can be fully transparent in this way. This raises the possibility that ASL pronouns can be used in contexts where other languages use nouns in order to provide sufficient information to distinguish possible referents. Pronouns are anaphoric and are therefore not expected to be used in ASL in the context of introducing referents. However, pronouns may conceivably be used more frequently in ASL for the reintroduction of a referent after a period of absence from the discourse, as compared to spoken languages where pronouns are less specific. Moreover, it might be differently informative to use a null reference with a plain verb, as opposed to with a classifier predicate. This is because classifiers provide iconic, visual information about one of the verb arguments, unlike other types of predicates. Because of this, it may be felicitous to use null pronouns with classifier predicates for less accessible referents as compared to other verb types.

Another open question is whether the quantity of marking material differs among the null reference types or not. For example, is there a difference between null references in the context

of agreement verbs, where the arguments may be recovered though the spatial locations, compared to plain verbs accompanied by non-manual spatial marking, and plain verbs without any kind of spatial marking? Similarly, does a sentence with a null subject contain more marking material when the verb is a classifier predicate than when it is lexical? The answers to these questions concerning referential specificity and quantity of marking material have consequences for whether existing referential hierarchies can capture the functions of ASL reference forms.

Chapter 2 of this dissertation aims to answer the questions brought up in this section. We test whether the principles described for and the model developed for spoken languages can accurately capture the ASL referential system in the context of referent tracking.

2.2 Producing and Resolving Pronouns

The possibility of creating unambiguous reference with pronouns in ASL also raises questions. Specifically, it is unclear whether the processes involved in the production and comprehension of pronouns are different in the visual-manual modality, compared to the spoken modality. In the traditional step-wise approach to pronouns, the comprehender's first task when encountering a pronoun is to identify possible referents. In a passage such as 9) possible referents of the pronoun 'she' initially include 'Lisa', 'Mary', 'grandfather', and 'aunt'. Next, the comprehender must eliminate referents that are morpho-syntactic mismatches, in this case 'grandfather' which is a mismatch based on gender. Finally, the comprehender then has to choose between the referents 'Lisa', 'Mary', and 'aunt' on the basis of one or more of the soft constraints identified in previous work (e.g. grammatical or thematic role).

9) Lisa and Mary went for a walk together. Lisa wanted Mary to see a new shop that had opened in the neighborhood. On the way there, they encountered Lisa's grandfather, who was on his way to visit Lisa's aunt. Lisa hadn't seen her aunt in a while, and Mary had never met her. She …

In the case of ASL, however, it is not clear that all three steps outlined for spoken pronoun resolution are necessary. Specifically, the way ASL pronouns have been described in previous research suggests that the third step might not apply. This is because under the assumption of previous work, the pronoun indicates a spatial locus, which has previously been associated with a specific referent. While the ASL system is quite unlike gender marking, we can draw a helpful parallel to the case where an English sentence has two antecedents of different genders, and the gender-marked pronoun consequently identifies exactly one of them (e.g. 'Lisa loves Pete, because he …'). Under the assumptions of previous work, an ASL pronoun indicating a referential locus is always unambiguous in this way. Consequently, the pronoun's spatial marking makes it a morpho-syntactic mismatch with all but the intended referent. Moreover, abstract referential loci are created ad hoc. They must therefore only be kept in short term memory for the duration of the ongoing discourse. This is unlike grammatical gender, which must be retained in long-term memory. Such different systems could result in a different role for pronouns in referential cohesion.

Even if we follow recent work on the psycholinguistics of spoken language in rejecting the step-wise process traditionally proposed for resolving a pronoun, we are nevertheless faced with questions about the role of language modality. In the Bayesian model proposed by Kehler and Rohde (2013, 2018), the producer pronominalizes referents based on information-structural

principles, such as grammatical role and topic-hood, irrespective of semantic and pragmatic factors. It is an empirical question whether ASL pronominalization exhibits similar tendencies. However, whether or not this is the case is closely related to another question, namely whether pre-established referential loci are required in order to use a pronoun.

The ASL literature has generally described the use of a pronoun as following the establishment of a referential locus. This raises the question whether mentioning a nominal suffices for subsequent pronominal reference, or whether the nominal must have been associated with a locus in order for a pronoun to be used felicitously in a subsequent clause. Essentially, if a referent has not been associated with a locus in signing space, does this preclude a signer from referring to it with a pronoun? In languages where pronouns match gender features of the nominal or the referent, the very act of using a noun will create a potential antecedent for a pronoun. It is unclear whether this is the case for ASL as well. In Experiment 1 of Chapter 4, we test the hypothesis that signers use more pronouns when potential antecedents have been associated with spatial loci than when they have not. We also examine whether the influences that have been found for production of spoken language pronouns matter for ASL as well.

Experiment 2 of Chapter 3 also compares pronouns in contexts where referential loci either have or have not been pre-established but focuses on pronoun comprehension rather than production. This experiment tests the hypothesis that in the absence of referential loci, pronouns will be interpreted in line with the types of semantic and pragmatic biases that influence pronoun comprehension in spoken language. We also ask what role, if any, these biases play for pronouns that are unambiguous by virtue of referring to pre-established spatial loci.

2.3 How Modality Influences Structure at the Root of Semantic Biases

Section 1.2 discussed the next-mention biases arising from the top-down predictive processes language users engage in. Verb semantics contributes to next-mention biases, and this dissertation focuses on the influence of implicit causality (IC) verbs. The biases of verbs can be linked to thematic roles: stimulus-experiencer verbs tend to elicit re-mentions of the subject referent, while experiencer-stimulus verbs elicit re-mentions of the object referent.

An interesting finding from sign language research raises the question of whether ASL verbs show a similar patterning of biases. Examining psychological verbs, Edge and Herrmann (1976) found that some verbs were preferentially used in intransitive instead of transitive sentence frames in ASL (e.g. FRIGHTEN). Healy (2015) found similar results. Moreover, among the psychological verbs that can be used as lexical transitives, the stimulus-experiencer structure seems to be dispreferred, such that sentences glossed like #LISA ANGER #MARY are not interpreted as Lisa being the stimulus for Mary's anger, as would be the case in English. Rather such sentences are interpreted as Mary being angry at Lisa, that is, with an experiencer-stimulus structure (Edge & Herrmann, 1977; Winston, 2013). This difference in interpretation could be attributed to the choice of ASL gloss. Arguably, a gloss like MAD-AT would be more appropriate for this context than ANGER. However, claims in the literature suggest that such differences in interpretation are symptoms of a more basic difference. Notably, researchers have argued that stimulus-experiencer verbs are simply not attested in certain sign languages (Meir et al., 2007; Kegl, 1990). This means that subject arguments cannot have the thematic role of stimulus. Meir and colleagues link the corresponding preference for the subject to be the experiencer to the concept of body-as-subject. The body-as-subject theory holds that sign languages encode the body as one of the arguments in the described event. This argument must

be both the subject of the verb, and the highest-ranking thematic role (Meir et al., 2007: 533). Under the thematic role hierarchy invoked in this work, the experiencer-role ranks above the stimulus-role. Thus, stimulus-experiencer verbs are not attested in sign languages because it is not possible for the body to encode an argument that is both subject and stimulus.

Cross-linguistically, restrictions on the occurrence of lexical stimulus-experiencer verbs are not uncommon (Chen, 1996; Hartshorne, O'Donnell, Sudo, Uruwashi, & Snedeker, 2010). What is unusual in sign languages, however, is the fact that the restriction has been proposed to be tied to body-anchoring. As such, it is assumed to be the specific articulation of signs that poses a constraint on how thematic roles can be lexicalized. Because of the close connection between a verb's thematic roles and the direction of its IC bias (discussed in section 1.2), it is possible that IC biases are distributed differently in languages like ASL compared to languages like English. Based on previous research, we would expect such a difference to be due to a smaller proportion of stimulus-experiencer verbs in ASL, which in turn should result from constraints on this thematic structure in body-anchored verbs. Chapter 3 tests these hypotheses by examining how IC biases are distributed in ASL verbs, how thematic roles contribute to this distribution, and the extent to which body-anchoring predicts lexicalization of thematic roles.

3 Overview of the Dissertation

Combining insights from psycholinguistic studies of referential cohesion with studies of sign languages leads to a series of questions about the role of the visual-manual modality in sign language referential cohesion, and about where potential modality effects occur. This dissertation explores referential cohesion in American Sign Language (ASL). Three experimental studies using behavioral methods focus on two main issues, namely 1) the production and

comprehension of referring expressions, both from a global perspective (i.e. the selection of referring expressions for differently accessible referents), and from a more local perspective (i.e. the production and resolution of pronouns in different linguistic contexts), and 2) lexicalization of thematic roles as one of the factors that affect which referents are likely to be re-mentioned in the upcoming discourse.

Chapter 2 asks broadly how ASL signers organize the referring expressions available to them for the purposes of producing referential cohesion. This study examines how referent accessibility correlates with referential form in ASL, and how this compares with the discourse-pragmatic organization found in spoken languages.

Chapter 3 investigates the biases of implicit causality (IC) verbs in ASL. This well-studied phenomenon is known to affect pronoun resolution in spoken languages. To date, however, IC biases have not been documented in any sign language, nor has their effect on the resolution of signed pronouns been investigated. Chapter 3 examines how realization of verb argument structure in ASL affects distribution of IC biases. We also ask whether the visual-manual modality imposes specific constraints on argument realization, which may have downstream consequences for discourse structure and cohesion. Thus, Chapter 3 departs from directly examining modality-effects in the production and comprehension of referring expressions at the discourse level. Instead, the chapter focuses on how modality differences might contribute to production and comprehension of referring expressions at the more basic linguistic levels.

In Chapter 4, two experiments test the effects on pronoun production and comprehension of modality-dependent and independent factors. The modality-dependent factor examined is the use of space for co-reference purposes, which is unique to the visual-manual modality. The

modality-independent factors examined are grammatical role of the antecedent and IC biases. Thus, this chapter connects the questions asked in Chapter 2 and Chapter 3 by examining how specific referring expressions, pronouns, are used and understood in ASL, and what the role of implicit causality is in these processes.

Finally, Chapter 5 synthesizes the results from the experimental studies presented in Chapters 2-4, contextualizing the contribution of these findings to the field of sign language linguistics and to our understanding of referential cohesion.

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CHAPTER 2

Who's on First? Investigating the Referential Hierarchy in Simple Native ASL Narratives

Abstract

Discussions of reference tracking in spoken languages often evoke some version of a referential hierarchy. In this paper, we asked whether this hierarchy applies equally well to reference tracking in a visual language, American Sign Language, or whether modality differences influence its structure. Expanding the results of previous studies, this study looked at ASL referential devices beyond nouns, pronouns, and zero anaphora. We elicited four simple narratives from eight native ASL signers, and examined how the signers tracked reference throughout their stories. We found that ASL signers follow general principles of the referential hierarchy proposed for spoken languages by using nouns for referent introductions, and zero anaphora for referent maintenance. However, we also found significant differences such as the absence of pronouns in the narratives, despite their existence in ASL, and differential use of verbal and constructed action zero anaphora. Moreover, we found that native signers' use of classifiers varied with discourse status in a way that deviated from our expectations derived from the referential hierarchy for spoken languages. On this basis, we propose a tentative hierarchy of referential expressions for ASL that incorporates modality specific referential devices.

1 Introduction

Sign languages, including American Sign Language, use the visual-manual modality for their production and perception. Since the beginning of sign language research, much work has explored the phonology, morphology, and syntax of visual languages (Klima and Bellugi, 1979; Sandler, 1986, 2003; Padden, 1988; Brentari, 1992; Engberg-Pedersen, 1993; Bahan, 1996; Neidle et al., 2000; Lillo-Martin, 1986, 2005; Johnston & Schembri, 2007; Meir & Sandler, 2007; Perniss, 2007; Lillo-Martin and Meier, 2011, Crasborn, van der Kooij & Ros, 2012). All this work has revealed language structure that in many ways bears a strong resemblance to structures found in spoken languages - evidence that signed languages are natural languages on par with spoken languages. In addition, researchers investigating sign languages have uncovered in these languages a range of more exotic and often modality specific uses of language, such as employing facial expressions for grammatical modifications, and using space for morpho-syntactic processes. Linguistic domains such as semantics and pragmatics, however, have received comparatively little attention (Davidson, 2013, 2014, but see Engberg-Pedersen, 1993 for an exception). This is also the case for the study of discourse, perhaps particularly in ASL where many researchers have focused more on phonological and syntactic topics (although see Wilbur, 2012 for a discussion of work related to the discourse notions of topic and focus).

The goal of the present paper is to expand our knowledge of discourse structure in one signed language by investigating the choices of referential expressions used throughout narratives in ASL. Our goal is to understand how ASL signers use the various forms of reference available to them to track reference in simple narratives and what discourse constraints these forms are subject to. Before describing the details of the present study, we first provide a selective overview of what is known about referential expressions in ASL.

2 Referential Expressions in ASL

ASL signers use the hands, face, and body for articulation and the eyes for perception of their language. Using the visual-manual modality, signers have access to some different linguistic devices than do speakers using the aural-oral modality. All lexical signs are of course articulated in the space surrounding the signer, or on the signer's body, but in addition, many grammatical processes rely on relative locations in this space. For example, locations in sign space can be assigned referential value in connection with predicates as well as nominals throughout the discourse (Klima and Bellugi, 1979; Lillo-Martin, 1995). To understand how signers manipulate spatial locations along with other referring expressions to construct coherent discourse, we must first consider the range of referential expressions available in ASL, starting with nominal reference, i.e. nouns and pronouns, then continuing on to reference implicit in verbs and other predicate-like expressions, i.e. constructed action, and ending with classifiers.

2.1 Nominal Reference

ASL makes use of space for nominal referential purposes. This process is perhaps best explained in a description of ASL pronouns. Anaphoric pronouns are points to referential loci, that is, locations in signing space that have previously been associated with a referent. Due to the gradient nature of spatial loci, ASL can in theory distinguish an unlimited number of spatial loci, each with its specific reference (Lillo-Martin and Klima, 1990). In practice though, this process is constrained such that distinguishing more than 2 or 3 loci at once is rare (Lillo-Martin and Meier, 2011).

Spatial loci also come into play in connection with nouns, which are also used for referential purposes. As opposed to English, ASL makes widespread use of bare nouns, (Sandler and Lillo-Martin, 2006: 341). With bare nouns, context is used to determine the givenness or accessibility of the referent of the noun in question. Although most nouns are lexical signs, some nouns are conventionally spelled using the hand alphabet, and other typically signed nouns may be fingerspelled at times.

Be they signed or fingerspelled, nouns in ASL may occur with spatial modification. For instance, a signer may produce a point to a location in space either preceding or following a noun. Under some analyses of ASL, a point followed by a noun has been treated as a definite noun phrase, meaning that the point is analyzed as a determiner. In contrast, under the same analysis a point to a location in space occurring after a noun is not considered a determiner, but an adverbial specifying location (Neidle et al., 2000). However, the status of pre- and post nominal points is still under debate (see Meier and Lillo-Martin, 2013 for a brief overview), and the use of points in combination with nouns is possibly entirely optional in ASL, although there has been very little systematic investigation of the matter (but see Swabey, 2002, 2011).

For the purposes of this paper, we also consider as types of nominal reference nouns that are modified by a classifier, either post-nominally as in Figure 2.1, or pre-nominally as in Figure 2.2. In addition to localizing referents in space with pointing signs, ASL allows for articulating the noun in a specific space, which serves the same purpose. However, because we observed only two instances of this strategy in our data, we will not discuss it further. We turn now to reference implicit in predicates.

Figure 2.1. Noun CL example: TABLE CL: SURFACE-OF-TABLE

Figure 2.2. CL noun example: CL: SHAPE-OF-BALLOON BALLOON

2.2 Reference Implicit in Predicates

Nominal references, such as the nouns and pronouns discussed above, are frequently omitted in ASL. In their place, signers can use null expressions. According to various scholars, signers may use verb agreement to identify subjects and objects (Fischer, 2009; Friedman, 1975; Coulter, 1979). ASL verb agreement takes the form of alternations in orientation or path movement through space by the verb. According to Lillo-Martin (1986), ASL displays properties of a so-called *pro-drop* language, primarily by allowing verbs to occur with null argument (subject and/or object) expressions. Some have suggested that this possibility is licensed by

agreement features of the verb, because these features allow the identification of the covert verb arguments (e.g. Neidle et al., 2000). Thus, in this way, such predicates may carry referential value similar to pronominal expressions, because they essentially incorporate pronouns via the starting and ending points of their path movement (or palm orientation), e.g. Kegl (1986). Not all languages that allow the omission of overt arguments mark agreement on verbs. In the case of ASL there are three classes of verbs, plain, inflecting and spatial and they do not all take agreement (Padden, 1988). Although an impression is created by previous literature on ASL that agreement verbs always agree (although Janzen, 2004, 2012 shows that this may not always be so), researchers of other signed languages have argued specifically that even agreement verbs do not always inflect (e.g. de Beuzeville et al, 2009 for Auslan). It is, however, widely accepted that ASL plain verbs (e.g. 'LOVE') cannot agree with their subjects or their objects (Fischer and Gough, 1978; Padden, 1988). One account for why plain verbs in ASL allow pro-drop, despite the lack of agreement shown by path movement to indicate subject/object, was proposed by Lillo-Martin (1986). She argued that there are two kinds of null arguments in ASL. Null reference that occurs with agreement verbs is licensed by features of the verb, whereas the null reference of plain verbs is licensed by topic-hood.

As mentioned above, ASL verb agreement consists of alternations in orientation or path movement in the verb sign. This process makes use of the spatial loci that are also used for pronominal reference, such that the verb path either moves from locus to locus, as in Figure 2.3, or indicates loci by the orientation of the hand (Fischer and Gough, 1978). In Figure 2.3, the signer moves the agreeing verb 'GIVE' between two loci in a path through signing space, creating the meaning 'he gives him'. Because the loci are associated with previously established

referents, this process allows the addressee to recover the subject and object referents when either is expressed only by a null argument.

Figure 2.3. The agreeing verb GIVE with use of spatial loci and in a role-shifted context.

However, ASL signers often choose to use their own body as locus, as either the starting or ending path of the verb. This happens in contexts where the signer has mapped a referent from the narrative onto him or herself, and signals the shifted referent. The referent is shifted because it is now represented at the locus of the signer's body (e.g. Lillo-Martin, 1995). In this paper, the term 'role-shifting' refers to a phenomenon observed in many sign languages: by subtle shifts in body posture (that is by shifting the position of the head, shoulders and/or torso and/or by gazing at the locus of the imagined interlocutor in the context), the signer indicates a previously established locus. Some researchers have used the term role-shift to refer to what the present paper calls constructed action (see Lillo-Martin, 2012 for an overview of terminology use). Here, however, we reserve the term role-shift to denote the physical shift that can serve as a marker of a shifted locus. An example is given in Figure 2.4, where the signer begins the verb GIVE in

front of her chest (panel 1) and ends it at a locus on her right (panel 2). In a non-role-shifted context, the utterance in the figure could be interpreted to mean 'I give her'. However, due to the signer's role-shift towards a pre-established locus, the first-person locus (beginning at the signer's chest) is in fact used to signal a third person referent to indicate "she gave it to her" (Friedman, 1975). This means that agreement verbs without overt arguments indicate which referents are subject and object in role-shifted context as well as in non-role-shifted contexts.

Figure 2.4. The agreeing verb GIVE with use of spatial loci and in a role-shifted context.

Verbs have been the topic of investigation in many ASL studies. Often, however, such investigations have been concerned with the linguistic status of verb modifications via movement or palm orientation. This means that the focus of these studies has often been on what is possible, and the data has often been elicited single sentences. As of yet, for example, we do not know whether there are discourse rules that determine when ASL signers can use agreement verbs with or without role-shift. Although studies have posited the use of spatial loci with agreement verbs as at least one option on equal footing with the role-shifted versions (e.g.

Padden, 1988; Neidle et al., 2000; Sandler and Lillo-Martin, 2006), in fact we know little about the function and distribution of these verb modulations in ASL discourse.

Finally, agreement verbs may also occur without the spatial indication of verb arguments, that is, neither through the spatial loci of path movement nor though role-shift. Janzen discusses this phenomenon under the heading of *mental rotation*. He states that signers may 'mentally rotat[e] their conceptualized space' and map a third person referent onto their bodies, without any spatial indication of which referent they are acting as (2004: 149). For agreement verbs, this means that the signer signs the verb path, or orientation, between the signer's locus and the canonical second person, even though the referents themselves are two third person referents. Thus, not only has the signer shifted the reference of their own locus, they have shifted the reference of the canonical second person locus as well.

Unlike the fixed spatial framework, that is, using third person pre-specified loci (as in Figure 2.3), or physically role-shifting towards a locus (as in Figure 2.4), mentally rotated signing does not provide spatial information about which referents are involved in the action. Rather this is understood via contextual inference. We show an example of this phenomenon from our data in Figure 2.5, where the signer moves the sign 'TAKE' inwards towards his body from a position in signing space directly in front of the center of his body.

Figure 2.5. The mentally rotated agreeing verb TAKE with no spatial loci

Constructed action, which we discuss below, can also occur in a mentally rotated framework. In a mentally rotated framework, context and, for constructed action, also the signer's facial expression provide the information about which entities are intended as referents. Janzen (2012) argues that the use of verbs and constructed action with fixed spatial locations appears to be reserved for comparing attributes and actions of referents, and mentally rotated space is used for shifting the perspective on the narrative to align with the perspective of a referent. No studies to date have investigated whether signers differentiate between the two types of space in a referent tracking context.

The choice between the static spatial and the mentally rotated framework is also relevant for the phenomena of constructed action and constructed dialogue, to which we now turn. Constructed action is when a signer enacts actions or emotions attributed to a character or object in their narrative (Padden, 1990; Winston, 1991; Metzger, 1995; Quinto-Pozos, 2007; Comier, Smith & Zwets, 2013; see Cormier, Smith & Sevcikova, in press for an overview). Constructed dialogue is when a signer recreates the speech or signing of a referent in the narrative (Winston,

1991). A signer can indicate the referent of the constructed dialogue or action with a nominal expression, or by role-shifting. This, however, is not necessary as long as the referent is sufficiently salient in the narrative. In such cases, the signer may opt to use constructed dialogue or action in a mentally rotated context. Thus, the possibility in ASL of using zero anaphora as verb arguments, which we described above, extends to constructed dialogue and action as well. However, although these different types of zero anaphora exist in ASL, at present we know little about how signers use each type to track reference.

Last, we turn to classifiers and classifier predicates (Frishberg, 1975; Supalla, 1982). Classifiers are handshapes (or, in the case of tracing SASSes, combinations of handshapes and tracing movements) that represent a referent or how an agent handles a referent. Classifier predicates are combinations of classifier handshapes with movement or with position in signing space, which encode information about the referent, such as motion and location (e.g. Perniss 2007, Zwitserlood, 2012). Previous studies of classifiers have grouped them into varying types (e.g. Supalla, 1982; Brennan, 1990; Corazza, 1990; Benedicto & Brentari, 2004. Here, we discuss three different types, namely *semantic classifiers*, *handle classifiers*, and *size-and-shape specifiers (SASSes)*. Classifiers are set apart from other elements of sign languages, because they share a unique way of linking form and meaning. This fact may be relevant for their use in referent tracking. For this reason, we do not subsume different classifier types under other referential categories. Although classifier predicates are verbal in nature and may occur with null arguments like other verbs, there is reason to believe that they may carry a referential saliency that differs from that of other verbs. This is because they represent some aspect (e.g. form or features) of the referent in a visible manner throughout the duration of the predicate. At the same time, it is not clear whether the various classifier types are more closely related to one another, or

to other referential expressions. For example, some researchers treat some classifiers as agreement markers (Glück & Pfau, 1998, Benedicto & Brentari, 2004), while other researchers treat classifiers as combinations of roots and affixes (Supalla, 1982, 1986), schematic visual representations (Cogill-Koez, 2000), or as lexically fixed features with gradient form aspects (Liddell, 2003), among others. Treating classifiers as agreement markers would make classifier predicates akin to agreement verbs, but at the same time the similarity of individual classifier types is also under debate, with some researchers maintaining that classifiers are a (somewhat) unified group, and others arguing that some SASSes should not be treated as classifiers at all (see Zwitserlood, 2012 for an overview of different treatments of classifiers). Hence, while we describe classifiers as a separate referential category in the present study, we will also be analyzing the individual properties of the different ASL classifier types.

Semantic classifiers represent referents holistically, that is, their shape denotes some semantic property or form property of the referent (e.g. Supalla, 1982), however, conventionality also plays a role. For example, ASL canonically represents a human with an upright extended index finger, but a vehicle with thumb, index and middle finger extended (the 3-handshape). Semantic classifiers can be incorporated into classifier predicates of motion and location. Handle classifiers serve predicative functions too – their primary use is as handshapes in agreement and locative verbs where they designate the object referent. Lastly, Size and Shape Specifiers (SASSes) are also considered classifiers, although there is some debate regarding the status of certain types of SASSes. SASSes indicate certain physical or geometric characteristics of the referent in question, for example, size, shape and depth. SASSes have been grouped into two different types: static SASSes, where handshapes indicate the shape of a referent, and tracing SASSes, where it is the movement of the hand(s) that indicate(s) properties of the referent by

outlining its shape and size (e.g. Supalla, 1982). We show an example of a tracing SASS from the data in Figure 2.6.

Figure 2.6. SASS example: CL: SHAPE-OF-VASE

SASSes in ASL have not received much attention. However, research on other sign languages describe SASSes as both nominal and adjectival (Johnston and Schembri, 2007; Zwitserlood, 2012). As mentioned, these different classifier types are sometimes discussed under the same heading, although, as we have described above, they clearly have different properties. These varying properties may lead to different pragmatic functions in ASL discourse. For example, Zwitserlood (2003, 2012) argues that tracing SASSes do not appear to function anaphorically, unlike static SASSes, handling classifiers and whole entity classifiers (which we refer to as semantic classifiers). This possibility however has not been explored systematically for ASL.

3 The Present Study

As explained in the previous section, ASL signers have various nominal and predicative reference types at their disposal, including classifiers and constructed dialogue/action. All these expressions could conceivably be used to refer to the same entity. However, it seems logical that signers do not merely choose expressions at random. Thus, a number of questions arise about the potential constraints on using referential expressions. Studies of linguistic properties of referential expressions in ASL do not explain how signers use these reference types to track reference in discourse. Investigating this question is crucial to our understanding of ASL discourse structure and coherence. In a larger perspective, this question is important because the ability to form coherent narratives is an essential part of language acquisition and proficiency.

Maintaining discourse coherence requires that the sender establish and uphold reference to the relevant persons and objects in their narrative. From spoken language research, we know that speakers accomplish this feat by employing their linguistic resources systematically. In nominative-accusative languages (as opposed to, for example, ergative-absolutive languages, which may exhibit different patterns of referent tracking, e.g. Nagaya, 2006), speakers show a preference for fuller linguistic referential expressions like nouns (e.g. 'the horse') for inaccessible or new discourse entities, and a preference for leaner referential expressions, such as pronouns (e.g. 'it') or zero anaphora (Ø) when referring to accessible or given discourse entities (Chafe, 1976; Givón, 1983), e.g. 'the horse approached the fence and Ø jumped over it'.[7] This has led researchers to propose hierarchies of referring expressions, e.g. the accessibility hierarchy (Ariel, 1988) and the givenness hierarchy (Gundel, Hedberg & Zacharski, 1993), to reflect the fact that speakers create coherence between sentences by using less specific, less full

[7] Note that English does not have actual null pronoun, but ASL does.

referring expressions for the same entity, as they assume higher accessibility of the referent in the mind of the addressee (or their own mind) as the discourse progresses. Signers need to create coherent narrative and discourse just as speakers do. Yet few studies have investigated this question for sign languages (Wulf et al., 2002; Swabey, 2002, 2011; Morgan, 2006; McKee et al., 2011; Perniss & Özyürek, 2015).

The first studies to investigate this question have primarily looked at variable subject presence, that is, overt versus null subjects, in Auslan and New Zealand Sign Language (McKee et al., 2011), and American Sign Language (Wulf et al., 2002). These studies found evidence confirming that the use of fuller versus leaner linguistic referential expressions varies as a function of referent accessibility across both the oral-aural and visual-manual modalities. Swabey (2002, 2011) looked in more detail at several referring expressions in ASL, but did not distinguish between different kinds of null arguments. As is evident from the above discussion of referential devices in ASL, the variety of referring expressions in signed languages has not been explained using a discourse framework. Given the many differences between the signed and spoken modalities, we might expect referent tracking in sign language to diverge from the patterns observed in spoken languages.

The purpose of the present study is to systematically investigate ASL discourse organization to discover how referent tracking is constructed in ASL narratives. In order to capture potential language or modality specificities, the present study considers the full range of referential expressions that occurred in the data. This is similar to a recent study by Perniss and Özyürek (2015) who looked at referring expressions in German Sign Language, DGS, as well as in German speech/gesture. Here we not only investigate the referential function of nouns and pronouns, and zero anaphora, but, as a novel contribution to the ASL literature, we also analyze

different classifier and different zero anaphora types, as well as the varying roles of space within the category of zero anaphora. Doing so allows us to uncover their roles in the referential hierarchy in ASL.

4 Methods

4.1 Stimuli

We asked a group of native signers of ASL to retell four short stories. The stimuli used for the experiment were constructed adopting the paradigm advanced by Karmiloff-Smith (1979), the *balloon stories*. The original balloon story consisted of a picture-story comprised of six causally related pictures, showing, essentially, a boy who gets a balloon from a balloon-man, but loses it when walking away. We adapted this paradigm in its essential parts, creating four stimulus items: two picture stories and two video stories; each story consisted of six causally related events. These events were presented as separate pictures in the picture stories and as parts of a dynamic whole in the video stories. The picture stories were black and white drawings, and the video stories were recordings of human actors. An example of a picture story can be found in the appendix. When designing the stimuli we opted for two different stimulus types (picture vs. video), because we intended to use them across different participant groups. We expected that the picture stories would create more coherence problems than video stories in some of these groups. We had no such expectations for the native signers. An analysis of variance (reference type by discourse status by stimulus type) confirmed that there was no statistical difference between stimulus types in how native signers use referring expressions across statuses ($F(6,42)=0.93$, $p=0.48$). Consequently, we collapsed the data across the two stimulus types for the analyses of this paper.

Each story involved a main character (e.g. the boy in the original balloon story), a secondary character (the balloon man), and a featured object (the balloon). The story line was identical across the stimuli; a character walked along somewhere, saw a person selling objects (balloons, popsicles, etc.), obtained one of these objects from the sales person, walked away with the object, lost or damaged the object, and then reacted to what happened to the object. We chose this simple narrative structure because we were interested in basic questions about how characters and objects are referred to throughout narratives in ASL. The simple structure of our stimuli allowed for introduction as well as maintenance and reintroduction of entities, while ensuring similar patterns across stories. Thus, we expected to be able to identify basic narrative structure on this basis.

4.2 Subjects

The native signers ranged in age from 19-54 years of age (mean age: 30.88; median age 29.5). The amount of ASL input they received from birth varied, due to the fact that some had hearing parents, but all signers had all begun learning ASL from birth from parents and/or older deaf siblings. The native signers were recruited from the San Diego Deaf community. Two signers were hard-of-hearing, the rest were deaf. The participants varied in their use and knowledge of English but had an overall preference for communicating in ASL. Six out of 8 participants reported that they currently used ASL 'all the time', and the two remaining participants reported their ASL use as 'daily' and 'every other day'. On a self-assessment scale of ASL production, where 1 is the lowest and 10 the highest, the participants' self-rated proficiency was 9.25 (SD: 1.165).

4.3 Procedure

After giving informed consent and filling out a background questionnaire, participants were given instructions in ASL. The participants watched and retold the stories one by one while being video recorded. A hearing signer greeted the participants and took care of practical details, such as consent forms. The instructions for the experiment were then given by a native Deaf signer, either in person or via a video recording. The stimuli were presented on a laptop screen. The video stories lasted 17 seconds each, from beginning to end; the pictures of the picture stories were shown in sequence, each picture displayed for 5 seconds. The order of presentation of the stimulus stories was counter-balanced across participants using a Latin squares design in which picture stories and video stories always alternated. Participants either told the stories to a native signer, or to the camera with the instruction that the recording would be shown to a signer who would then be asked to pick out the correct story based on their description.

4.4 Data Transcription and Coding

After recording, the videos were imported into ELAN (Crasborn and Sloetjes, 2008), an audio/video annotation tool developed at the Max Planck Institute for Psycholinguistics. The retellings were glossed sign by sign using standard sign glossing conventions (Baker-Shenk and Cokely, 1980), with a few modifications concerning the notation of classifier referents and spatial loci. Individual signs are glossed with an English word in capital letters, which approximates the meaning of the sign, as in example 1). Hyphens are used where a sign contains multiple morphemes, as in example 2 and 3).

1) SMALL GIRL WALK

‘A/the small girl walks’

2) IX:1(popsicle seller)-GIVE-CL:A(popsicle)-IX:F(boy)

‘She gives it to him’

The abbreviations CL and CA are used to refer to classifiers and constructed action respectively. For example, in 3), CL:A indicates that the handshape used in the agreement verb GIVE is a classifier with an A-handshape. The word in parenthesis following the specification of the classifier indicates the entity referred to by the classifier. In example 2, this means that CL:A(popsicle) is a classifier, with an A-handshape, which designates a/the popsicle. IX is used for signs that indicate a spatial locus. The number or letter following the colon specifies the position of the locus in the signing space relative to the signer. In 2) therefore, IX:1 refers to the locus of the signer, who in this case has mapped another character onto his/her locus, and IX:F refers to a locus directly in front of the signer. The word in parenthesis specifies which referent the locus refers to.

All narratives were then divided into clauses and sentences. The guiding principle for clause boundaries was the presence of predicates (e.g. Berman & Slobin, 1994). Thus, we generally annotated boundaries between predicates, even when they expressed the same meaning. This is exemplified in example 3) where a sequence of a lexical predicate immediately following a classifier predicate with the same general meaning is coded as two separate sentences as indicated by the square brackets.

3) [BOY SMALL CL:2-WALK] [WALK]

‘A/the small boy walks. He walks’

In most cases, clause boundaries also corresponded to sentence boundaries. However, when signers used overlapping signs or constructed action sequences across multiple predicates, and when there were no prosodic markers (such as eyeblinks, Wilbur, 1994), pauses or lengthened signs (Hansen and Hessman, 2007) that indicated a boundary, multiple predicates were annotated as belonging to different clauses within the same sentence (indicated by square brackets), as in example 4.

4) [a) WALK b) WALK + CA:WALK.HOLDING-CL:A(popsicle)

c) CA:LET.GO.OF-CL:A (popsicle)]

‘While walking with it, he let go of it’

a b c

4.5 Annotation of Referents, Referent Status and Reference Type

We identified each referring expression in the narratives, and we coded which referent the expression denoted. We defined a referring expression as any overt or null reference to animate and inanimate entities. This information was then used in the coding of reference status. Table 1 shows the criteria used for determining referent status. We followed Gullberg (2006) in coding every first mention of a referent as 'introduced', and sentence subjects as 'maintained' if they had been referred to by any referring expression, null or overt, in any position in the previous clause. Referents were coded as 'reintroduced' if they appeared as the subject in a clause following a clause where the referent in question had not been mentioned in any position. Note that this procedure means that all maintained and reintroduced referents are subjects, whereas introduced referents can have any syntactic role.

Table 2.1. Referent status definitions (adapted from Gullberg, 2006: 170)

Discourse status	**Definition**
Introduced	First mention of a referent, independent of clause position
Maintained	A referent having appeared in any position in the previous clause appearing in the current clause as sentential subject
Reintroduced	A referent appearing as sentential subject in the current clause, subsequent to a clause where the referent was not mentioned

Only references that received status coding were counted from this point on, although as mentioned in Table 1, we used the presence/absence of non-subject referents to determine the status of the subject referents. We then coded the remaining referential expressions for linguistic type. Based on the principles we discussed above regarding ASL referential expressions, each

remaining reference was coded as one of the reference types in Table 2.1. The reference implied in verbs was only coded when no overt arguments were present. In addition, we noted the reference category (Nominal, Pronominal, Zero Anaphor, Classifier) that each reference belonged to. The reference categories are also shown in Table 2.2.

Table 2.2. Reference categories and reference types

Reference Category	Reference Type
Nominal	Bare noun Fingerspelled (FS) noun[8] Modified noun (IX noun; noun IX; noun CL; CL noun)
Pronominal	Pronoun
Zero Anaphor	Constructed action/dialogue (fixed spatial marking; mental rotation) Plain verb Agreement verb (spatial marking; mental rotation)
Classifier	SASS[9] Semantic classifier Handle classifier

ASL signers take advantage of the possibility of simultaneous articulation afforded by multiple articulators (hands, body, face), a phenomenon that has been documented for other sign

[8] Although there is no semantically based reason to distinguish between fingerspelled nouns and signed nouns, we expected that signers may avoid using fingerspelled nouns in maintained and reintroduced contexts simply because of the relatively greater effort required for fingerspelling compared to signing a noun.
[9] In this category, we only counted SASSes that occurred independently of nouns, and that, though they were used to refer to entities, were not lexicalized

languages as well (e.g. Perniss & Özyürek, 2008). In the present study, we focus on referent tracking, a linguistic phenomenon that proceeds sequentially though the narrative. For this reason, when we encountered simultaneity in the form of null or overt referring expressions occurring with constructed action, which is often sustained across multiple predicates, we opted to count only one of the types. If a lexical (plain or agreeing) or classifier predicate that was not considered quotational co-occurred with constructed action, we counted only the predicate. Consequently, what we have called constructed action in our data corresponds to what Metzger (1995) calls *Direct Action*, and excludes *Indirect* and *Simultaneous Direct and Indirect Action*.

5 Results

Recall that we are interested in how native signers utilize the referential expressions available in ASL, both the cross-linguistically common ones like nouns, pronouns and zero anaphora, and the more modality specific ones like classifier predicates, and constructed action. We also wanted to know if ASL signers use the various zero anaphora types and the various spatial frameworks differentially based on discourse function.

As anticipated, the signers produced short narratives in response to the simple stimulus materials. The average retelling had a duration of 15.03 seconds and consisted of 12.19 sentences. To get an overview of the structure of the ASL narratives, we first examined the distribution of referential expressions across referential statuses. Across all stimuli, the signers produced a total of 449 referential expressions of the types that we counted. Of these, 24% (N=109) were referent introductions, 69% (N=310) were referent maintenances, and 7% (N=30) were referent reintroductions. The most frequently used status in the present retellings was maintenance. The low proportion of reintroduction statuses compared to introduction and

maintenance shows that in these simple narratives the native signers reintroduced referents infrequently.

By examining the four reference categories defined above, we next considered the specific means by which ASL signers make reference and how they use these categories within each of the three statuses. The four reference categories we defined for ASL were: nominal, classifier, pronominal and zero anaphor. Our prediction based on previous literature was that the signers would use nouns and some classifiers, SASSes in particular, for referent introduction, as these appear to be the fullest referential expressions in ASL. For referent maintenance, we expected to see classifiers, especially semantic classifiers, pronouns, and zero anaphora. Pronouns and zero anaphora, because these are cross-linguistically lean referential forms, and semantic classifiers because they may serve functions similar to pronouns, as explained above. Last, we expected the signers to use classifiers and pronouns, zero anaphora, as well as some nouns for reintroduction. We also expected that pronouns might be more frequent in reintroductions than in maintenances.

Table 2.3. Mean proportion (number) of references by status and category

	Nominal	**Pronominal**	**Zero Anaphor**	**Classifier**	**Total**
Introduced	0.91 (101)	0 (0)	0.01 (1)	0.07 (7)	109
Maintained	0.07 (24)	0.01 (4)	0.71 (219)	0.20 (63)	310
Reintroduced	0.20 (10)	0 (0)	0.68 (20)	0 (0)	30

Table 2.3 shows the mean proportion of reference category used by the native signers to introduce, maintain and reintroduce referents. A 3x4 ANOVA, reference status by category,

performed on arcsine transformed proportions for the native signers' use of reference categories revealed no main effect of reference status, $F(2,14) = 1.24$, $p=0.32$, but there was a main effect of reference category, $F(3,21) = 25.06$, $p<0.0001$, and an interaction between category and status, $F(6,42) = 30.46$, $p<0.0001$. These results indicate, as predicted, that native signers do not use all reference categories equally often, nor do they use the reference categories similarly as a function of discourse status, as Figure 2.7 shows. In other words, the native signers differentially use ASL reference devices to track referents as a function of their narrative structure.

Post-hoc analyses (Student's T-tests on the arcsine transformed proportions) were performed on the categories among discourse statuses to tease apart which categories the native signers use differentially. In the following, we report p-values greater than 0.05 as non-significant. In accordance with our predictions, native signers used nominals to introduce referents more often than to maintain or reintroduce them. However, counter to our predictions, the proportion of classifiers used for introductions was no higher than their use for any other status. Note though, that this result is relevant only in so far as all classifiers can be grouped together. As we will see below, dividing the category of classifiers into semantic classifiers vs. SASSes reveals their differential use in discourse structure.

With respect to maintained contexts, our analyses revealed a preference in the native signers for zero anaphora. The signers used this category more for maintained than introduced reference. However, there was no significant difference between use of zero anaphora for maintained and reintroduced references. We had also expected a large proportion of classifiers in maintained contexts. While the numbers and proportions in Table 2.3 suggest differential use of classifiers across statuses, the t-tests on the arcsine transformed proportions did not reach significance.

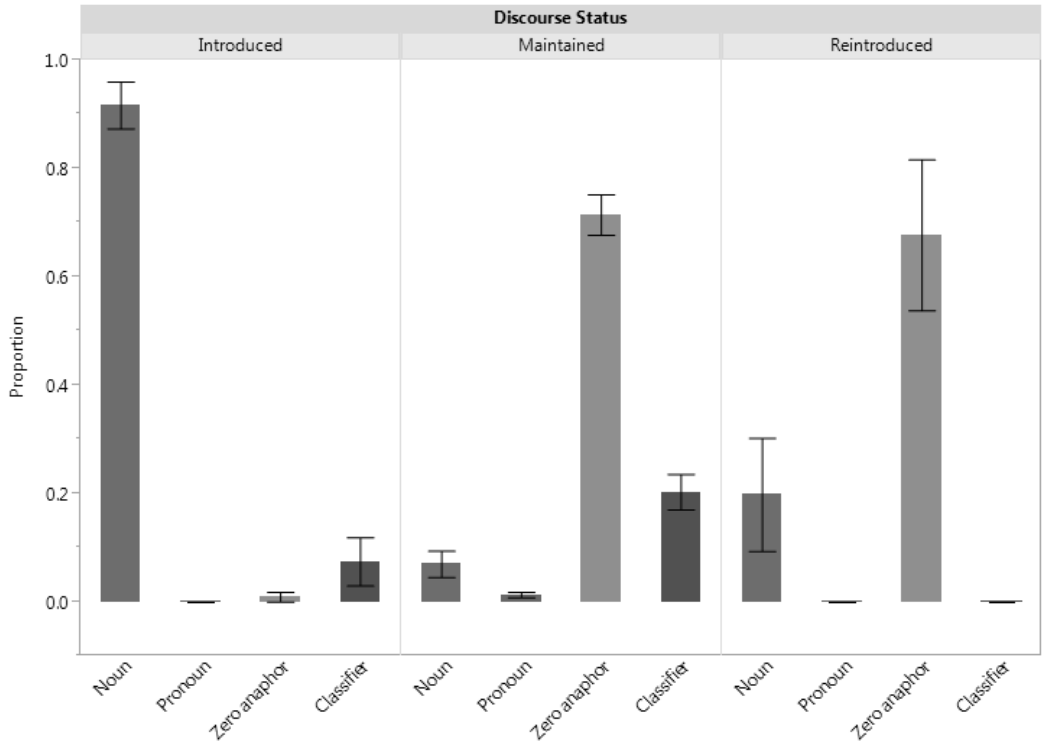

Figure 2.7. Mean proportion of reference category by status (Introduced, Maintained, and Reintroduced)

Finally, we expected that native signers would use pronouns frequently to maintain reference. This is not what we found. As indicated in Table 2.3, the number of pronouns was low overall, and proportionally the role of pronouns in maintaining reference was negligible. As these numbers suggest, the post-hoc test revealed no significant differences in the use of pronouns as a function of status.

In reintroduction contexts, we expected to see the native signers use a mixture of lean and fuller forms, that is classifiers and pronouns, but also some zero anaphora and some nouns. In this, our predictions were not borne out in this data set. It should be stressed, however, that the low proportion of referent reintroductions that our stimuli elicited means that the distribution of reference forms could look different in narratives where more reintroductions were required. We

will take up this point again in the discussion. The most prominent category in the reintroduced status was zero anaphor.

However as reported above, there was no significant difference between use of zero anaphora in maintained and reintroduced references, rather only between introduced and reintroduced references. Similarly, we found no statistically significant differences between maintained and reintroduced references for nouns, indicating that nouns were not used more frequently to reintroduce than to maintain referents.

Last, contrary to our expectation, the signers used no pronouns and no classifiers for referent reintroduction. As mentioned above, the native signers used proportionally more classifiers in maintained than in reintroduced contexts, although the difference was not statistically significant. There was no difference between the use of classifiers in introduced and reintroduced contexts. As for the pronouns, their overall use was small and we found no differences as a function of status.

Summing up, these results suggest that in ASL discourse, nominals are the primary means of introducing new referents, as we predicted. Counter to our predictions, classifiers are used only a little for introductions and not at all for reintroductions. They are, however, a prominent means of maintaining reference. Zero anaphor is the primary means for both maintaining and reintroducing referents. We also observe that, where classifiers are used both to introduce and maintain reference, pronouns are all but absent from the data.

While these results show that native ASL signers vary their referential expressions with discourse context, several questions remain. What, for example, are the discourse properties of the different subtypes of classifiers, nominals and zero anaphora, that is, what does the signer signal about the discourse structure by choosing one subtype over another? What is the role of

spatial modulation? To begin answering these questions, we now turn to a more detailed discussion of the subcategories of the various reference categories we have discussed so far.

Recall that ASL uses different kinds of nominal reference in addition to the ubiquitous bare nouns. Table 2.4 shows the proportion of each of these noun types in the native signers' discourse as a function of reference status. The table shows that native signers use the greatest variety of noun types when introducing referents. All noun types are used for referent introduction, although the proportions of types, other than bare nouns, are relatively small. For maintained reference, the signers only use fingerspelled nouns (FS nouns), IX nouns, bare nouns, and noun IX. When reintroducing referents, they use only bare nouns. This distribution indicates that native signers use nouns types differentially as a function of reference status, although the difference in proportion is not statistically significant, possibly due to the low number of tokens.

Table 2.4. Proportion (number) of noun types by discourse status

	CL Noun	**FS Noun**	**IX Noun**	**Noun**	**Noun CL**	**Noun IX**
Introduced	0.04 (4)	0.04 (4)	0.07 (7)	0.72 (73)	0.07 (7)	0.06 (6)
Maintained	0.00 (0)	0.04 (1)	0.04 (1)	0.88 (21)	0.00 (0)	0.04 (1)
Reintroduced	0.00 (0)	0.00 (0)	0.00 (0)	1.00 (10)	0.00 (0)	0.00 (0)

In the main analysis, we found that the signers used classifiers for introduction contexts, as well as in maintained contexts, but not for reintroductions. Recall that we predicted that SASSes might be considered a relatively full form of reference and some might not have anaphoric properties, and classifier predicates might be considered a type of overt yet lean

reference, similar in function to that of pronouns in spoken languages. Table 2.5 shows the native signers' use distribution of SASSes, semantic classifiers and handle classifiers over the three statuses across all subjects. An analysis of variance of discourse status (introduced vs. maintained) by classifier type (SASS vs. Semantic CL) was performed by subject on arcsine transformed proportions.

Table 2.5. Proportion (number) of classifier types by discourse status

	SASS	**Semantic CL**	**Handle CL**
Introduced	0.71 (5)	0.29 (2)	0.00 (0)
Maintained	0.03 (2)*	0.95 (60)	0.02 (1)
Reintroduced	0.00 (0)	0.00 (0)	0.00 (0)

*One maintained SASS was a tracing SASS, the other one was a static SASS

As no classifiers occurred in reintroduction contexts, we excluded this status from the analysis. We also excluded the one occurrence of handle classifier. The results of the analysis revealed a main effect of both discourse status, $F(1,7) = 16.67$, $p<0.01$, and classifier type, $F(1,7) = 18.53$), $p<0.01$, as well as an interaction between the factors, $F=(1, 7) = 57.65$, $p<0.01$, (Figure 2.8).

Post-hoc tests revealed no significant difference between native signers' use of SASSes and semantic classifiers in introduction contexts, but there was a significant difference between the two categories in maintained contexts, $p<0.001$, with semantic classifiers occurring more frequently. In addition, the signers used significantly more semantic classifiers for maintenance than for introduction, $p<0.001$. These results show that native signers use semantic classifiers primarily for maintained reference, which is in line with our predictions. The general pattern of SASSes being proportionally more frequent in introduced as compared to maintained contexts is

also as expected, although it did not reach statistical significance. However, the complete absence of classifiers from reintroduced contexts is unexpected.

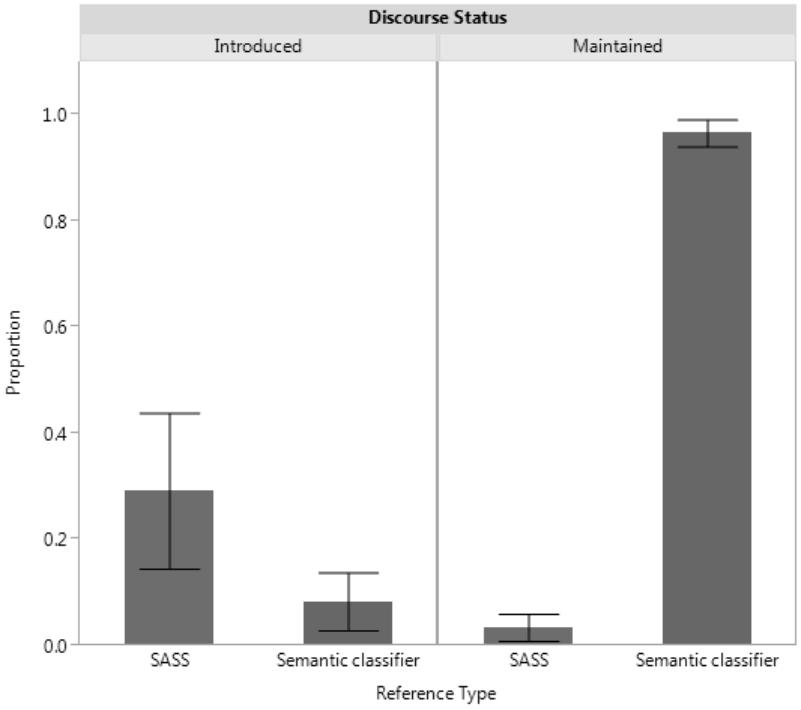

Figure 2.8. Classifier type as a function of discourse status (Introduced, Maintained)

Last, we hypothesized that the different types of zero anaphora might serve different referential functions in ASL. Because different verb types and constructed action vary in their referential value, we hypothesized that signers might use the zero anaphora types differentially as a function of discourse status. Although the choice of predicate type is first and foremost a consequence of verb semantics, it is possible that certain verb types are more likely than others to occur with null arguments in certain discourse contexts. This would be reflected as a greater proportion of occurrence in our analysis, as we only considered predicates without overt subjects. We first looked at the distribution of null references. Within the reference category of

zero anaphor, we grouped tokens according to whether they were connected to plain verbs, agreeing verbs or constructed action. Table 2.6 shows the proportion across all subjects of the different zero anaphora types. As shown in the table, zero anaphora from plain verbs predominate in maintained contexts, where they account for just over half of the zero anaphora tokens. In reintroduced contexts, zero anaphora from agreement verbs and constructed action are used to similar extents, and both occur in greater proportion than zero anaphora from plain verbs.

Table 2.6. Proportion (number) of zero anaphora type as a function of discourse status

	Plain Verb	**Agreement Verb**	**Constructed Action**	**Total**
Introduced	0 (0)	0 (0)	1.0 (1)	1
Maintained	0.54 (119)	0.23 (50)	0.23 (50)	219
Reintroduced	0.15 (3)	0.4 (8)	0.45 (9)	20

A 2x2 by subject ANOVA (zero anaphor type by discourse status) of the raw numbers, excluding introduced contexts, showed main effects of discourse status, $F(1,7) = 126.81$, $p<0.001$, and zero anaphor type, $F(1,7) = 8.86$, $p<0.01$, as well as an interaction effect, $F(2,14) = 20.39$, $p<0.001$. Post-hoc tests showed significant differences between plain verb zero anaphora vs. agreement verb and constructed action zero anaphora in maintenance contexts. By contrast, there was no difference between zero anaphora types in reintroduction contexts. While it is clear that verbs and constructed action are not necessarily exchangeable, these results suggest that native signers prefer to use the zero anaphora types differentially to maintain and reintroduce referents. This may reflect a preference for overt vs. null arguments for different predicates in different discourse contexts. Plain verbs are preferred in maintenance contexts over reintroduction contexts, while the reverse is true for agreement verbs. This pattern is not surprising if we assume that agreement verbs carry more referential value than plain verbs, due

to their indication of subject/object referents. Somewhat counter to intuition however, constructed action zero anaphora are used proportionally more in reintroduction than in maintenance contexts.

To explore this result further, we looked at the instances of constructed action in more detail. We examined whether the use of spatial framework, that is whether the signer overtly signals which third person referent is being denoted or not, plays a role in structuring discourse. Recall that both agreement verbs and constructed action can occur in a fixed spatial framework, i.e. with overt spatial marking, or in a mentally rotated framework, i.e. without spatial indication of which referents are involved. Our expectation was that constructed action in reintroduced contexts might be marked spatially, rather than occurring in mentally rotated frameworks. This is because mental rotation might occur primarily when the signer could expect the referent to be highly accessible to the addressee, that is, in maintained contexts as compared to reintroduced contexts. This expectation is similar to the finding that German Sign Language users use more spatial modification of predicates in reintroduction contexts than in maintenance contexts (Perniss & Özyürek, 2015).

Table 2.7 shows the distribution across all signers of zero anaphora from verbs and constructed action split by framework: fixed spatial versus mentally rotated as a function of discourse status. The table excludes plain verbs (n=122), as these cannot be used differentially in mentally rotated or static frameworks. Table 2.7 shows that there is a preference for using agreement verb zero anaphora in fixed spatial frameworks, and a preference for using constructed action in mentally rotated frameworks. This is the case for maintained contexts as well as reintroduced contexts. We asked how the sign interlocutor is then capable of recovering the reference of the constructed action. However, when looking at the contexts of occurrence we

found that in 5 of the 6 instances, the constructed action without spatial marking appeared immediately after a sentence in which the subject was an inanimate entity, and consequently not a possible referent for the constructed action.

Table 2.7. Proportion (number) of zero anaphora from agreement verbs versus constructed action, as a function of spatial framework and discourse status

Status	AGREEMENT VERB Framework			CONSTRUCTED ACTION Framework		
	Fixed Spatial	Rotated	N	Fixed Spatial	Rotated	N
Introduced	0 (0)	0 (0)	(0)	0 (0)	1.0 (1)	(1)
Maintained	0.94 (47)	0.06 (3)	(50)	0.28 (14)	0.72 (36)	(50)
Reintroduced	0.88 (7)	0.13 (1)	(8)	0.33 (3)	0.67 (6)	(9)

One last result should be mentioned here. Within the fixed spatial framework, we only found one instance of a verbal zero anaphor that was used with two fixed loci. All remaining instances occurred in the role-shifted context, where the signer used his/her own locus as the beginning or ending point of an agreement verb.

6 Discussion

We now discuss the patterns of referent tracking displayed by the ASL signers in the data and relate our findings to previous work. In their use of reference categories as function of discourse status, native signers showed a preference for introducing with nouns. This was expected, given the referential hierarchy, since nouns are the fullest form of reference in ASL.

This result is also consistent with the findings from Swabey (2002, 2011). Bare nouns were by far the most frequently used referent type. In addition, we found the greatest variety of nominal forms (i.e. modified nouns) in introduction contexts. We also found sporadic use of classifiers for introductions. When signers introduce with classifiers, they tend to use SASSes over other classifier types although the analysis did not reach statistical significance.

Native signers maintained referents primarily with zero anaphora, which was expected and consistent with findings from previous literature (e.g. Swabey, 2002, 2011; Wulf et. al., 2002; Mckee et al, 2011). They used zero anaphora from plain verbs more than from agreement verbs and constructed action. When we examined the use of spatial frameworks in maintained zero anaphora, we further discovered a differential preference for the spatial vs. mentally rotated frameworks as a function of zero anaphor type. Thus, in these ASL data, spatial marking did not signal discourse status, contrary to what has been found for DGS (Perniss & Özyürek, 2015). Classifiers occurred in maintained contexts as well, and here we found a preference for using semantic classifiers over SASSes.

Zero anaphora were used in reintroductions too, and the preferred zero anaphora types were from agreement verbs and constructed action. Zero anaphor in general was the primary means of reintroducing referents as well as maintaining them. For verbal zero anaphora in reintroduction contexts, the signers showed a preference for the fixed-spatial over the mentally-rotated framework. This pattern was reversed for constructed-action zero anaphora. However, this lack of marking did not obscure the reference of the zero anaphor, demonstrating that ASL signers' choice of referential form is a systematic interaction among the referential hierarchy, sentence structure, and the discourse context.

Although the proportions suggest a greater use of nouns in reintroductions than in maintained contexts, the difference was not statistically significant. When the signers used nouns for reintroductions, they exclusively chose bare nouns. For reintroduction in this study, native signers never used classifiers of any kind. As a broad characterization, these findings suggest that nouns and SASSes are fuller referential expressions whereas semantic classifiers and zero anaphora are leaner expressions in ASL. Given what we know about referent tracking cross-linguistically, this is an expected result.

More surprising is what we did not find in the data. First, there was an almost complete absence of pronouns, suggesting that pronouns are prominent ways to signal neither maintenance nor reintroduction in these short ASL narratives. It is possible that this could be an artifact of the dataset. Compared to the findings for DGS (Perniss & Özyürek, 2015), where pronouns occurred frequently in both maintained and reintroduced contexts, the proportion of pronouns in the present study is extremely small. As previously mentioned, our stimuli elicited only a very small proportion of referent reintroductions. It is possible that the simple nature of the narratives, and the sequential nature of the episodes, influenced the choice of reference forms. The fact that most actions in the stories are performed by one main protagonist may have allowed the signers to use more null references than they would have in the case of more complex stories with multiple protagonists, as was the case in the work on DGS. However, if we assume that discourse structure follows similar principles whether applied to basic or more complex narratives, and is simply scaled up in the later case, then the small number of pronouns in our data raises some interesting questions about pronouns in ASL (and possibly other sign languages). ASL has pointing signs that appear to be pronouns (e.g. Meier and Lillo-Martin, 2010), and we might thus expect pronouns to play the same important role for referent tracking as they do in English and

other spoken languages. However, the results of the present study suggest that anaphoric pronouns do not play the same prominent role in referent tracking in simple ASL narratives as they do in spoken languages.

Given previous research suggesting that pronouns could be considered as incorporated into verbs, rendering it unnecessary to always articulate them independently (Kegl, 1986), one might speculate that a potential reason for the absence of pronouns could be that agreement verbs were used in their place. However, in this study we found only one instance of an agreement verb actually moving between two spatial locations. In all other cases, mental rotation or, more often, role-shifting was involved. Thus, if agreement verbs are filling the role of pronouns, they do so partly though shifted reference. Given our present findings, we propose that role-shifting may eliminate the need for anaphoric pronouns in brief narratives with only one main character. This phenomenon may serve as one visual language analog to the spoken language pronoun. An idea that is emerging across various studies is that sign language pointing signs may be partly gestural (e.g.; Cormier, Schembri & Woll, 2012) but also pronominal (Meier & Lillo-Martin, 2013). While it could be argued that the absence of pronouns in our findings supports the hypothesis that sign language pronouns are different from spoken language pronouns, the present study provides us with insufficient data to address the status of pronouns directly. At most, our findings allude to the possibility that ASL signers may not need to use anaphoric pronouns in narratives. Given that the present study looked only at short and simple narrative retellings, the general properties of ASL pronouns and their use in other types of discourse merits further investigation.

Another notable absence was that of classifiers in reintroduction contexts. On a general level, if classifiers in ASL were to function similarly to spoken language pronouns, we would

expect to observe them in a considerable proportion of the reintroduced references. For example, for German narratives Debreslioska et al. (2013) found that pronouns were used more frequently in reintroductions than in maintenances. Our findings, however, were that native signers used classifiers for referent introduction and for maintenance, but never for reintroduction. We should emphasize that our data contained only few reintroductions in general. Consequently, it is possible that this finding does not reflect a principle of native ASL discourse, but rather the simple structure of our elicited narratives. However, in other work, we have compared the native signer narratives with those of second language ASL learners (Frederiksen & Mayberry, 2015). This work suggests that more frequent reintroductions are possible with these stimuli, and in fact, L2 learners do not show a dispreference for using classifiers for reintroductions. The fact that native signers did not use this referring expression in reintroduction contexts suggests that the discourse function of classifiers is less similar to that of pronouns than we anticipated. This raises the question of how to quantify the material contained in classifiers and requires further investigation, perhaps in the context of more complex narratives that might necessitate more referent reintroductions.

On a more specific level, we ask why SASSes are not used in reintroduction contexts. As previously discussed, research on Auslan has suggested that SASSes are often nominal in nature. As such, we might expect them to play a role in reintroduction contexts where, as we know from spoken languages, nominal expressions tend to be relatively frequent (Debreslioska et al., 2013). However, some researchers have argued that SASSes are incorrectly described as classifiers, that only static SASSes belong to this category whereas, tracing SASSes have been argued to be adjectival and to lack anaphoric properties (Zwitserlood, 2012). The fact that they played no role

in referent reintroduction in the present study supports the hypothesis that these expressions are adjectival in nature. Clearly more research is need on the function of SASSes in ASL discourse.

To summarize, we found that, on the surface, native ASL signers use nouns primarily and SASSes secondarily to introduce referents. They use zero anaphora primarily and semantic classifiers secondarily to maintain referents. For reintroductions, the signers also use zero anaphora. The main difference between the two discourse statuses is the preference for plain verb zero anaphora over agreement verb and constructed action zero anaphora in maintained contexts, while no differences were found in reintroduction contexts. In addition, no differences were found between the maintained and reintroduced contexts regarding native signers' use of nouns and pronouns. Recent research of spoken language reference in reintroduced and maintained contexts suggests that speakers prefer fuller forms, i.e. they use a larger proportion of nouns and a smaller proportion of zero anaphora, for reintroduced reference than for maintained reference (Debreslioska et al., 2013). Similarly, recent results from German sign language suggests that overt referring expressions are leaner, specifically pronouns, in maintained contexts, and fuller, specifically nouns, in reintroduced contexts (Perniss and Özyürek, 2015). The present ASL results do not align with this finding. This may indicate that the distinction between the two statuses, maintained and reintroduced, is not particularly important in ASL. On the other hand, our narrative stimulus was relatively simple by design so that a replication and extension of this study with a more complex narrative structure is needed to confirm this hypothesis.

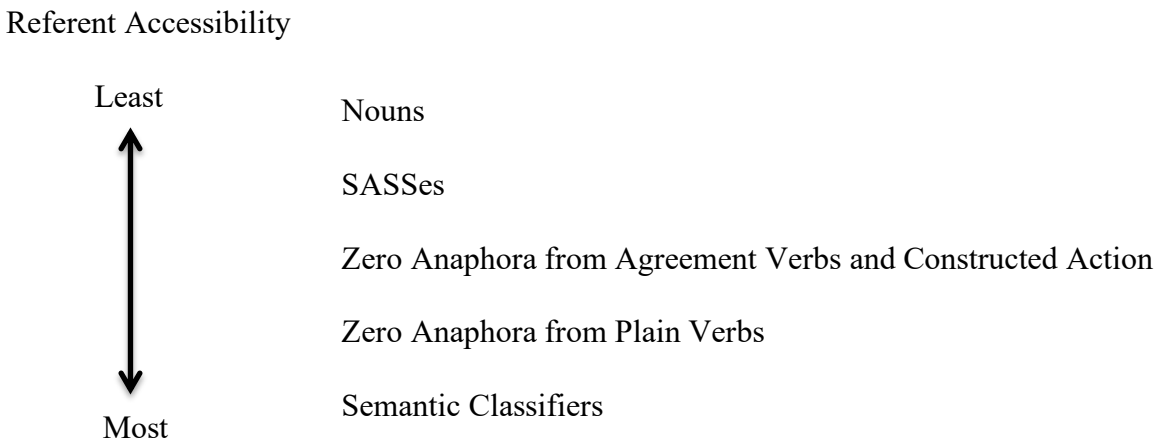

Figure 2.9. Preferred ASL referring expressions as a function of referent accessibility

Taken together, the findings of the present study lead us to propose a hierarchy of referential expressions for ASL shown in Figure 2.9. The upper part of the figure shows the referring expressions used when the referent is less accessible to the interlocutor in the discourse context, and the lower part shows the referring expressions used for the most accessible referents. Note that the form distribution proposed here looks somewhat different from the hierarchy generally proposed for spoken language referent tracking. The absence of pronouns and the distinction between different types of zero anaphora, as well as the similarity in markings in maintained and reintroduced contexts, suggest that referent tracking in simple ASL narratives may rely on devices than other than those used in spoken languages, even when the same forms are available. Because the visual modality offers the opportunity to conventionalize the use of space, devices such as role-shift may carry the referential functions reserved for pronouns in many spoken languages. Future research will determine if our proposed referent hierarchy for ASL predicts the referential pattern in more complex stories and discourse genres and in ASL signers other than native deaf learners.

7 Conclusion

We investigated referent tracking in ASL. We asked whether the referential hierarchy in a visual language conforms to the cross-linguistic patterns observed in spoken languages, or whether the different affordances of the visual modality might influence its structure. As a novel contribution to the ASL literature, this study looked at a considerable range of referential devices in ASL, in addition to nouns, pronouns and zero anaphora. This led to the discovery of the differential referential functions played by types of classifier and zero anaphora in ASL. Although signers appear to follow some of the general principles of the referential hierarchy as they appear in spoken languages, there are clear differences as well. The similarities we found were reliance on nouns for referent introductions, and on zero anaphora for referent maintenance. As for the differences, the deaf native signers in our study largely refrained from using pronouns for referential purposes, despite the fact that ASL has this referential device. In addition, we found differences in the how native signers use various types of zero anaphora, and we showed that that the use of spatial frameworks in this category seems to depend on the particular type of zero anaphor, rather than on referent accessibility. Our results further revealed that deaf native signers' use of semantic classifiers was not predictable from the referential hierarchy for spoken language. In addition, rather than showing evidence of a unified function, different discourse functions favored different classifier types. Finally, we proposed a hierarchy of referential expressions for ASL that provides a testable framework for future studies of sign language discourse.

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Chapter 2, in full, is a reprint of the material as it appears in Frederiksen, Anne Therese & Mayberry, Rachel I. (2016). Who's On First? Investigating the Referential Hierarchy in Simple ASL Narratives. Lingua 180, 49-68. The dissertation author was the primary investigator and author of this material.

Appendix

Example of Stimulus Story

Figure 2.10. Picture story. Read from left to right.

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CHAPTER 3

Implicit Causality Biases and Thematic Roles in American Sign Language

Abstract

This study provides implicit causality (IC) bias norms for over 200 verbs in American Sign Language (ASL). We adapted a sentence continuation task developed for written language to be used in a sign language. Gathering data from native signers, we determined whether continuations for each of 239 verbs were biased towards NP1 (e.g. 'Lisa surprises Mary because she doesn't like chocolate') or NP2 (e.g. 'Lisa likes Mary because she makes funny jokes'). Results show a wide distribution of biases, with a tendency towards more NP2 than NP1-biased verbs, which is the opposite of what has been found for English. Past research has found thematic roles to predict bias direction with stimulus-experiencer verbs being NP1-biased and experiencer-stimulus verbs being NP2-biased. Consequently, we probed the relationship between the ASL preference for NP2-biased verbs and the claim that stimulus-experiencer verbs do not to exist in sign languages. An investigation of thematic roles in the subset of verbs that are lexicalized as stimulus-experiencer in English revealed a variation in bias among the verbs. This was driven by unexpected thematic role lexicalizations in ASL, including the use of some of these verbs with experiencer-stimulus structure. We conclude that thematic structure predicts IC bias in ASL, and that the stimulus-experiencer structure while permitted, is infrequent, which impacts the distribution of IC biases in ASL. These results will facilitate future psycholinguistic studies of American Sign Language.

1 Introduction

Understanding how listeners and readers resolve pronouns is one of the great challenges in psycholinguistic research. How is it that examples such as 1) and 2) do not cause problems in communication, despite the fact that the pronoun is at least temporarily ambiguous?

1) Lisa impresses Mary, because she …
2) Lisa hates Mary, because she …

Numerous studies have attempted to discover what affects addressees' interpretation of such pronouns (Grober, Beardsley & Caramazza, 1974; Hobbs, 1979; Frederiksen, 1982; Gernsbacher & Hargreaves 1988; Gernsbacher, Hargreaves & Beeman 1989; Crawley, Stevenson & Kleinman, 1990; Smyth 1994; Stevenson, Crawley, & Kleinman, 1994; Chambers & Smyth 1998; Arnold, 2001; and others). One well-known influence on pronoun resolution is the tendency to resolve the pronoun *she* in (1) and (2) to the subject antecedent and object antecedent, respectively. This tendency is the result of a bias towards re-mentioning the causally implicated referent, which is known as the *implicit causality bias* (Au, 1986; Brown & Fish, 1983a 1983b; Caramazza, Grober, Garvey, & Yates, 1977; Garvey & Caramazza, 1974, and others), or the *re-mention bias* (Hartshorne, 2013). The implicit causality (IC) bias arises from semantic properties of the verb and the surrounding discourse structure (Brown & Fish, 1983a, 1983b; Au, 1986; Rudolph & Försterling, 1997; Ferstl et al, 2011, Hartshorne & Snedeker, 2012). Based on the languages examined to date, this appears to hold cross-linguistically (Hartshorne et al., 2013; Bott & Solstad, 2014), but it remains an empirical question as to whether implicit causality biases behave the same across sensory-motor modalities.

The present paper provides implicit causality norming for verbs in American Sign Language (ASL) and investigates whether differences in how thematic role is lexicalized in signed compared to spoken languages might influence the distribution of verb biases in ASL. To that end, we gather verb acceptability ratings from Deaf, native signers and use these data to adapt a sentence continuation paradigm to ASL, allowing us to examine the IC biases of more than 200 verbs.

2 Implicit Causality Biases

Implicit causality (IC) refers to the phenomenon that language users implicitly ascribe the cause of an event or state to one of the nominal arguments of the verb (Garvey & Caramazza, 1974, but see also Hartshorne, 2013). For example, in 1) above it is assumed that Mary has done something detestable to cause Lisa to hate her. Conversely, in 2) the assumption is that something about Lisa is impressive to Mary. In both cases, one expects the discourse to continue with an explanation of why this is. Therefore, the discourse is likely to continue referencing the causally implicated referent (e.g. 'Lisa impresses Mary, because she (=Lisa) has a stellar resume'). Because of the alternation between ascribing causation to the subject (as in 2) or the object (as in 1), IC verbs are classified as either subject-biased or object-biased, often called NP1 and NP2-biased verbs (Garvey & Caramazza, 1974).

This phenomenon plays a role in many processes in language comprehension, most notably perhaps in resolution of anaphora (Garvey, Caramazza & Yates, 1976). IC biases in verbs exist on a continuum ranging from fully biased towards the subject (NP1-biased) to fully biased towards the object (NP2-biased), with some verbs exhibiting stronger biases than others. Nevertheless, it has been shown that the bias of a verb is a salient factor in different linguistic

processes.[1] Several studies have noted the so-called *congruency effect* (Stewart, Pickering and Sanford, 2000). Going against the direction of the verb bias is by no means ungrammatical. For example, the sentence 'Kate praised Liam because she felt obliged to do so' is grammatical despite the re-mention of NP1 in the context of an NP2-biased verb (Ferstl et al., 2011: 125). Yet, studies have shown that such incongruence leads to slower comprehension compared to bias-congruent discourses. This has been found in the context of pronoun interpretation (Caramazza, Grober, Garvey, & Yates, 1977; Ehrlich, 1980; McKoon, Greene, & Ratcliff, 1993, Koornneef & van Berkum, 2006) and timed reading tasks (Garnham & Oakhill, 1985).

A number of studies have examined IC biases in English (Ferstl, Garnham & Manouilidou, 2011; Garvey, Caramazza & Yates, 1976; Garvey & Caramazza, 1974, among others; see also Rudolph and Försterling, 1997 for an overview of earlier studies). It is known that IC verbs exist in many languages, across cultures and ages. Studies have examined IC biases in languages such as Cantonese (Brown & Fish, 1983a), German (Fiedler & Semin, 1988; Rudolph, 1997; Bott & Solstad, 2014), Dutch (Semin & Marsman, 1994; Koornneef & van Berkum, 2006), Italian (Franco & Arcuri, 1990; Manetti & De Grada, 1991), Spanish (Goikoetxea, Pascual & Acha, 2008), Finnish (Pyykkönen & Järvikivi, 2010), Mandarin, Russian, Japanese (Hartshorne, Sudo, and Uruwashi, 2013), and Norwegian (Bott & Solstad, 2014). Overall, these studies have found that IC verbs in these languages pattern similarly to what has been found for English, though the strength of the biases varies (Rudolph & Försterling, 1997; Hartshorne, Sudo, and Uruwashi, 2013). As noted by Goikoetxea et al. (2008), this variation suggests that it is necessary to gather normative data specifically for any language in which IC biases are used as a controlled variable.

[1]Although note that bias directions can change with type of sentence connective (Stevenson et al. 1994; Pickering & Majid, 2007; Fukumura & van Gompel, 2010) and discourse context (Kehler et al., 2008, Rohde & Kehler, 2014).

No documentation exists of biases in IC verbs in any sign language to date. Given the growing interest in conducting psycholinguistic studies in signed languages, achieving an understanding of this phenomenon in sign languages and obtaining normative data on sign verbs constitute valuable tools for future research.

3 The Present Study

Determining the distribution of implicit causality (IC) biases in American Sign Language (ASL) will provide a foundation for future psycholinguistic studies. In addition, understanding implicit causality in a sign language is important given claims that the foundation for this phenomenon is similar across languages and cultures (Hartshorne, Sudo & Uruwashi, 2013). This is particularly so in the light of findings from past work in sign language linguistics. Specifically, some studies have suggested that the visual-manual modality imposes restrictions on the mapping between verb semantics and syntax that do not exist in spoken languages (Edge & Herrmann, 1977; Kegl, 1990; Meir et al., 2007). Such restrictions might exert a strong influence on IC biases in ASL.

To discover how IC biases are distributed in ASL, we conducted a norming experiment on a large set of verbs. Experiment 1 provides a valence norming study, with the goal of defining a set of transitive verbs. This set of verbs was used to build the stimuli for Experiment 2, which aimed to discover the direction of the verbs' IC-biases.

3.1 Experiment 1

Participants, Materials and Procedure

Five Deaf ASL signers rated the acceptability of 292 ASL signs in transitive contexts. We constructed the list of 292 signs by using the 305 verbs from the stimuli used by Ferstl et al (2011) and adding a number of additional verbs from other sources (Baker-Shenk & Cokely, 1980; Padden, 1988), as well as verbs that we knew to occur in ASL but that do not have (lexical) English translation equivalents. We then evaluated these verbs with the help of a Deaf native ASL consultant. The evaluation procedure was as follows: 1) we discarded verbs that did not have sign equivalents, including certain verbs of sound and hearing (e.g. 'echoed') that have little relevance in a visual language (Anderson & Reilly, 2002: 86), 2) we kept only one sign where multiple English verbs were translated with the same ASL sign, and 3) for English verbs whose signs shared a manual form but differed in mouthing, we kept both signs. In order to avoid excluding potential verbs from norming, we kept all remaining signs, including translations of words that work as more than one part of speech in English (e.g. 'wow', 'value'), even when we assumed that they would only function as one category in ASL.

The rating procedure was as follows. We introduced pictures of two characters MAYA and LISA and asked the signers to imagine the two names as two referents in an utterance. Leaving the pictures of the characters visible on the screen, we then showed video clips of the verbs from our list one at a time. The signers judged if the verb was acceptable in the presented frame and noted their answer in a booklet. The signers were informed that they could have more time if they needed it, and some signers occasionally made use of this possibility. The task took 45-55 minutes.

Results

We calculated an acceptance score for each verb by summing the number of signers that deemed the verb acceptable in the provided context. A score of 5 indicates that all signers found the verb to be acceptable in a transitive context, while a score of 0 indicates that no signer found the verb acceptable in this context. The results (Table 3.1) show that 5.48% of the verbs were rejected by all signers, and 53.42% were accepted by all signers. Thus, the signers deemed the majority of the verbs fully acceptable.

Table 3.1. Number and proportion of verbs by acceptance score

Score	No. Verbs	Proportion of Total
0	16	0.055
1	13	0.045
2	24	0.082
3	33	0.113
4	50	0.171
5	156	0.534
Total	292	1.000

Verbs that were accepted by a majority of signers (that is, by at least three out of five signers) comprised 81.85% of the total. 18.15% of the verbs (N=53) were deemed unacceptable by three or more signers. Table 3.2 shows which verbs were rejected by all five, by four, and by three signers. The full verb distribution can be found in the appendix.

Table 3.2. Verbs rejected by all five, by four, and by three signers

Acceptance Score	% (N)	Verb
0	5% (16)	BUG, CHILL, DEPRESS, DISTRESS, ENTERTAIN, FANCY, GOOGLE, GRIEVE, IMPROVE, PREPARE, PROMOTE_2, RELAX, SHAKE, SICKEN, VALUE, WOW
1	4% (13)	AGGRAVATE, BATTLE, CALM, CARESS, CHEAT_2, DEVASTATE, EXHAUST, FLOOR, GALL, MOVE, PUZZLE, SHAME, WEARY
2	8% (24)	ABDUCT, ADD, ANTAGONIZE, ARREST, BAFFLE, BORE, CARRY, COACH, CONCERN, CONSIDER, CURE, DELIGHT, DREAM, EXCITE, FLAPPERGAST, HEAL, IMPRESS, INCENSE, PLAY, REFUSE, REPELL, RUMINATE, RUIN, THRILL

3.2 Experiment 2

We used the verbs from Experiment 1 that were deemed acceptable by at least three out of five signers as the basis for the stimuli in Experiment 2. For each of these verbs, we created a sentence fragment to be used in a sentence completion task intended to reveal the verbs' biases.

Participants and Procedure

Eight Deaf native signers (mean age: 31.63, range: 22-50) participated in the experiment.[2] After giving informed consent and filling out a background questionnaire, the signers were shown a pre-recorded experiment introduction video, which provided instructions in ASL. We gave each signer three practice trials and offered suggestions or clarification where

[2] Given the scarcity of native signers, the work required for recruitment, testing, and data coding we had to limit our sample size to eight signers. However, our large number of stimulus items ensures that our conclusions about IC biases are nonetheless built on a sizeable number of data points.

necessary. When the signer felt comfortable with the demands of the task, we turned on the video camera to record their sentences, and they proceeded to the experiment proper, which lasted around one hour.

Materials

We created 239 sentence fragments from the verbs that were found to be acceptable transitives in Experiment 1. The sentence fragments were of the type NP V NP WHY?, *'NP V NP because … ',* e.g. '#MARY LOVE #DEAN WHY?'.[3] This construction is the ASL equivalent of the 'Name Verb Name because …' sentence frame that has been used in research of spoken language verb biases (Garvey & Caramazza, 1974; Stevenson et al., 1994; Koornneef & van Berkum, 2006, among others). Each NP consisted of a fingerspelled four-letter name drawn from a pool of 49 names. The sentence fragments were presented in randomized order. The participants' task was to use the sentence fragments as context for free sentence continuations. The instructions were to watch the fragments and complete the sentence with the first continuation that came to mind.

Sentence completion tasks have traditionally been conducted in writing. This has the advantage of giving participants the option of revisiting the context sentence while composing their answer, thereby ensuring that they do not forget its content. Because ASL has no widely accepted written form, the possibility of conducting the experiment in writing was not available to us. We opted instead to ensure participants' familiarity with the context sentence by asking them to repeat it before providing their own continuation.

[3] We are using the convention of glossing ASL signs with capitalized English words. The hash-key notation indicates that a word is spelled with the manual alphabet (as opposed to being a lexical sign).

Coding and Evaluation

After collection, a Deaf, native signer coded the participants' responses for next-mention, that is, which referent they mentioned as the subject in their free continuation. Next-mention was coded as *NP1*, *NP2*, *Both*, *Unclear*, or *Other* (see examples 3-7 below. The next-mention is shown in bold).

3) NP1:

#LOLA-R APPROACH #GALE WHY? **IX-R** NOTICE MANY THINGS CONFLICT APPROACH DISCUSS RESOLVE

'Lola$_i$ approached Gale$_j$, because **she$_i$** noticed a lot of conflicts, so she$_i$ approached (her$_j$) to discuss and resolve (them)'

4) NP2:

#KATE ASSIST IX-R #ANDY WHY? **IX-R** BROKE #LEG CRIPPLE

'Kate assisted Andy, because **he** broke his leg and was unable to walk'

5) Both:

#SAUL BEGUILE #ROSS IX-L WHY? **BOTH** WANT BRING WATCH #CONCERT MUSIC PERFORMANCE

'Saul beguiled Ross, because **they both** wanted to go watch a concert, a music performance.

6) Unclear:

#TYRA ATTRACT LENA WHY? **Ø** REALLY LIKE IX-L

'Tyra attracts/is attracted to Lena, because **she** really likes her'

7) Other:

#NOAH SCARE #EARL WHY? #ITS **HALLOWEEN** COSTUME SCARE

'Noah scares Earl, because it's **Halloween**, he puts on a costume and scares him

Trials where the participant did not provide a meaningful answer to (e.g. responded with "I don't know') were discarded, as were trials that were accidentally skipped (N=38). We also discarded trials where the participant had understood the verb incorrectly (N=52).[4] These two categories together amounted to 5% of the total trials.

Independently, another Deaf, native signer coded 50% of the data (four full subjects). The inter-coder agreement was found to be Kappa = 0.916. Differences were resolved through discussion where possible; otherwise the first coder's choice was retained. The coders were instructed to be conservative and code potential ambiguities as 'unclear'.

Results

We first provide an overview of how participants' responses were distributed (Table 3.3). In addition to the 5% of trials that were discarded from further analysis due to not providing a meaningful response or to containing an incorrect verb meaning, 40 responses were coded as 'unclear', 135 responses as 'Both', and 80 responses as "Other'. Responses with these three labels were also excluded from further analysis, amounting to an additional 13% of the total data set. As shown in Table 3.3, the remaining responses were categorized as NP1-biased (38%) and

[4] The proportion of misunderstood verbs can likely be attributed to the fact that a number of ASL verbs have multiple meanings that are usually disambiguated by context, which was not present in our information-lean stimulus structure.

NP2-biased (44%). A statistical analysis showed a trend towards more NP2 continuations than NP1 continuations ($t(238) = -1.85$, $p=0.065$).

Table 3.3. Coding of responses

Annotation	N	%	Mean %	SD	Range
No answer	38	.02	.020	4.56	.00-.15
Wrong verb	52	.03	.025	2.10	.01-.04
Unclear	40	.02	.014	3.06	.00-.04
NP1	718	.38	.359	29.32	.21-.55
NP2	849	.44	.483	24.17	.33-.63
Both	135	.07	.072	8.24	.03-.11
Other	80	.04	.028	6.78	.01-.10
Total	1912	1.00	1.001		

We next provide an overview of the biases for individual verbs by calculating a bias score (100*(no.NP1- no.NP2)/(no.NP1+ no.NP2)) for each verb, collapsing across subject variation.[5] Across verbs, the calculated bias scores covered the full range of values ($M = -7.35$, SD=61.27, range = -100 to +100). Similar to the pattern in the continuations overall, the negative mean bias score suggests a preference towards NP2-biased verbs over NP1-biased verbs.

Table 3.4. Bias score distribution

Bias	Bias Score	No. Verbs
NP1	100	17
	66-99	16
	33-65	37[6]
	1-32	18

[5] no.NP1 and no.NP2 is the total number of NP1 and NP2 continuations for each verb.
[6] This bin contains one verb with a bias score between 51-65

	Total	**88**
Equal	0	9
NP2	-1 - -32	27
	-33 - -65	40[7]
	-66 - -99	23
	-100	26
	Total	**116**
	TOTAL	213

Table 3.4 bins the bias scores by strength and shows the number of verbs in each bin, excluding verbs for which we had less than 5 responses (n=26). Overall, fewer verbs were biased towards NP1 (41%, n=88), than towards NP2 (54%, n=116). Moreover, fewer verbs were strongly biased towards NP1 (n=34) than were strongly biased towards NP2 (n=55), based on bias scores of above 50 and below -50. Taken together, these results show converging tendencies pointing towards a stronger representation of NP2-biases in the present data set.

Discussion

Experiment 2 examined the distribution of implicit causality (IC) biases in 239 ASL verbs for the first time, and provided norming data that serve as the foundation for future psycholinguistic studies in ASL.

The IC-biases in our sample are distributed across the full range of possible values, from strongly NP1-biased to strongly NP2-biased. The results also suggest differences between ASL and English. Specifically, we found a trend towards more NP2 continuations as opposed to the trend towards more NP1 continuations in English reported by Ferstl et al. (2011). Moreover,

[7] This bin contains six verbs with bias scores between -51- -65

among the strongly biased verbs in Ferstl et al (2011), more were NP1-biased than NP2-biased (88 NP1 vs. 73 NP2 verbs), whereas the opposite was true in the present study, where the number of verbs strongly biased towards NP2 was higher that of those strongly biased towards NP1. However, this difference should be considered in the light of variation between the data sets.[8] We based our stimuli on the verbs used in Ferstl et al. (2011). However, the final data set in Experiment 2 used just over half of the verbs (n=125) used by Ferstl et al. (an additional 47 verbs from Ferstl et al. were excluded after Experiment 1). The use of glosses to represent ASL signs also introduces variation. Because ASL glosses are English words, it is easy to assume that an ASL sign is equivalent in meaning to the English word used for the gloss. In fact, there is limited consensus among both signers and sign language researchers in to how to choose which English word(s) to use as the gloss for a sign. For now the choice is, to some extent, arbitrary. This is essentially the problem of determining what the best translation is between words in any two languages. As noted by Hartshorne, Sudo and Uruwashi (2013), this problem poses a challenge for researchers trying to determine whether the same verbs exhibit the same re-mention biases across languages.

Nevertheless, our results indicate fewer and less strongly biased NP1-biased verbs in the current data set, compared to NP2-biased verbs. In as far as these data extend to ASL as a whole, this suggests a difference in distribution between ASL and English, and a comparative dispreference in ASL for the type of verbs that gives rise to NP1-bias.

In the following sections, we examine how previous work has sought to discover how differences in verb type can explain differences in bias direction. Specifically, we look at approaches to predicting IC-biases from verb semantics and argument realization. We discuss

[8] Two more recent studies of biases for larger samples of verbs reported an overall bias towards the object in English, although to different degrees (Hartshorne & Snedeker, 2012; Hartshorne, O'Donnell & Tenenbaum, 2015). This emphasizes that the overall preference for bias direction varies as a function of the verbs included in the test.

whether cross-linguistic variation in syntax-semantics mapping might account for the pattern we observe in ASL. We also examine whether modality-specific restrictions proposed for ASL argument structure may influence the distribution of IC biases.

4 How Verb Semantics Influences Implicit Causality in American Sign Language

4.1 Implicit Causality and Verb Semantics

A number of studies have attempted to identify the factors that determine the direction of implicit causality (IC) biases. Brown and Fish (1983) found evidence that IC bias could be partially predicted from the semantic class of a verb. They divided verbs into mental (or state) verbs vs. behavioral (or action) verbs, linking the semantic classes to thematic roles and making different predictions about bias for each type. The revised action-state taxonomy built on this work to create a more fine-grained taxonomy (Rudolph, 1997; Rudolph & Försterling, 1997). This taxonomy divides verbs into four categories, based on their thematic roles: agent-evocator, example 8); agent-patient, example 9); stimulus-experiencer, example 10); and experiencer-stimulus, example 11).

8) Lisa blamed Matt, because he had sabotaged the group project.
9) Lisa kissed Matt, because she was in love with him.
10) Lisa annoyed Matt, because she never cleaned the kitchen.
11) Lisa loved Matt, because he was a good person.

This work and subsequent studies have revealed a close link between thematic roles and the direction of bias in IC verbs (Brown & Fish, 1983a, 1983b; Au, 1986; Rudolph & Försterling,

1997; Crinean & Garnham, 2006), such that thematic roles roughly predict IC biases. Large-scale normative studies have provided additional support for this relationship: Goikoetxea, Pascual, and Acha (2008) tested 100 verbs in Spanish and Ferstl et al. (2011) tested 305 verbs in English. Their studies showed that agent-patient and stimulus-experiencer verbs are generally NP1-biased, and agent-evocator and experiencer-stimulus verbs are generally NP2-biased. Some researchers, however, have raised questions about whether thematic roles are the best predictor of IC biases. For example, Pickering and Majid (2007) argue against the existence of the agent-evocator thematic structure. Bott and Solstad, (2014) highlight how thematic roles do not explain why biases can vary within groups of verbs. Hartshorne and Snedeker (2012) argue that IC biases result from verb classes (such as proposed by Levin, 1993, and Levin and Rappaport Hovav, 2005) and consequently suggest that a more fine-grained semantic verb classification better predicts IC bias in general (Hartshorne & Snedeker, 2012; Hartshorne, O'Donnell, & Tenenbaum, 2015). Nevertheless, the thematic role approach and the verb class approach make the same predictions for psychological verbs: Verbs with stimulus-experiencer structure (sometimes also referred to as experiencer-object verbs) are subject-biased while experiencer-stimulus verbs (sometimes referred to as experiencer-subjects verbs) are object-biased.[9] Because the remainder of this paper focuses on psychological verbs, we do not distinguish between these approaches.

The proposed relationship between verb semantics and IC biases is supported by the fact that it has been found in studies of languages other than English and Spanish (Norwegian and German: Bott & Solstad, 2014; Mandarin, Russian and Japanese: Hartshorne, Sudo & Uruwashi, 2013). Due to the cross-linguistic nature of this phenomenon, we expect the mapping of thematic

[9] We use the terms 'stimulus-experiencer verbs' and 'object-experiencer verbs' interchangeably in the remainder of this paper. The same goes for 'experiencer-stimulus verbs' and 'experiencer-subject verbs'.

roles onto syntactic ones to be an important predictor for how IC biases are distributed within a language. This could result in different bias distributions cross-linguistically, especially when attempting to compare biases across languages within similar verb meanings. For example, the lexical meaning 'to miss' is lexicalized in French with an experiencer-object verb ('manquer') but with an experiencer-subject in English (Hartshorne et al., 2010). Similarly, some languages, such as Mandarin, Japanese, and Atsugewi, have many verbs lexicalized with experiencer-subjects, but few or none with experiencer-objects. In Mandarin, most stimulus-experiencer structures are expressed using periphrastic constructions, e.g. 'Lisa makes Mary angry', instead of 'Lisa angers Mary' (e.g. Chen, 1996; see also Zhang, 2002), rather than morphologically simple lexical items. In Japanese (Hartshorne O'Donnell, Sudo, Uruwashi, & Snedeker, 2010; Pesetsky, 1995) and Atsugewi (Talmy, 2003), the base form of psychological verbs typically takes an experiencer-subject. To modify the verb to take an experiencer-subject instead, speakers then add an affix typically analyzed as a causative. As a result, languages such as Japanese have very few morphologically simple verbs with experiencer-objects (5, compared to 74 experiencer-subject verbs, according to a survey by Hartshorne et al., 2010). This is in comparison to other languages with an abundance of (morphologically simple) psychological verbs with experiencer-objects, for example English (220, compared to 44 experiencer-subject verbs; see Levin, 1993).

To date, no study has examined the relationship between verb semantics and IC biases in signed languages. However, as the previous discussion has made clear, a low proportion of verbs lexicalized with stimulus-experiencer structure in ASL might account for the bias distribution we observed in Experiment 2. Alternatively, the observed distribution of IC biases in ASL might indicate that thematic roles do not predict IC biases in the manual modality as they do in the spoken modality. In the next section, we focus on previous findings related to realization of

thematic roles in sign languages. These findings provide some expectations about IC biases in ASL and whether thematic roles should impact the distribution of biases in implicit causality verbs in the manual-visual modality.

4.2 Transitivity and Mapping between Semantic and Syntactic Roles in Sign Languages

Previous studies of psychological verbs have claimed that verbs with stimulus-experiencer structure are largely or totally absent in the sign languages under examination (Edge & Herrmann, 1977; Kegl, 1990; Winston, 2013, Healy, 2015, for ASL, Oomen, 2017, for Dutch Sign Language, Meir et al. 2007, for Israeli Sign Language, Sapountzaki, 2005, for Greek Sign Language). In many spoken languages, verbs with stimulus-experiencer structure are not only biased towards NP1, but strongly so (Rudolph & Försterling, 1997; Crinean & Garnham, 2006). Consequently the possible absence of stimulus-experiencer verbs in ASL should affect the distribution of IC biases.

One possible cause for the reported stimulus-experiencer dispreference in sign languages is transitivity. Researchers have noted that some predicate meanings do not appear to map onto transitive structures in sign languages, despite doing so in the spoken language surrounding the Deaf communities. Examining a small number of verbs from elicited ASL narratives, Edge and Herrmann (1977) noted that certain verbs, e.g. 'FRIGHTEN', were not used as transitives (e.g. 'LISA FRIGHTEN MARY', 'Lisa frightens Mary'), but rather as one-place predicates (e.g. 'LISA FRIGHTEN', 'Lisa is frightened'). Kegl's (1990) study of ASL came to a similar conclusion for psychological verbs in general, as did later studies of other sign languages (Meir et al., 2007; Oomen, 2017). Kegl (1990) specifically notes a lack of stimulus-experiencer psychological verbs in ASL. Findings from experimental studies by Winston (2013), Healy

(2015) and Oomen (2017) lend support to the idea that experiencer-objects (which occur in stimulus-experiencer verbs), are dispreferred in sign languages, or at least ASL and Dutch Sign Language (NGT). Winston (2013) conducted an online study in which participants rated sentences for correctness in ASL, and determined which argument was affected by the verb. The sentences were intended to have experiencer-subjects (using verbs such as 'FEAR' and 'LOVE'), and experiencer-objects (using verbs such as 'EMBARRASS' and 'INSPIRE'). Winston's findings indicate that constructions involving experiencer-subjects are preferred over those with experiencer-objects in ASL. Healy (2015) similarly documents a production preference in ASL for construing events involving psychological verbs with the subject rather than the object as the experiencer. Specifically, Healy shows that when describing events involving verbs like 'INFURIATE', 'IMPRESS', and 'FASCINATE', native ASL signers prefer to use the verb intransitively with the experiencer as the subject. This is instead of the transitive stimulus-subject plus experiencer-object construction that is common in English. Oomen (2017) found that all psychological verbs in the NGT sign language corpus (Crasborn et al., 2008) select a subject-experiencer, rather than an object-experiencer. Both Healy (2015) and Oomen (2017) also note that the type of event that is described with psych verbs is sometimes (for NGT) or generally (for ASL) expressed with bi-clausal structures, with the stimulus and the experiencer occurring in separate clauses (e.g. 'The girl saw a bear. She was frightened').

However, while the aforementioned studies have noted a general tendency to use as intransitives verbs that are lexicalized as transitive stimulus-experiencer verbs in many spoken languages, their findings also include examples where such verbs are in fact transitive. Kegl (1990), Healy (2015), and Oomen (2017) all find that some psychological verbs can occur in transitive contexts in ASL and NGT. Nevertheless, the proposed constraint against experiencer-

objects appears to hold even when the verb is in fact used transitively. Edge and Herrmann (1977) report that their ASL consultant expressed the meaning 'Leora angered Vicky' by signing the experiencer as the subject, and the stimulus as the object, i.e. 'VICKY ANGER LEORA'. Similarly in Winston's (2013) experiment, participants showed substantial disagreement about whether they interpreted the syntactic subject or the syntactic object as the experiencer in sentences with intended stimulus-experiencer constructions. Despite this disagreement, these sentences were consistently given relatively high grammaticality ratings, indicating that the signers considered them acceptable ASL structures. Finally, Kegl (1990) notes that the ASL verb SCARE appears to work with an object experiencer, although she suggests that it may not be a psychological verb at all. Rather she proposes that in 'SCARE', the subject purposefully acts in a way so as to scare the object. Thus, what these findings suggest is that the type of verb that has stimulus-experiencer structure in languages like English, Spanish, and Dutch resists being put in transitive sentence frames in sign languages. Consequently when these verbs are used in a transitive construction, the experiencer and not the stimulus is the subject.

In summary, two related issues in sign language linguistics likely influence the language specific distribution of IC verb biases in ASL, namely 1) whether stimulus-experiencer verbs can be used in transitive contexts, and 2) whether their thematic structure is in fact that of stimulus-subject plus experiencer-object, as opposed to the reverse. So far, the evidence appears to suggest that ASL is similar to Mandarin in having psychological verbs lexicalized with experiencer-subjects, but few or no experiencer-objects. As discussed above, previous studies have shown that stimulus-experiencer verbs reliably elicit NP1-biases. NP1-biases are also found in agent-patient verbs, but to a much smaller degree and less reliably (Goikoetxea et al., 2008; Ferstl et al., 2011). The absence of verbs with stimulus-experiencer in sign languages would

account for the skew in biases observed in Experiment 2 towards comparatively more NP2-biased verbs and fewer NP1-biased ones. We next assess this possibility, and also address the question of whether thematic roles predict IC biases in ASL psychological verbs as in other languages.

4.3 Stimulus-Experiencer Verbs in American Sign Language

The first question we address is whether verbs that may have stimulus-experiencer structure in other languages are lexicalized as such in American Sign Language (ASL). As a first approach to this question, we focus on the verbs in our stimuli whose glosses are classified as stimulus-experiencer verbs in Ferstl et al., (2011).[10] We first examined whether these verbs are likely to be intransitive, rather than transitive, as compared to verbs from other categories. We do this by analyzing the verbs that were rejected by the majority of signers in Experiment 1. This analysis shows that 55% of the rejected verbs (n=53) were classified as stimulus-experiencer by Ferstl and colleagues. Nevertheless, 58% of all verbs with stimulus-experiencer glosses (n=69) were judged to be acceptable by three or more signers. As these verbs were included in Experiment 2, we can examine the distribution of their bias scores. A bias score examination helps us assess whether these verbs were consistently biased in one direction over the other. The analysis revealed bias scores distributed on a continuum from strongly NP2-biased (scores of -100 to -66: CHEER, COMFORT, ANNOY, AMAZE, DISGUST, INTEREST, AMUSE, FASCINATE, ENTICE), to not clearly biased (scores of -25 to 25: e.g. ENCOURAGE, TEMPT,

[10] This approach does not guarantee that we have included all verbs lexicalized as stimulus-experiencer verbs in our ASL data set. However, previous studies have found that thematic role structures such as experiencer-stimulus behave in sign languages as expected from English. This suggests that only the stimulus-experiencer structure is systematically different. We therefore believe it unlikely that we will find many stimulus-experiencer verbs among the verbs whose translation equivalents belong in other thematic role classes.

SCARE, CONFUSE), to strongly NP1-biased (scores of 100 to 66: ATTRACT, HARASS, INSULT, CHARM, FLATTER, EMBARRASS, PAIN).

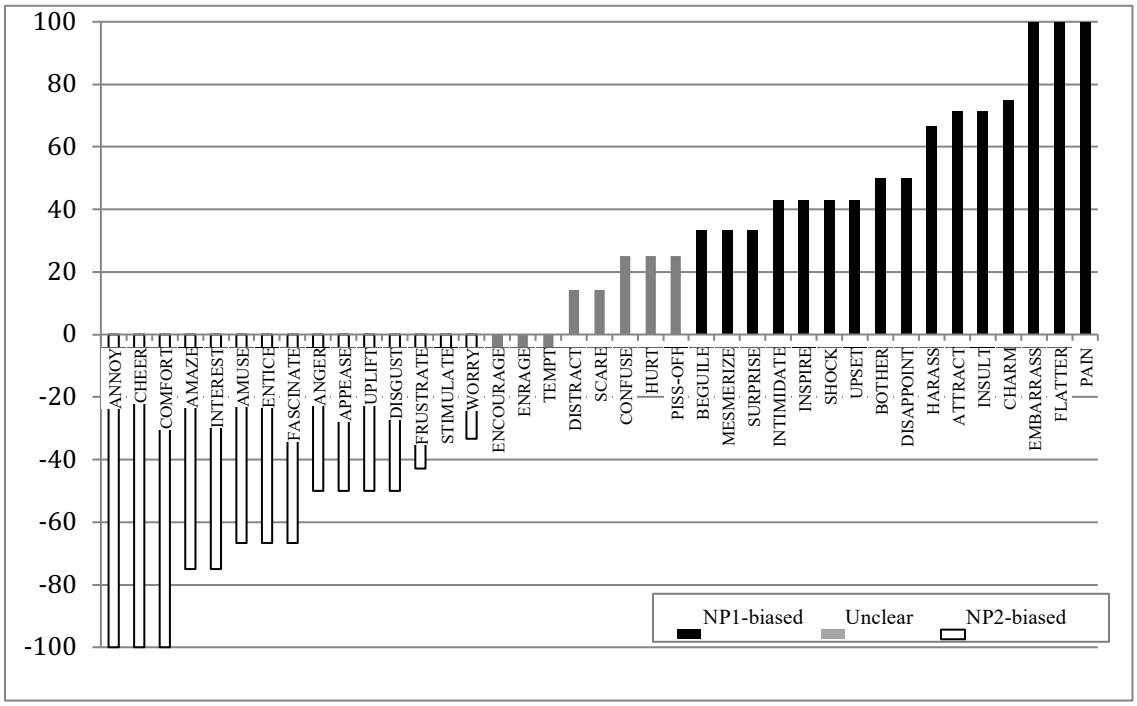

Figure 3.1. Distribution of bias scores for verbs lexicalized as stimulus-experiencer in English

Thus, there is an even distribution of NP2-biased (N=15) and NP1-biased (N=16) verbs (Figure 3.1). The fact that the majority of these verbs show clear biases suggests overall agreement between signers about the bias of individual verbs rather than a pattern based on ideolectal differences. On the other hand, the fact that the distribution encompasses both types of biases suggests that in ASL these verbs are not homogenous with respect to thematic role structure.

We next used the sentence contexts produced by the signers to determine the thematic roles most frequently occurring with each of the potential stimulus-experiencer verbs (Table 3.5). This analysis reveals that the split in the bias direction within this category of verbs is accompanied by a split in thematic structure for the most part. Specifically, as a group the NP1-

Table 3.5. Biases and thematic structures in the stimulus-experiencer category

Verb	Bias	Bias strength	Predominant thematic role
CHEER	NP2	-100 to -75	AgP
ANNOY			ExpStim
AMAZE			ExpStim
DISGUST			ExpStim
INTEREST			ExpStim
COMFORT			StimExp/AgP
AMUSE		-74 to -33	ExpStim
FASCINATE			ExpStim
ANGER			ExpStim
FRUSTRATE			Unclear
WORRY			ExpStim
ENTICE			AgP
APPEASE			StimExp/AgP
UPLIFT			AgP
STIMULATE			StimExp/AgP
ENRAGE	Unclear	-32 to 32	ExpStim
TEMPT			StimExp
DISTRACT			AgP
SCARE			StimExp
CONFUSE			StimExp
PISS-OFF			ExpStim
ENCOURAGE			StimExp/Agp
HURT			StimExp/Agp
MESMERIZE	NP1	33-74	Unclear
SURPRISE			StimExp
INSPIRE			StimExp
SHOCK			StimExp
UPSET			ExpStim
DISAPPOINT			StimExp
BEGUILE			Unclear
BOTHER			AgP
INTIMIDATE			AgP
ATTRACT		75-100	StimExp
EMBARRASS			StimExp
HARRASS			AgP
CHARM			AgP
INSULT			StimExp/AgP
FLATTER			AgP
PAIN			StimExp

biased verbs are more frequently lexicalized with stimulus-experiencer structure compared to other structures. Including 'INSULT', which was ambiguous between stimulus-experiencer and agent-patient, eight out of sixteen verbs occurred with stimulus-experiencer structure more often than with any other structure. The reverse was true for the NP2-biased verbs, which were most frequently lexicalized with experiencer-stimulus structure. Here, eight out of fifteen verbs occurred with experiencer-stimulus structure more frequently than with any other structure.

Thus, despite their glosses suggesting that they should be stimulus-experiencer verbs, some verbs, such as 'ANNOY' and 'AMAZE', in fact had experiencer-stimulus structure and were biased towards NP2. This suggests that when they are used in transitive contexts ('MARY ANNOY LISA'), they are understood along the lines of 'Mary is annoyed with Lisa' rather than 'Mary annoys Lisa' (Example 12). Consequently, although the direction of bias is unexpected compared with the English verb matching the ASL gloss, it is nevertheless in line with the prediction based on thematic structure.

Within the NP2-biased verbs we also find examples with neither stimulus-experiencer or experiencer-stimulus structure. Some signers instead used the first NP in a more agentive role, such that the verbs are best interpreted as agent-patient verbs (Example 13).

12) #DANA ANNOY #JADE WHY? #JADE ALWAYS COMPLAIN ANNOY
'Dana is annoyed with Jade, because Jade always complains. [Dana is] annoyed'

13) #TROY CHEER #NORA WHY? IX-R SCORE
'Troy cheered Nora, because she scored'

For NP1-biased verbs, although stimulus-experiencer occurred as the predominant role more often than did any other thematic structure, we also found a number of other structures. Importantly, many involved the agent-patient thematic roles. Some structures were ambiguous between agent-patient and stimulus-experiencer structures. In other instances, a verb that is lexicalized as stimulus-experiencer verbs in other languages was used as agent-patient verbs in this sample of ASL. This is similar to what Kegl (1990) reported for 'SCARE'. In the examples below, the subject is an agent intentionally causing something to happen to the patient in 14), and a potentially unwitting stimulus for an emotion in the experiencer in 15),

14) #MARA HURT #GALE WHY #MARA MAD HIT HIT #GALE
'Mara hurt Gale, because Mara got angry and hit Gale'

15) #MARA HURT #GALE WHY IX-L DECIDE CUT DONT-WANT
IX-R IN POSS-L LIFE ANY MORE
'Mara hurt Gale, because she decided to cut her off, she didn't want her in her life anymore'

All told, there are sixteen stimulus-experiencer verbs in this sample (including six with ambiguous stimulus-experiencer/agent-patient structure), corresponding to 7.5% of the 213 verbs in Experiment 2 for which we calculated bias scores. This suggests a low proportion of stimulus-experiencer verbs in ASL overall. Below, we discuss whether this state of affairs can be explained by reference to properties that are specific to the visual-manual modality.

4.5 Body-Anchoring and Thematic Roles

Previous research has proposed that body-anchoring may explain the preference for experiencer-subjects in sign languages. The term body-anchoring refers to the fact that some signs are obligatorily articulated on or near a particular part of the signer's body, rather than in neutral signing space. For psychological verbs, body-anchoring fosters the interpretation that it is the signer's body experiencing the emotion or mental state.[11] As stated by Edge and Herrmann,'[b]ecause these verbs are always articulated on or at the body, they formationally incorporate the experiencer […]' and thus 'this argument must appear overtly' (1977: 146). Accordingly, this explanation holds that ASL signers interpret a phrase like 'LISA FRIGHTEN' to mean '*Lisa is frightened*' rather than '*Lisa frightened (someone)*', as doing so ensures that the experiencer is the subject. Kegl (1990) similarly notes that experiencers are obligatorily body-anchored. Meir et al. (2007) examine body-anchored verbs (not limited to psychological verbs) that are at least partially iconic. They argue that across these verbs, the signer's body always correlates with the subject, rather than with a particular thematic role. Under their analysis, general principles of mapping between thematic and syntactic structure (Fillmore, 1968; Jackendoff, 1990) ensure that the highest-ranking thematic role becomes the subject argument. The highest-ranking role is the agent in agent-patient action verbs, and the experiencer in experiencer-stimulus psychological verbs. Meir et al. simply note that psychological verbs with stimulus-experiencer structure are not attested in ASL or Israeli Sign Language (ISL). Body-anchoring thus provides an explanation for the absence of the stimulus-experiencer structure. Whereas experiencer-stimulus structures allow the body to simultaneously fulfill the roles of subject and experiencer, this is not the case for stimulus-experiencer structures. In the stimulus-

[11] In the case of constructed action, where another referent has been mapped onto the signer's body (Metzger, 1995), the interpretation would instead be that the referent in question was experiencing the emotion or mental state.

experiencer structure the impetus to interpret the signer's body as the experiencer conflicts with the interpretation of the body as the subject. Oomen (2017) notes that 70% of the psychological verbs in the NGT corpus she examined were body-anchored. She speculates that this might be the case for other sign languages as well. These findings beg the question whether the split in thematic role structure in the potential stimulus-experiencer verbs might be linked to body-anchoring.

Table 3.6. Body-anchoring and thematic roles within the assumed stimulus-experiencer category

Thematic Structure	No.	Verbs	
		Body-anchored	Not body-anchored
ExpStim	11	AMAZE, AMUSE, ANGER, ANNOY, DISGUST, ENRAGE, FASCINATE, INTEREST, PISS-OFF, WORRY, UPSET	
StimExp	10	CONFUSE, DISAPPOINT, EMBARRASS, INSPIRE, SCARE, SHOCK, SURPRISE, TEMPT	ATTRACT, PAIN
StimExp/AgP	6		APPEASE, COMFORT, ENCOURAGE, HURT, INSULT, STIMULATE
AgP	9	CHEER, DISTRACT	BOTHER, CHARM, ENTICE, FLATTER, HARASS, INTIMIDATE, UPLIFT
Unclear	3	FRUSTRATE, MESMERIZE	BEGUILE

Table 3.6 shows how body-anchoring interacts with actual thematic role in the potential stimulus-experiencer verbs in the current study. An examination of the phonological structure of the verbs does not suggest a strong role for body-anchoring in determining whether verbs are lexicalized with stimulus-experiencer or experiencer-stimulus structure. If body-anchoring were to require the experiencer to appear as the first argument, we would not expect to find body-anchored verbs with stimulus-experiencer structure. However, as Table 3.6 shows, all of the verbs that have experiencer-stimulus structure are in fact body-anchored, but nearly all of the actual stimulus-experiencer verbs are body-anchored as well. On the other hand, the verbs which are used in contexts allowing for an agent-patient reading in addition to the stimulus-experiencer reading are *not* body-anchored. Therefore, the overall results of the present study do not support the idea that body-anchoring is the primary predictor in ASL for whether a verb will be lexicalized as a stimulus-experiencer verb or not. The results do suggest, however, a correlation between potential psychological verbs being articulated on the body and being interpreted as involving experiences or emotions rather than actions.

5 General Discussion

In two experiments, we examined the distribution of implicit causality (IC) biases in 239 verbs from American Sign Language (ASL) and looked closely look at the relationship between thematic role and IC bias in ASL verbs lexicalized as stimulus-experiencer in English. IC biases are the foundation for much psycholinguistic research, and the present study is the first to document these in ASL and to provide norming data that can be applied in further studies.

The conclusions of the present study are limited by the relatively low number of participants compared to studies of IC biases in spoken languages. Although we believe our IC

bias norming results to be representative for ASL in general, our thematic role analyses are susceptible to characteristics of our signer sample, due to the small number of verbs analyzed. Future work should confirm these results by obtaining IC biases from a larger and more geographically varied group of signers and by studying ASL thematic roles in a larger sample of verbs.

Nevertheless, comparing our results to previous work revealed some differences between ASL and spoken languages. First, we found a trend towards more NP2 continuations as compared to the trend in Ferstl et al. (2011) towards more NP1 continuations. This was despite the facts that our data set was largely based on the verbs used in Ferstl et al., and that the IC-biases we observed in our sample ranged from strongly NP1-biased to strongly NP2-biased. We attributed this in part to the observed preferences for lexicalizing thematic roles in ASL verbs. Previous work has found that verb semantics, including thematic role, predicts the direction of a verb's IC bias. Stimulus-experiencer verbs in particular are known to exhibit robust NP1-biases that are even stronger than those of the agent-patient verbs. Indeed, Ferstl and colleagues found that their stimulus-experiencer verbs were almost exclusively NP1-biased. Across their entire sample of verbs, 36% (110/305) were lexicalized as stimulus-experiencer verbs. In our sample, the corresponding number was 7.5% (16/213), mostly because many of the verbs lexicalized as stimulus-experiencer in English were discovered to have experimenter-stimulus structure in ASL. This suggests a rather low rate of stimulus-experiencer verbs in ASL overall. Moreover, the strength of NP1-bias in the actual stimulus-experiencer verbs does not appear to be as strong as in other languages. Of the sixteen verbs, which were used either primarily with stimulus-experiencer structure or were ambiguous between stimulus-experiencer and agent-patient structure, only seven were clearly NP1-biased in our results.

These findings indicate that NP1-biased verbs are rarer in ASL than in languages like English, and that the reason for this is likely related to variation in verb semantics, particularly to the lexicalization of stimulus-experiencer thematic roles. Despite this, our findings show that the stimulus-experiencer structure exists in ASL, a somewhat surprising finding, given previous indications in the sign language literature that this structure is not attested. Given how infrequent the stimulus-experiencer structure is, however, the main patterns in our results are consistent with previous claims.

Experiment 1 offered partial support for the claim put forth in previous studies that verbs lexicalized as stimulus-experiencer verbs in other languages tend not to occur as syntactic transitives in ASL. Our results showed that the majority of verbs that were unacceptable in transitive contexts were verbs lexicalized as stimulus-experiencer verbs in English according to Ferstl et al. (2011). On the other hand, more than half the verbs lexicalized as stimulus-experiencer verbs in English were acceptable as transitives and were also understood without reported problems in the sentence contexts used in Experiment 2. However, these verbs exhibited a mixture of experiencer-stimulus, stimulus-experiencer, and agent-patient thematic structures. Kegl (1990) suggests that verbs like 'SCARE', which she found to occur with what seemed like a stimulus-experiencer structure, are in fact construed as non-psychological verbs. In our results, a number of verbs were indeed used with agent-patient structure or were ambiguous between stimulus-experiencer and agent-patient structures. However, this explanation cannot fully account for our results because we also found a number of verbs that were most frequently used with a clear stimulus-experiencer structure.

Eight verbs from the present study were also tested by Winston (2013), namely 'EMBARRASS', 'SCARE', 'SURPRISE', 'INSPIRE' (which have stimulus-experiencer

structure in the present study), 'WORRY', 'AMUSE', 'FASCINATE' (which have experimenter-stimulus structure in the present study), and 'BORE'.[12] Although Winston does not provide results for the individual verbs, her overall finding is similar to what we find in the present study, namely that these verbs are rated as acceptable in transitive contexts, but there is no consistency within the group with respect to thematic role.

The present study cannot clearly determine the causes underlying variation of lexicalization of thematic roles in ASL. Previous research has offered body-anchoring as an explanation for the lack of stimulus-experiencer verbs in ASL, but our results revealed the existence of body-anchored verbs with stimulus-experiencer structure, so this factor alone cannot account for the scarcity of this thematic structure in ASL. It has been argued that the reason why psychological verbs are incompatible with stimulus-experiencer structure is because these verbs are often body-anchored and thus require the body of the signer to simultaneously function as the subject argument and the experiencer. We found some evidence of this in the present study. A number of the verbs with glosses that were stimulus-experiencer verbs in the study of English by Ferstl et al. (2011) were found to instead be experiencer-stimulus verbs in the present study. Notably, these verbs were all body-anchored. Similarly, the potential stimulus-experiencer verbs whose actual thematic structure was ambiguous between stimulus-experiencer and agent-patient structure were all non body-anchored. These facts suggest that a relationship between a verb's phonological form and its argument realization may exist. On the other hand, most of the verbs with actual stimulus-experiencer structure were also body-anchored. This finding suggests that body-anchoring is correlated with signs being interpreted as verbs of emotion rather than of action. This kind of difference in behavior between psychological and action verbs is in line with

[12] In the present study, 'BORE' was deemed unacceptable in a transitive context in Experiment 1 and thus not included in Experiment 2.

conclusions from spoken language research that places psychological verbs in a class of their own, based on their syntactic and semantic properties. This is also in line with Oomen's (2017) finding that the vast majority of psychological verbs in NGT are body-anchored. However, this observation does little to explain why some verb meanings can be lexicalized with stimulus-experiencer structure, while other seemingly cannot.

Several alternative explanations need to be pursued in future studies of variation of thematic role lexicalization in ASL. For example, it is possible that frequency plays a role in determining whether a verb will be interpreted as a stimulus-experiencer or an experiencer-stimulus verb. Although much progress has been made towards producing a frequency database in ASL (see Mayberry et al, 2014; Caselli et al, 2017) existing resources were insufficient for our stimulus items to be analyzed as a function of frequency. Another possibility is that variation in English proficiency could help reconcile the present findings with those from studies such as Healy (2015) and Kegl (1990) who found that ASL signers do not produce the stimulus-experiencer structure. Most Deaf signers know some amount of English, and many are highly proficient sign-text bilinguals. Future work should explore this possibility by examining whether there is a correlation between English skills and use/acceptance of the stimulus-experiencer structure in ASL.

Finally, there may be a difference in the acceptability of the stimulus-experiencer structure depending on whether signers are producing or comprehending ASL. The study by Healy (2015) looked at what signers produce, and found no instances of the stimulus-experiencer structure. By comparison, Winston (2013), who had signers rate pre-recorded ASL utterances, found that although sentences with experiencer-subjects were rated as more acceptable than those with experiencer-objects, the latter type was not seen as unacceptable in ASL. The findings

of the present study are in line with this. We asked signers to judge the acceptability of structures and then to copy and complete a number of sentence fragments, some of which contained potential stimulus-experiencer verbs. Thus, it is possible that many signers are willing to accept stimulus-experiencer structures from other signers but tend to avoid them in their own signing.

Regardless of whether there is a difference between production and comprehension, the fact remains that there is a limited number of stimulus-experiencer verbs in ASL. We have have discussed here whether this should be attributed to articulatory properties specific to sign languages. However, as we have noted, a small proportion of stimulus-experiencer verbs is not necessarily indicative of a difference between the visual-manual and the aural-oral modality. In fact, Mandarin is also reported to disprefer experiencer-objects. This could suggest that the lexicalization pattern observed in ASL is unrelated to any properties of its modality. Another possibility, however, is that the same system can occur in spoken and signed languages as a result of different factors or trajectories. In their work on body-as-subject, Meir et al make the prediction that all sign languages should initially have verbs where the body is understood as the subject, and that over time, other verb classes, may develop, such as verbs that move in space without contact to the body (2007: 534). If the overall association between body and subject weakens as such verbs develop, then such a diachronic change should eventually allow for a dissociation between subject and body in body-anchored verbs as well. This could result in a system like the one we observe in the present study, where stimulus-experiencer verbs are attested but infrequent. Thus while the ASL and Mandarin systems may look nearly identical on the surface, they may be products of drastically different processes.

To summarize, NP1-biased IC verbs are be hard to come by in ASL. This can likely be attributed to the scarcity of stimulus-experiencer verbs. Therefore, other sign languages probably

show similar bias distributions. Verb meanings lexicalized as stimulus-experiencer in other languages is not a reliable predictor of these verbs in ASL, neither in terms of the number of verbs nor in bias strength. These findings have consequences for researchers aiming to design psycholinguistic studies of ASL where IC biases are experimentally manipulated. Nonetheless, thematic role appears to be a good predictor for the direction of IC bias in ASL. ASL biases were largely determined by actual thematic roles, even though we limited ourselves to analyzing the verbs that were lexicalized as stimulus-experiencer in English. ASL is thus comparable to other languages in which verb semantics, including thematic role, is a predictor of IC bias. Future research should investigate whether variation among languages in the distribution of IC biases is indicative of systemic differences that may affect processes such as pronoun resolution.

6 Conclusion

The current study presented norming data for implicit causality (IC) biases in American Sign Language (ASL) verbs and examined whether differences related to lexicalization of thematic role and phonological restrictions in ASL are correlated with a different distribution of IC biases compared to many spoken languages.

To the best of our knowledge, the present study is the first to offer norming data for implicit causality biases in ASL verbs. Almost 300 verbs were assessed for transitivity, resulting in 239 transitive verbs being tested for their IC bias in a sentence continuation experiment. We found that IC biases in ASL cover the full range from strongly NP1-biased to strongly NP2-biased, and that ASL may have a smaller proportion of NP1-biased verbs compared with some spoken languages. Because past studies have shown that verb semantics predicts direction of IC-

bias, we hypothesized that the distribution of verb biases we observed in ASL could be linked to the claim from previous literature that ASL lacks stimulus-experiencer verbs. Our results revealed a very small number of verbs with stimulus-experiencer structure. A number of those verbs lexicalized as stimulus-experiencer verbs in English were interpreted in ASL as having experiencer-stimulus structure instead, and consequently many of these verbs were biased towards NP2 rather than NP1. The fact that many NP1-biased verbs in spoken languages owe their bias to their stimulus-experiencer structure led us to conclude that the limited number of true stimulus-experiencer verbs impacts the distribution and overall number of NP1-biased verbs in ASL. This is an important finding for future experimental psycholinguistics studies of ASL. Overall, our analyses provide some evidence that thematic role predicts IC bias in ASL. Finally, we did not find that the phonological feature of body-anchoring predicts whether a verb will be lexicalized as a stimulus-experiencer verb, contrary to the claims in previous research. Based on our analysis, we instead proposed that body-anchoring correlates with the likelihood that a verb will be interpreted as a psychological, rather than an action verb.

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Chapter 3, in full, is currently being prepared for submission for publication of all of the material presented here. Frederiksen, Anne Therese & Mayberry, Rachel I. The dissertation author was the primary investigator and author of this material

		Exp. 1	Experiment 2									
Verb	Thematic Role of Gloss Translation Equivalent (see Ferstl et al., 2011)	Accep-tance Score	Most Frequent Thematic Role Realiza-tion	Next-Mention					Wrong verb	No answer	Sum NP1+ NP2 Next-Mentions	Bias Score
				NP1	NP2	Both	Other	Unclear				
abandon	AgP	5	N/A	6	2	0	0	0	0	0	8	50.000
abduct	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
accept	AgP	5	N/A	2	5	0	1	0	0	0	7	-42.857
accompany	AgP	4	N/A	2	3	3	0	0	0	0	5	-20.000
add-to	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
admire	ExpStim	5	N/A	0	7	0	1	0	0	0	7	-100.000
adore	ExpStim	3	N/A	1	5	0	0	0	0	2	6	-66.667
advise	AgP	5	N/A	2	5	0	0	1	0	0	7	-42.857
aggravate	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
aid	AgP	5	N/A	1	6	0	1	0	0	0	7	-71.429
alienate	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
amaze	StimExp	3	ExpStim	1	7	0	0	0	0	0	8	-75.000
amuse	StimExp	4	ExpStim	1	5	1	0	0	1	0	6	-66.667
anger	StimExp	5	ExpStim	2	6	0	0	0	0	0	8	-50.000
annoy	StimExp	5	ExpStim	0	8	0	0	0	0	0	8	-100.000
answer	AgP	5	N/A	2	1	0	0	0	5	0	3	33.333
antagonize	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
apologize-to	AgEvo	4	N/A	7	0	0	1	0	0	0	7	100.000
appease	StimExp	4	StimExp/ AgP	2	6	0	0	0	0	0	8	-50.000

applaud	AgEvo	5	N/A	0	8	0	0	0	0	0	8	-100.000
appoint	AgP	5	N/A	1	7	0	0	0	0	0	8	-75.000
approach	AgP	5	N/A	6	2	0	0	0	0	0	8	50.000
arrest	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
assassinate	AgP	5	N/A	4	2	1	0	0	0	1	6	33.333
assist	AgP	5	N/A	1	7	0	0	0	0	0	8	-75.000
attend-to	ExpStim	4	N/A	3	5	0	0	0	0	0	8	-25.000
attract	StimExp	3	StimExp	6	1	0	0	1	0	0	7	71.429
avoid	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
baffle	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ban	AgP	4	N/A	0	7	0	0	1	0	0	7	-100.000
banish	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
battled	AgP	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bawl-out	AgEvo	5	N/A	2	6	0	0	0	0	0	8	-50.000
beat	AgP	4	N/A	8	0	0	0	0	0	0	8	100.000
beat-up	AgP	5	N/A	6	0	0	1	0	0	1	6	100.000
beguile	StimExp	5	Unclear	4	2	1	1	0	0	0	6	33.333
believe	ExpStim	5	N/A	2	4	0	1	1	0	0	6	-33.333
betray	AgP	4	N/A	2	4	0	0	0	0	2	6	-33.333
bite	AgP	5	N/A	5	2	1	0	0	0	0	7	42.857
blame	AgEvo	5	N/A	5	2	0	1	0	0	0	7	42.857
bless	AgEvo	4	N/A	1	5	1	0	1	0	0	6	-66.667
bore	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
bother	StimExp	5	AgP	6	2	0	0	0	0	0	8	50.000
break	AgP	3	N/A	5	0	0	2	0	0	1	5	100.000
bribe	AgP	3	N/A	5	2	0	0	0	1	0	7	42.857
bug	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

bust	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
call	AgP	5	N/A	4	0	2	2	0	0	0	4	100.000
call-on-landline	AgP	5	N/A	7	0	0	0	1	0	0	7	100.000
calm	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
capture	AgP	5	N/A	5	3	0	0	0	0	0	8	25.000
caress	AgP	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
carry	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
catch	AgP	5	N/A	2	5	1	0	0	0	0	7	-42.857
celebrate	AgEvo	4	N/A	0	6	0	2	0	0	0	6	-100.000
challenge	AgP	4	N/A	6	1	0	0	0	0	1	7	71.429
change	AgP	5	N/A	3	4	0	1	0	0	0	7	-14.286
charm	StimExp	5	AgP	7	1	0	0	0	0	0	8	75.000
chase	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
cheat_version_A	AgP	3	N/A	5	1	1	0	0	0	1	6	66.667
cheat_version_B	AgP	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
cheer	StimExp	5	AgP	0	7	0	0	0	1	0	7	-100.000
cheer-up	AgP	5	N/A	3	4	0	0	0	1	0	7	-14.286
cherish	ExpStim	5	N/A	0	3	4	0	1	0	0	3	-100.000
chill	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
coach	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
coax	AgP	5	N/A	3	4	0	0	0	0	1	7	-14.286
collide-with	AgP	4	N/A	1	2	4	0	0	0	1	3	-33.333
comfort	StimExp	5	StimExp/AgP	0	7	0	1	0	0	0	7	-100.000
command	AgP	5	N/A	6	2	0	0	0	0	0	8	50.000
compensate	AgP	5	N/A	2	5	1	0	0	0	0	7	-42.857

complement	AgP	3	N/A	0	0	8	0	0	0	0	0	0.000
concern	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
confess-to	AgP	5	N/A	4	2	2	0	0	0	0	6	33.333
confide-in	AgP	5	N/A	7	1	0	0	0	0	0	8	75.000
confuse	StimExp	5	StimExp	5	3	0	0	0	0	0	8	25.000
congratulate	AgEvo	5	N/A	0	8	0	0	0	0	0	8	-100.000
consider	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
contact	AgP	5	N/A	7	1	0	0	0	0	0	8	75.000
control	AgP	5	N/A	8	0	0	0	0	0	0	8	100.000
copy	AgP	5	N/A	6	2	0	0	0	0	0	8	50.000
corrupt	AgP	5	N/A	6	2	0	0	0	0	0	8	50.000
court	AgP	4	N/A	1	0	7	0	0	0	0	1	100.000
criticize	AgEvo	5	N/A	0	6	0	1	0	1	0	6	-100.000
cure	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
date	AgP	5	N/A	4	0	3	1	0	0	0	4	100.000
debate-with	AgP	4	N/A	1	3	3	0	1	0	0	4	-50.000
deceive	AgP	5	N/A	4	3	0	1	0	0	0	7	14.286
decline	AgP	3	N/A	2	2	1	1	0	2	0	4	0.000
defriend	AgP	4	N/A	0	0	8	0	0	0	0	0	0.000
delight	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
denigrate	AgEvo	5	N/A	3	4	0	0	1	0	0	7	-14.286
depress	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
deride	AgEvo	3	N/A	4	2	0	0	2	0	0	6	33.333
devastate	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
disappoint	StimExp	5	StimExp	6	2	0	0	0	0	0	8	50.000
discover	AgP	5	N/A	1	2	0	1	0	4	0	3	-33.333
discuss-with	AgP	3	N/A	3	2	2	1	0	0	0	5	20.000

disgust	StimExp	3	ExpStim	1	7	0	0	0	0	0	8	-75.000
dislike	ExpStim	5	N/A	0	7	1	0	0	0	0	7	-100.000
distract	StimExp	3	AgP	4	3	0	0	1	0	0	7	14.286
distress	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
divorce	AgP	5	N/A	2	1	4	1	0	0	0	3	33.333
doubt	ExpStim	5	N/A	0	7	0	1	0	0	0	7	-100.000
dread	ExpStim	4	N/A	0	5	2	1	0	0	0	5	-100.000
dreamt-about	ExpStim	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
dumbfound	ExpStim	4	N/A	0	8	0	0	0	0	0	8	-100.000
embarrass	StimExp	4	StimExp	8	0	0	0	0	0	0	8	100.000
encourage	StimExp	5	StimExp/ AgP	3	5	0	0	0	0	0	8	-25.000
enrage	StimExp	3	ExpStim	3	4	0	0	0	0	1	7	-14.286
entertain	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
entice	StimExp	4	AgP	1	5	1	0	0	0	1	6	-66.667
envy	ExpStim	5	N/A	1	6	0	1	0	0	0	7	-71.429
escape-from	AgP	3	N/A	4	4	0	0	0	0	0	8	0.000
escort	AgP	5	N/A	1	3	2	1	1	0	0	4	-50.000
evaluate	ExpStim	5	N/A	5	1	0	2	0	0	0	6	66.667
excite	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
exclude	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
excuse	AgEvo	5	N/A	1	5	0	0	0	2	0	6	-66.667
exhaust	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
fancy	ExpStim	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
fascinate	StimExp	4	ExpStim	1	5	0	2	0	0	0	6	-66.667
favor	ExpStim	4	N/A	0	8	0	0	0	0	0	8	-100.000
fear	ExpStim	5	N/A	2	6	0	0	0	0	0	8	-50.000

feed	AgP	5	N/A	0	6	0	0	0	2	0	6	-100.000
fight	AgP	4	N/A	1	1	5	0	1	0	0	2	0.000
film	AgP	5	N/A	2	3	0	3	0	0	0	5	-20.000
fire	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
flabbergast	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
flatter	StimExp	5	AgP	7	0	0	0	0	0	1	7	100.000
floor	AgP	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
follow	AgP	5	N/A	5	3	0	0	0	0	0	8	25.000
force	AgP	4	N/A	0	6	0	0	1	1	0	6	-100.000
frustrate	StimExp	4	Unclear	2	5	1	0	0	0	0	7	-42.857
gall	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
get-even-with	AgP	5	N/A	1	2	4	0	0	1	0	3	-33.333
get-revenge-on	AgP	4	N/A	1	6	0	0	0	0	1	7	-71.429
gift	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
go-up-to	AgP	5	N/A	6	1	1	0	0	0	0	7	71.429
google_ version_A	AgP	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
google_ version_B	AgP	4	N/A	8	0	0	0	0	0	0	8	100.000
grab	AgP	4	N/A	3	4	0	0	1	0	0	7	-14.286
graze	AgP	5	N/A	4	1	2	1	0	0	0	5	60.000
greet	AgP	3	N/A	6	0	2	0	0	0	0	6	100.000
grieve	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
guide	AgP	5	N/A	3	5	0	0	0	0	0	8	-25.000
harass	StimExp	5	AgP	6	1	0	0	0	0	1	7	71.429
hate_ version_A	ExpStim	5	N/A	0	8	0	0	0	0	0	8	-100.000
hate_ version_B	ExpStim	5	N/A	5	3	0	0	0	0	0	8	25.000

healed	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
hit	AgP	4	N/A	7	1	0	0	0	0	0	8	75.000
honor	AgEvo	5	N/A	0	8	0	0	0	0	0	8	-100.000
hurt	StimExp	5	StimExp/ AgP	5	3	0	0	0	0	0	8	25.000
ignore	AgP	5	N/A	3	5	0	0	0	0	0	8	-25.000
impede	AgP	5	N/A	3	5	0	0	0	0	0	8	-25.000
impress	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
improve	AgP	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
incense	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
include	AgP	3	N/A	4	4	0	0	0	0	0	8	0.000
inform	AgP	5	N/A	2	3	1	1	0	0	1	5	-20.000
inspire	StimExp	5	StimExp	5	2	0	1	0	0	0	7	42.857
insult	StimExp	5	StimExp/ AgP	6	1	0	0	0	0	1	7	71.429
interest	StimExp	3	ExpStim	1	7	0	0	0	0	0	8	-75.000
interrogate	AgP	5	N/A	3	4	0	1	0	0	0	7	-14.286
intimidate	StimExp	5	AgP	6	2	0	0	0	0	0	8	50.000
investigate	AgP	4	N/A	2	3	0	2	1	0	0	5	-20.000
invite	AgP	5	N/A	6	0	0	2	0	0	0	6	100.000
join	AgP	4	N/A	5	1	1	1	0	0	0	6	66.667
judge	AgEvo	5	N/A	5	2	0	1	0	0	0	7	42.857
kick	AgP	5	N/A	4	3	1	0	0	0	0	7	14.286
kill	AgP	5	N/A	4	2	1	0	0	0	1	6	33.333
kiss	AgP	5	N/A	7	0	1	0	0	0	0	7	100.000
leave	AgP	5	N/A	4	3	0	1	0	0	0	7	14.286
lie-to	AgP	4	N/A	7	1	0	0	0	0	0	8	75.000

like	ExpStim	5	N/A	1	7	0	0	0	0	0	8	-75.000
limit	AgP	3	N/A	2	5	0	1	0	0	0	7	-42.857
long-for	ExpStim	5	N/A	1	4	1	0	0	2	0	5	-60.000
look-for	AgP	4	N/A	1	4	2	1	0	0	0	5	-60.000
love	ExpStim	5	N/A	1	4	2	0	1	0	0	5	-60.000
marry	AgP	5	N/A	3	0	5	0	0	0	0	3	100.000
meet	AgP	5	N/A	1	0	5	0	0	0	2	1	100.000
mesmerize	StimExp	3	Unclear	4	2	2	0	0	0	0	6	33.333
miss	ExpStim	3	N/A	4	2	2	0	0	0	0	6	33.333
mock	AgEvo	5	N/A	0	7	0	1	0	0	0	7	-100.000
mooch-from	AgP	5	N/A	5	2	0	1	0	0	0	7	42.857
move	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
need	ExpStim	5	N/A	6	2	0	0	0	0	0	8	50.000
notice	ExpStim	5	N/A	2	5	0	1	0	0	0	7	-42.857
obey	AgP	3	N/A	0	1	0	0	0	5	2	1	-100.000
oppress	AgP	5	N/A	6	2	0	0	0	0	0	8	50.000
order-around	AgP	5	N/A	6	2	0	0	0	0	0	8	50.000
overlook	AgP	5	N/A	1	3	0	4	0	0	0	4	-50.000
overthrow	AgP	5	N/A	1	7	0	0	0	0	0	8	-75.000
owe	ExpStim	4	N/A	4	4	0	0	0	0	0	8	0.000
pain	StimExp	3	StimExp	5	0	1	1	1	0	0	5	100.000
pardon	AgEvo	5	N/A	0	5	0	0	1	1	1	5	-100.000
pass	AgP	5	N/A	3	4	0	0	1	0	0	7	-14.286
pay	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
pay-again	AgP	4	N/A	4	2	1	1	0	0	0	6	33.333
persuade	AgP	5	N/A	5	2	0	0	1	0	0	7	42.857
pet	AgP	5	N/A	2	4	0	0	0	2	0	6	-33.333

pick-on	AgEvo	5	N/A	7	1	0	0	0	0	0	8	75.000
pick-up	AgP	5	N/A	1	4	2	1	0	0	0	5	-60.000
piss-off	StimExp	5	ExpStim	5	3	0	0	0	0	0	8	25.000
pity	ExpStim	5	N/A	0	7	0	1	0	0	0	7	-100.000
play	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
play-with	AgP	5	N/A	4	2	2	0	0	0	0	6	33.333
preach-to	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
prepare	AgP	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
promote_ version_A	AgP	5	N/A	2	6	0	0	0	0	0	8	-50.000
promote_ version_B	AgP	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
protect	AgP	5	N/A	3	4	1	0	0	0	0	7	-14.286
protest	AgEvo	3	N/A	4	4	0	0	0	0	0	8	0.000
provoke	AgP	4	N/A	6	1	1	0	0	0	0	7	71.429
punish	AgEvo	5	N/A	0	8	0	0	0	0	0	8	-100.000
push	AgP	5	N/A	3	3	1	0	1	0	0	6	0.000
put-thumbs-down-on	AgEvo	5	N/A	4	3	0	1	0	0	0	7	14.286
puzzle	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
question	AgP	5	N/A	5	2	0	0	1	0	0	7	42.857
recommend	AgEvo	5	N/A	3	3	1	1	0	0	0	6	0.000
record	AgP	5	N/A	4	0	0	2	1	0	1	4	100.000
recruit	AgP	5	N/A	3	4	0	1	0	0	0	7	-14.286
refuse	AgEvo	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
relax	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
remember	ExpStim	5	N/A	1	1	5	1	0	0	0	2	0.000
repel	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
resent	ExpStim	4	N/A	2	4	1	1	0	0	0	6	-33.333

resist	AgP	5	N/A	0	8	0	0	0	0	0	8	-100.000
respect	ExpStim	5	N/A	1	7	0	0	0	0	0	8	-75.000
revere	ExpStim	5	N/A	1	7	0	0	0	0	0	8	-75.000
reward	AgEvo	4	N/A	1	7	0	0	0	0	0	8	-75.000
ruminate (about)	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
salute	AgEvo	4	N/A	2	2	3	1	0	0	0	4	0.000
satisfy	StimExp	4	N/A	1	3	0	1	3	0	0	4	-50.000
save	AgP	5	N/A	2	5	0	1	0	0	0	7	-42.857
scare	StimExp	4	StimExp	4	3	0	1	0	0	0	7	14.286
scold	AgEvo	5	N/A	0	7	0	1	0	0	0	7	-100.000
serve	AgP	5	N/A	3	3	0	0	1	0	1	6	0.000
shadow	AgP	5	N/A	3	4	0	0	1	0	0	7	-14.286
shake	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
shame	AgP	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
shock	StimExp	4	StimExp	5	2	0	0	1	0	0	7	42.857
sicken	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
slander	AgEvo	3	N/A	4	3	0	0	0	0	1	7	14.286
snub	AgEvo	4	N/A	4	2	1	0	0	1	0	6	33.333
spank	AgP	3	N/A	1	3	0	0	0	1	3	4	-50.000
spoil	AgP	5	N/A	0	0	0	0	0	8	0	0	0.000
spoil/ruin	AgP	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
spy-on	AgP	5	N/A	2	4	0	1	1	0	0	6	-33.333
squash	AgP	5	N/A	7	0	0	1	0	0	0	7	100.000
stare-at	AgP	5	N/A	5	3	0	0	0	0	0	8	25.000
stimulate	StimExp	4	StimExp/ AgP	2	4	0	0	0	1	1	6	-33.333
stop	AgP	5	N/A	3	5	0	0	0	0	0	8	-25.000

supervise	AgP	5	N/A	0	6	0	2	0	0	0	6	-100.000
support	AgEvo	5	N/A	3	5	0	0	0	0	0	8	-25.000
surprise	StimExp	5	StimExp	4	2	0	1	0	1	0	6	33.333
suspect	ExpStim	4	N/A	3	5	0	0	0	0	0	8	-25.000
switch	AgP	3	N/A	1	4	0	0	3	0	0	5	-60.000
take-away	AgP	5	N/A	5	2	1	0	0	0	0	7	42.857
tattle-on	AgP	4	N/A	3	4	0	0	0	1	0	7	-14.286
taunt	AgEvo	5	N/A	5	2	0	1	0	0	0	7	42.857
tease	AgEvo	5	N/A	7	1	0	0	0	0	0	8	75.000
telephone	AgP	5	N/A	8	0	0	0	0	0	0	8	100.000
tempt	StimExp	3	StimExp	3	4	0	0	0	0	1	7	-14.286
text	AgP	4	N/A	7	0	1	0	0	0	0	7	100.000
thank	AgEvo	5	N/A	1	7	0	0	0	0	0	8	-75.000
think-about	ExpStim	3	N/A	2	5	0	0	1	0	0	7	-42.857
threaten	AgEvo	5	N/A	3	4	0	0	0	0	1	7	-14.286
thrill	StimExp	2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
toast	ExpStim	4	N/A	1	4	2	0	1	0	0	5	-60.000
tolerate	ExpStim	4	N/A	2	4	0	2	0	0	0	6	-33.333
track	AgP	5	N/A	4	4	0	0	0	0	0	8	0.000
train	AgP	5	N/A	0	7	0	0	1	0	0	7	-100.000
transform	AgP	3	N/A	3	2	0	0	0	0	3	5	20.000
trust	ExpStim	5	N/A	1	6	1	0	0	0	0	7	-71.429
understand	ExpStim	4	N/A	4	2	2	0	0	0	0	6	33.333
uplift	StimExp	4	AgP	2	6	0	0	0	0	0	8	-50.000
upset	StimExp	5	ExpStim	5	2	0	0	0	0	1	7	42.857
value	ExpStim	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
victimize	AgEvo	3	N/A	1	2	0	0	0	5	0	3	-33.333

video-chat-to	AgP	5	N/A	6	0	1	0	1	0	0	6	100.000
visit	AgP	5	N/A	4	2	2	0	0	0	0	6	33.333
want	ExpStim	5	N/A	4	4	0	0	0	0	0	8	0.000
warn	AgP	4	N/A	3	2	1	1	0	1	0	5	20.000
weary	StimExp	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
worry	StimExp	3	ExpStim	2	4	0	1	1	0	0	6	-33.333
worry-about	ExpStim	5	N/A	1	7	0	0	0	0	0	8	-75.000
worship	ExpStim	5	N/A	2	5	0	0	0	1	0	7	-42.857
wow	StimExp	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
yearn-for	ExpStim	3	N/A	3	4	0	0	0	0	1	7	-14.286
yell-at	AgP	5	N/A	5	3	0	0	0	0	0	8	25.000

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CHAPTER 4

Pronoun Production and Comprehension in American Sign Language: The Influence of Space, Grammar, and Semantics

Abstract

Pronouns occur in signed as well as spoken languages. Spoken language research has investigated the influence on pronouns of grammar, semantics and pragmatics. Sign language research has focused on the fact that their articulation in space allows signed pronouns to unambiguously pick out one specific referent. This study investigates how factors specific to and independent of the signed perceptual modality affect pronouns in American Sign Language (ASL). We considered the linguistic use of space (a modality-specific factor), the grammatical role of the antecedent, and the role of implicit causality biases in verbs (both modality-independent factors). In two sentence-continuation experiments, we investigated how these factors affect ASL signers' choice of referring expression (Experiment 1) and their resolution of pronouns (Experiment 2). In production, signers used more pronouns for referents articulated in localized compared to neutral space. They also used more pronouns for the referent focused by the verb bias. However, pronouns were the preferred referring expression across all conditions, verb types, and antecedents. In comprehension, signers resolved pronouns using both spatial and verb bias information. Comparing the results of Experiments 1 and 2 showed signers to continue with the previous object more frequently when starting the continuation with a pronoun. This suggests that ASL pronouns are influenced by grammatical role as well. Our results demonstrate for the first time that ASL pronouns are subject to modality-specific as well as modality-

independent factors, despite their use of space. These findings have implications for the development of cross-linguistically valid models of pronoun production and comprehension.

1 Introduction

The production and comprehension of referential cohesion and particularly the role of pronouns are complex processes that language users perform automatically and seemingly effortlessly. Uncovering the principles underlying these processes has played a central role in psycholinguistic research for the past decades. Pronouns are of longstanding interest to sign language researchers, too, especially personal pronouns because of their modality-specific nature. More particularly, overt pronouns in some sign languages are pointing signs that can be disambiguated though the use of the space surrounding the signer, rather than through lexical features such as gender. Perhaps because of this difference from spoken languages, research on sign language pronouns has taken a somewhat different trajectory compared to work on spoken language pronouns. This has resulted in limited overlap between the two bodies of work. Because sign language linguistics has focused on discovering how spatial co-reference works in pronouns, less attention has been paid to the possible effects of factors known to influence the processing of spoken language pronouns. This question is of vital importance in order to discover a set of grammatical, semantic, and discourse-pragmatic factors that universally govern pronoun production and comprehension. The present paper reports on two experiments examining how factors specific to the visual-manual modality, such as spatial co-reference, and modality-general factors, such as grammatical role and semantic verb biases, influence pronouns in American Sign Language (ASL). Our findings reveal that although ASL pronouns show some

effect of modality-specific factors, they are primarily affected by factors that are present in spoken language as well.

2 Pronouns in American Sign Language

Like spoken languages, sign languages make use of a variety of referring expressions to create cohesion. Among the more frequent referring expressions in American Sign Language (ASL) are nouns, overt pronouns, and null pronouns. While these expressions are also frequent in the spoken modality, the manual-visual modality affects how these referring expressions are realized in sign languages (Friedman, 1975; Klima & Bellugi, 1979; Lillo-Martin, 1986). For example, when signers introduce (absent) entities into the discourse, they can do so with names or common nouns, just as in spoken languages. However, unlike the situation in spoken languages, signers have the option of associating a nominal (and thereby also the denoted referent) with an area of signing space, i.e., the space around the signer, primarily to the front and sides and from the torso up.[1] Such areas are called referential loci (Klima & Bellugi, 1979; Lillo-Martin & Klima, 1990). The association between a nominal and a locus can be achieved in different ways (Lillo-Martin, 1986; Padden, 1988, Baker-Shenk & Cokely, 1980): the signer can articulate the nominal in the space that then becomes the locus, or precede or follow the noun with a pointing sign indexing a locus.[2] It is also possible to accompany the nominal with an eye-gaze directed towards a locus. The established referential locus can subsequently contribute to

[1] Studies of co-speech gesture have shown that speakers can associate areas of space with referents though their gestures (see Kendon & Versante, 2003; So et al., 2005; So et al., 2009; Foraker, 2011). However, most studies of referential cohesion do not discuss the contribution of co-speech gesture (but see Gullberg 2006, Goodrich Smith & Hudson Kam, 2011; Debreslioska et al, 2013; Perniss & Özyürek, 2015; and Debreslioska & Gullberg, 2019 for exceptions)

[2] Some researchers have argued that pre-nominal and post-nominal points serve as definite and indefinite determiners, respectively in ASL (Neidle et al, 2000). Regardless whether these are or are not treated as determiners, they have the ability to anchor a nominal to a locus in the signing space.

cohesion in different ways. Third person singular anaphoric pronouns, for example, are pointing signs that can index areas of the signing space (Friedman, 1975). Such pronouns can be understood by retrieving the referent associated with the indicated referential locus. This contrasts with the situation in many spoken languages, where pronouns match lexical features of their referents, such as gender. As a result, some processes related to using and interpreting pronouns have been understood to be different in sign vs. speech.

2.1 Factors Dependent and Independent of Modality in Studies of Signed Pronouns.

Much research has focused on the use of space in the resolution of signed pronouns, both in theoretical linguistic (Schlenker, 2013, Kuhn, 2015; Steinbach & Onea, 2016) and psycholinguistic studies (Emmorey, Norman, & O'Grady, 1991; Emmorey & Lillo-Martin, 1995; Emmorey, 1997; Wienholz et al., 2018). The referential transparency of ASL pronouns suggests that they may be different from pronouns in spoken languages. This in turn is indicative of modality-based differences in both production and processing. Few experimental studies have investigated modality-independent factors in the production and resolution of pronouns in sign languages. Examining online processing, Emmorey and colleagues found that pronouns reactivate their antecedents (Emmorey, Norman, & O'Grady, 1991; Emmorey & Lillo-Martin, 1995). Given two potential referents, Emmorey (1997) found inhibition of the non-antecedent in ASL sentences. Although these studies examined processes that occur in speech (Corbett & Chang, 1983, Dell et al., 1983; MacDonald & MacWhinney, 1990), they also did so from the perspective of pronominal reference being determined by spatial co-reference in sign language.

Friedman (1975) explicitly argues that ASL pointing signs are different from pronouns in spoken languages. For this reason she does not consider pointing signs to be pronouns. While

subsequent work has debated whether pointing signs should be considered partly or fully gestural (Liddell 2000, 2003; Cormier, Schembri & Woll, 2013, or linguistic (Lillo-Martin & Klima, 1990; Meier, 1990, Perlmutter, 1991, Meier & Lillo-Martin, 2010), the notion that the third person singular sign language pronoun is radically different from spoken language pronouns has largely persisted.

It would be strange if the factors that have been documented to affect pronoun production and interpretation in a range of spoken languages (discussed below) were to play no role for sign language pronouns. However, this implicit assumption arises from previous sign language studies. For example, sign language pronouns are generally explained by noting that, first, the locus is established, and *then* the signer can direct pronouns towards it (see for example, Friedman, 1975; Emmorey, 1997; Sandler & Lillo-Martin, 2006; Schlenker, 2013; Kuhn, 2015). Although not explicitly said, this leaves the impression that a locus *must* be established first before a pronoun can be used. Conversely a pronoun cannot be used unless its intended referent has previously been associated with a locus. This assumption is heightened by the fact that no alternative means of pronominal reference are presented, that is, no way for pronouns to be used and understood though non-spatial factors. Schlenker's (2011) brief mention of the possible first-mention effect (i.e. the first-mentioned NP in a sentence is the preferred referent for a pronoun) and Engberg-Pedersen's (1998) brief mention of 'undirected' pointing signs are exceptions.

The assumption that a locus must be established before the signer can use a pronoun leads to predictions about pronoun production and comprehension in a language like ASL, which are unusual from a linguistic standpoint. For pronoun comprehension, the ensuing expectation is that a pronoun that does not index a pre-established referential locus cannot be resolved. To our knowledge, the experimental study by Wienholz et al. (2018) is the only one to date to examine

how signers interpret pronouns that index areas of signing space that have not been explicitly pre-associated with referents. Wienholz and colleagues asked whether, in the absence of overt associations between referents and loci, signers of German Sign Language (DGS) associate sentential subjects with the right side of signing space, and sentential objects with the left side of signing space. They found some support for this hypothesis. However, their study did not investigate how non-spatial influences that have been reported for spoken language pronoun resolution may also influence this process in sign language.

The assumption that a locus must be established before the signer can use a pronoun also leads to expectations about pronoun production. Specifically, pronouns are not expected to be licensed in the absence of established referential loci. At its most extreme, this would mean that pronouns should be unattested in all contexts where referential loci have not been established prior to the occurrence of the pronoun. Only two studies that we know of have suggested an alternative way for pronouns to be used and understood. Baker-Shenk and Cokely (1980) note that a pronoun may be used without prior establishment of a referential locus, if the referent is obvious. However, they do not describe what makes a referent obvious. Engberg-Pedersen (1998) discusses an example of an undirected pointing sign, which is not directed towards a locus, but can be resolved without problems because it occurs in an utterance that only mentions one referent.

Thus, past research leads to a number of related questions. First, could factors that govern the use and resolution of pronouns in spoken language also apply to signed pronouns? In particular, can senders produce and can addressees understand ASL pronouns even in the absence of spatial loci? Similarly, what role, if any, do the factors that underlie spoken pronoun production and resolution play when ASL pronouns *do* index spatial locations, that is, when their

antecedents are assumed to be unambiguous? The present paper reports on two experiments addressing these fundamental questions about ASL pronouns. We ask whether the factors involved in producing and resolving pronouns that do not index established referential loci are also relevant for the pronouns that do. We further ask whether approaches developed for spoken languages can accurately capture the behavior of pronouns in the visual-manual modality.

3 Production and Comprehension of Pronouns

An integral part of successful communication is that senders must refer to referents and discourse entities in such a way that the addressee can reconstruct the intended message. The speakers' choice of referring expression should be systematic in such a way that it enables the listener to retrieve the intended referent. It is widely accepted that the accessibility of a referent in the discourse is relevant with respect to relatively coarse-grained distinctions, such as explaining why senders generally introduce referents with lexical noun phrases (e.g. 'a man with a hat'), rather than with reduced expressions such as pronouns (Givon, 1983; Ariel 1990; Gundel et al, 1993). Less clear is whether accessibility can account for variation in the production and interpretation of the third person singular pronoun. Such pronouns are linguistically underspecified, that is, their meaning must be interpreted within a given context. Consider the sentence fragment in 1). The first clause introduces the referents 'Lisa' and 'Mary'. By the time the pronoun is encountered, they are therefore both given entities and thus are both possible referents for the pronoun in the second clause.

1) Lisa loves Mary, because she …

Given how unremarkable a sentence like 1) seems, it stands to reason that addressees do not find this type of (temporarily) ambiguous pronoun to be disruptive to the discourse.

This has led a to a large body of work attempting to identify the specific factors that guide addressees in assigning a referent to a pronoun. A variety of heuristics have been proposed including: a preference for a grammatical subject antecedent (Frederiksen, 1982; Crawley, Stevenson & Kleinman, 1990); a preference for assigning the pronoun to a referent with the same grammatical role (Smyth 1994; Chambers & Smyth, 1998, Grober, Beardsley & Caramazza, 1978); a preference for the first-mentioned referent (Gernsbacher & Hargreaves 1988; Gernsbacher, Hargreaves & Beeman 1989); and for assigning a pronoun to the thematic role favored by a particular context (Stevenson, Crawley, & Kleinman, 1994). Other researchers have argued that the pronoun will be resolved to the most prominent referent, which in turn is determined by the interaction of several factors, such as subjecthood and semantics (Arnold, 2001), or that pronoun interpretation is guided by generalized reasoning and world knowledge (Hobbs, 1979).

3.1 Evidence for a Dissociation between Production and Comprehension

As pointed out by Kehler and colleagues, an implicit assumption of the above accounts of pronouns is that the production and resolution of pronouns are subject to the same principles (Kehler et al., 2008; Kehler & Rohde, 2013, 2018; Rohde & Kehler, 2014). Producers signal referent accessibility with their choice of referring expression. Consequently, they choose less semantically specific referring expressions, such as pronouns, for referents that are highly activated in the comprehender's mental discourse model. However, recent studies have found evidence for a dissociation between the factors that guide pronoun comprehension and those that

guide production. In a study of pronouns in English, Stevenson et al. (1994) found that grammatical role appears to determine *how* a speaker will refer, such that pronouns are preferred for subject antecedents, and nominals are preferred for non-subject antecedents. We will refer to this as the *production bias*. At the same time, Stevenson et al. found that semantically-based, top-down predictive processes are at play in determining *which* entity will be referenced, such that certain referents appear to be focused by the discourse context. In addition, encountering a pronoun increases the likelihood that a comprehender will interpret the sentence as being about the previous grammatical subject, which suggests that comprehenders rely jointly on semantic/pragmatic biases and pronoun production biases in their interpretation of pronouns (Kehler et al., 2008). Producers, however, do not condition their choice of referring expression on referent accessibility, as the rate of pronominalization stays constant across different semantic contexts (Miltsakaki, 2007; Kehler et al., 2008; Fukumura & Van Gompel, 2010).

To formalize these insights, Kehler and Rohde (2013) proposed the Bayesian model of pronoun interpretation. This model predicts that, whether or not a pronoun is ambiguous, the choice to pronominalize a referent depends on information-structural factors, such as topic-hood and grammatical role (Rohde & Kehler, 2014). Consequently, pronoun production is insensitive to the semantic and pragmatic biases involved in comprehension. What little work that has examined this model in languages other than English suggests that its principles largely apply cross-linguistically (Zhan, Levy & Kehler, 2016; Ueno & Kehler, 2016). However, an open question is the extent to which the model can account for the behavior of different types of pronominal reference (null pronoun, personal pronoun, demonstrative) used cross-linguistically (see Kaiser, 2013)

3.2 The Effect of Next-Mention Biases on Comprehension

The predictive processes determining which referent is likely to be re-mentioned (which we will refer to as the *next-mention bias* following Rohde & Kehler, 2014) rely on different factors (Kehler 2002, Kehler et al., 2008; Kehler & Rohde 2013, 2018). Some of these factors are semantic, such as implicit causality (discussed below). Others are pragmatic, such as the coherence relations holding between clauses and sentences in the discourse. Of particular importance to the experiments in the present paper is the *explanation* relation. Explanation relations lead to the inference that "the second sentence describes a cause or reason for the eventuality described in the first sentence" (Kehler & Rohde, 2013:7; see also Kehler, 2002), as in the sentence 'Lisa annoys Mary, (because) she sings while doing the dishes'. Comprehenders often infer explanation coherence relations in contexts involving implicit causality verbs, especially when used with the conjunction 'because'.

Implicit causality (IC) verbs are interpersonal verbs ('surprise', 'love', etc.), which implicitly assign causality to one of the verb's arguments. This in turn results in a tendency to focus on that referent in upcoming discourse (Au, 1986; Brown & Fish, 1983a 1983b; Caramazza, Grober, Garvey, & Yates, 1977; Garvey & Caramazza, 1974, and others). Implicit causality verbs are generally grouped into two categories. One category is NP1, or subject-biased verbs, which elicit proportionally more re-mentions of the subject referent than of non-subject referents. The other category is NP2, or object-biased verbs, which elicit re-mentions of the object (or non-subject) referent. There is a corresponding bias towards resolving ambiguous pronouns to the causally implicated referent, that is, the subject referent in NP1-biased verbs (such as 'annoy') and the object referent in NP2 –biased verbs (such as 'love').

Studies of English have quantified the next-mention bias, that is, the likelihood that a given referent will be mentioned next. In the context of IC-verbs in explanation frames, Kehler and colleagues found the re-mention rate to be 85% for the previous subject for NP1-biased verbs, 90% for the object for NP2-biased verbs, and 56% for the subject in non-IC verbs (Kehler et al., 2008). Implicit causality verbs exist not only in English but also in many languages (see Rudolph & Försterling, 1997 and Hartshorne et al., 2013 for an overview of biases in multiple languages). A higher proportion of re-mentions of the causally implicated referent compared to the non-causally implicated referent has been found in Japanese (86/68% in NP1/NP2-biased verbs, Ueno & Kehler, 2016) and Mandarin (78/88% in NP1/NP2-biased verbs, Zhan et al., 2016)). Because implicit causality verbs exert a strong influence on which entity will be mentioned next, they shape the next-mention bias. In turn, next-mention biases influence which referent producers will mention in upcoming discourse, and comprehenders use this information when resolving pronouns. Because of their demonstrated cross-linguistic importance, we would expect next-mention biases to affect pronouns in sign languages as well as in spoken language. To date, however, the effect of next-mention biases on pronouns has not been examined in a sign language.

3.3 Effects of Bias-Incongruency

Implicit causality verbs result in next-mention biases, but sentences where the referent is ultimately incongruent with the bias (e.g. “Lisa loves Mary, because she loves all her friends named Mary”) are not ungrammatical. However, parsing such sentences presents a challenge. This is evidenced by slower comprehension compared to congruent discourse. Studies have demonstrated this in the context of pronoun interpretation (Caramazza, Grober, Garvey, & Yates,

1977; Ehrlich, 1980; McKoon, Greene, & Ratcliff, 1993, Koornneef & van Berkum, 2006) and timed reading tasks (Garnham & Oakhill, 1985). ERP research has shown that pronouns that are bias-incongruent by virtue of gender mismatch elicit a P600 effect (Van Berkum et al., 2007). The exact nature of the P600 effect is still under debate (see Barkley, Kluender and Kutas, 2015), but the effect is interpreted by some to indicate syntactic processing or parsing difficulties (Hagoort et al., 1993, Osterhout & Holcomb, 1992; Kaan et al., 2000). Under this interpretation, comprehenders differentiate between when the reference of a pronoun is expected or unexpected based on preceding discourse. This suggests that gender-based bias-incongruency is hard to parse and may be construed initially as an error.

When given the option, language users try to mitigate the effects of bias-pronoun incongruency by varying coherence relations. Specifically, when encountering a pronoun that is incongruent with the IC-bias, people tend to continue the sentence with a coherence relation other than Explanation, which is otherwise preferred IC-contexts. In a sentence-continuation experiment, Rohde (2008:84 pp.) presented participants with pronouns that were bias-incongruent by virtue of a gender-marking (e.g. 'John infuriated Mary. She…'). In such contexts, participants used different coherence relations in their continuations compared to when the pronoun was congruent with the bias.[3] Explanation relations were preferred in congruent NP1-biased contexts, e.g. 'John infuriated Mary. He cheated at Scrabble'. In incongruent contexts, however, result relations were used more frequently. Result relations occur when the second sentence is understood as the result of the event in the first sentence, e.g. 'John infuriated Mary.

[3] Sentence-continuation tasks involve both production and comprehension processes (Arnold, 2001). When the continuation is forced to begin with a pronoun, this provides a constraint on which referent can be mentioned, particularly when the options differ by gender, but participants can vary the rest of the continuation based on their expectations about how the discourse will unfold.

She told him to take a hike' (Kehler, 2002). There was a parallel preference for explanation relations in congruent NP2-biased contexts, e.g. 'John scolded Mary. She cheated at Scrabble'. However, this preference was reduced in favor of more elaboration relations in incongruent contexts, e.g. 'John scolded Mary. He yelled at her in front of everybody'. Elaboration relations occur when the second sentence is a restatement of events in the first from a different perspective or at a different level of detail (Kehler, 2002). All else being equal, IC verbs tend to elicit explanation relations. The fact that the bias-pronoun incongruency leads participants to deviate from the preferred explanation relation suggests that language users are highly sensitive to incongruencies with verb bias and seek to avoid them or mitigate their effects whenever possible.

3.4 Interim Summary

Pronoun studies in spoken languages suggest that there is a dissociation between the processes that apply to pronoun production and comprehension. Producers are affected by next-mention biases when they determine which entity to talk about. Next-mention biases result from pragmatic influences such as coherence-relations and from semantic influences, such as implicit causality biases. However, the producer's decision (known as the production bias) of whether to refer to an entity with a pronoun or with another referring expression, such as a noun or a name, is not affected by the next-mention bias. Instead, this decision depends primarily on information-structural factors, such as the grammatical role of the antecedent.

To resolve a pronoun, comprehenders must essentially reverse-engineer the referential intentions of the producer (Kehler & Rohde, 2018). They do this by taking into account both the next-mention and production biases. In other words, the comprehender must draw inferences between sentences and use information from sources such as implicit causality verbs to

determine the likelihood that a given referent was mentioned. This information must then be combined with their estimate of the probability that the producer referred to the given entity with a pronoun.

Although these findings are based primarily on English, cross-linguistic research indicates that semantic/pragmatic and information-structural biases are important for pronouns in languages other than English. Unknown is the extent to which these factors carry across modalities to pronouns in the visual-manual modality.

4 The Present Study

Here we examine the roles of spatial referent localization, implicit causality verb bias, and grammatical role in guiding the production and resolution of pronouns in American Sign Language (ASL). We ask how the spatial co-reference, that has been hypothesized to render ASL pronouns unambiguous, impacts the influence of next-mention and production biases.

To this end, we designed two sentence-continuation experiments, one focused on production and one focused on comprehension. In both experiments, participants were presented with sentence-fragments naming two referents and asked to continue the sentences. We manipulated spatial localization by varying where in relationship to the signer the referent names were articulated. The names were fingerspelled using the manual alphabet[4]. We created two localization conditions in which referents were either associated with referential loci (localized condition) or not (neutral condition). In the neutral condition, both names were articulated in the area where fingerspelling generally occurs, that is, in front of the shoulder of the signer's

[4] Most proper nouns, and some common nouns are conventionally represented by spelling out the English letters with the manual alphabet in ASL. The manual alphabet consists of handshapes that correspond to letters in alphabet. Creating words by spelling them out with the manual alphabet is referred to as *fingerspelling.*

dominant hand. In the localized condition, names were articulated to the right and left of the signer's midline. We also manipulated next-mention biases using implicit causality verbs. As discussed above, these verbs have been shown to predictably influence which referent will be mentioned next. NP1-biased verbs elicit continuations about the subject referent. NP2-biased verbs elicit continuations about the object (or non-subject) referent. Frederiksen & Mayberry (in prep) found that IC-biases occur in ASL, similar to what has been found for spoken languages (e.g. 'SURPRISE' is an NP1-biased verb in ASL, similar to 'surprise' in English) and gathered bias norming data for a large set of ASL verbs. We used these norms to select equal groups of NP1-biased, NP2-biased, and unbiased (non-IC) verbs.

4.1 Experiment 1

We first address the question whether the choice of referring expressions in ASL is primarily a function of spatial localization, a modality-specific process, or alternatively of the factor of grammatical role, a modality-general process. If the choice of referring expressions in ASL is primarily a function of spatial localization, then the rate of pronominalization should be higher in the localized compared to the neutral condition. This hypothesis predicts that using a pronoun is only felicitous in contexts where referential loci have been established. If, however, ASL is similar to English such that the choice to pronominalize depends primarily on grammatical role, then the rate of pronominalization should not differ across localization conditions. Because ASL allows for null pronouns (Klima and Bellugi, 1979), and these occur primarily with subject antecedents (Wulf et al., 2002), we further hypothesize that an effect of grammatical role will manifest as a preference by overt pronouns for object antecedents. Finally, we also hypothesize that pronoun production will be insensitive to IC verb biases.

Methods

Participants

Sixteen Deaf, native ASL signers (12 female, mean age: 36, range: 23-59) participated in the experiment in return for monetary compensation. All had been exposed to ASL from birth by two Deaf parents, except for one participant who was exposed to another sign language (the participant did not disclose which one) and the sign system SEE (Seeing Exact English) in the home and acquired ASL in high school. The participants' average ASL self-ratings (on a 10-point scale where 10 indicates the highest level of proficiency) were 9.33 for production and 9.67 for comprehension. All signers were familiar with written English. Their average written English self-ratings were 8.53 for production and 9.33 for comprehension. On average, participants rated their use of spoken English as 1.04 (where 0 is never and 5 is daily).

Materials and Procedure

The stimulus items for this experiment consisted of 90 verbs occurring in NAME-1 VERB NAME-2 WHY? sentence-frames (e.g. 'HOPE KICK CHAD WHY?')[5]. The names were chosen from a list of 120 fingerspelled English four-letter names (60 typically male and 60 typically female names). Each name occurred twice as the subject and twice as the object in sentence frames. The verbs were 30 NP1-biased (e.g. 'FLATTER'), 30 NP2-biased (e.g. 'ADMIRE'), and 30 non-IC verbs (e.g. 'PASS'), taken from Frederiksen and Mayberry (in prep) who structured their list based on the verbs assembled by Ferstl et al. (2011). Each group of verbs consisted of an equal number of agreeing and non-agreeing verbs. Agreeing verbs use referential loci to indicate their subject and object arguments, and non-agreeeing verbs do not[6].

[5] The ASL conjunction 'WHY' is coordinating, rather than subordinating
[6] For more information about verb agreement see Padden (1988)

Each signer saw every verb twice – once in the neutral condition, and once in the localized condition, summing to a total of 180 critical stimuli per signer. In the localized condition, reference to the subject or the object referent was articulated on the right/left of the signer. The experiment additionally contained 60 fillers, some of which were stimulus items for another experiment not reported here.

Data were collected by video-recording the signers' sentence continuations. Participants first gave consent and filled out a background questionnaire. They then watched a video recording with an ASL explanation of the experiment and completed three practice trials. Following Frederiksen & Mayberry (in prep) we used a sentence-continuation task based on previous spoken language research paradigms and adapted it to ASL (see for example Garvey & Caramazza, 1974; Stevenson et al., 1994). Signers were seated in front of a large computer screen displaying video recordings of a model signer (also a Deaf, native ASL user) signing the experimental ASL stimuli. Participants first saw the prompt consisting of a sentence fragment; they then copied the prompt before adding their own continuation. The repetition procedure was adapted to encourage signers to attend to and remember the prompt, and to replicate and internalize the spatial locations presented in the fragment.[7] Participants were instructed to produce the first natural continuation that occurred to them. The experiment took 45-60 minutes.

Coding, Evaluation and Analysis

A Deaf, native ASL signer transcribed the participants' video recorded responses. For each response to a critical trial, the coder noted the following: 1) the referent that was mentioned first in the continuation, which we will refer to as the *next-mention*; 2) the referring expression

[7] When facing the conversational partner, the addressee must mentally rotate the sender's signing space in order to align referential loci with their own space (see discussion in Emmorey et al., 1993).

used for the next-mention; and 3) whether and how spatial localization was applied in the copy of the prompt.

Next-mentions were coded as Subject, Object, Both, Other or Unclear. Referring expressions were coded as Name (including name only, and any combination including a name (e.g. name + IX[8], name + possessive), Pronoun (IX, IX + SELF[9], IX + classifier[10]), Null Pronoun, and Other (classifier, possessive, SELF). The responses from two randomly chosen subjects (12.5% of the dataset) were coded for reliability by a second coder who was also a Deaf, native ASL signer. The coders agreed on 92.9% of next-mentions (Cohen's Kappa = .89), and on 98.1% of referring expressions (Cohen's Kappa = .97). In cases of disagreement, the first coder's judgment was retained. 12.8% of the data were excluded due to no response given, or the signer interpreting the verb differently than intended.

Focusing on the responses where either subject or object was chosen as the next-mention, we analyzed the data using mixed-effect logistic regression (Jaeger, 2008). We fit models in R using the lme4 package. Here and throughout the paper, we applied the following steps: we centered the next-mention and localization predictors, and applied sum-coding to the verb bias predictor for all relevant analyses. Where possible, models included both participant and item random effects and were constructed with both random intercepts and random slopes for predictors and their interactions (following Barr, Levy, Scheepers, & Tily, 2013). Below we note where the maximal model did not converge. In such cases, we iteratively pruned the random effects until we obtained a converging model, starting with random slopes from items, then from

[8] Pointing signs are conventionally glossed as IX. We use a -R/-L tag to indicate where the pointing sign was directed (e.g. IX-R describes a pointing sign indexing a locus on the signer's right side).
[9] The sign glossed as SELF is an upright A-handshape. It has a variety of functions, including reflexive pronoun and nominalizer (Fischer & Johnson, 2012).
[10] Classifiers are handshapes or combinations of handshapes and tracing movements that represent salient visual features of referents (e.g. Supalla, 1982; Zwitserlood, 2012).

participants, and then random intercepts from items, and then from participants.[11] For the binary predictors (localization condition and next-mention), we report coefficient estimates, and p-values based on the Wald Z statistic. For verb bias, which is a three-level predictor, we estimate the main and interaction effects through likelihood-ratio tests comparing models that differ only in the fixed parameter in question. Throughout the paper, we report the mean proportions in the text and figures, where the error bars show +/-1 standard error.

Results and Discussion

Examining the overall distribution of referring expressions, signers primarily produced overt pronouns for their next-mentions in the continuations (Overt Pronoun: 60%, Name: 24%, Null Pronoun: 15%, Other: 1%). We analyze the factors that influence ASL pronoun production. Our focus is on overt pronouns, but we also examine the use of null pronouns and names in order to see how these ASL referring expressions are distributed compared to overt pronouns.

First, we asked whether the signers followed the prompt with respect to localization. The signers manually indicated localization several ways: by fingerspelling names in different areas of space, by marking the location of referents through verb orientation or movement, or by adding pointing before or after names. An analysis of whether signers differentiated their use of manual localization as a function of localization in the prompt showed a significant effect of localization condition (β=1.6157, p<0.0001). The signers used a higher mean rate of manual localization in the localized condition (81%) compared to the neutral condition (68%). The signers could also indicate location non-manually with a head-tilt, body-lean, or eyegaze. The mean proportion of responses marking location solely with non-manuals was higher in the

[11] Non-convergence is a known problem of fitting models in R using lme4. We adopted the kind of pruning approach followed by Michael Frank and colleagues (see https://osf.io/zqzsu/wiki/Standard%20Analytic%20Procedures/)

neutral (12%) compared to the localized condition (8%). An analysis of the signers' manual and non-manual localization makers combined revealed a significant effect of localization condition (β= 1.3151, p<0.001). Signers localize referents at a mean rate of 89% in the localized condition vs. 81% in the neutral condition.

To see how referring expressions are distributed in ASL, we asked if pronouns as a group (including both null or overt, pronouns) are used differently compared to other referring expressions as a function of spatial localization, antecedent grammatical role, and verb bias. We grouped together all pronouns (overt and null) and compared them to all other referring expressions (names and other). The rates of overall pronominalization are shown in Figure 4.1. We found a significant effect of the grammatical role of the antecedent (β=-1.164, p<0.001), with a higher mean proportion of pronouns when the next-mention was the previous subject (82%), compared to the previous object (70%), and an effect of localization condition (β=-0.403, p<0.05), with more pronouns in the localized condition (77%) compared to the neutral condition (75%).[12] Model comparisons revealed no main effect of verb bias (comparing the full model to a model without a fixed effect of verb bias, p= 0.378, 2 d.f.), and no interactions (comparing the full model to a model with only a main effect of verb bias, p=0.099, 4 d.f.).These results indicate that the use of pronouns is affected both by grammatical role and by spatial localization. As a group, null and overt pronouns are used more for subject antecedents than object antecedents and are also used more when referents are localized, than when they are not.

[12] The final model excluded random slopes from both participants and items, and also excluded random intercepts from items

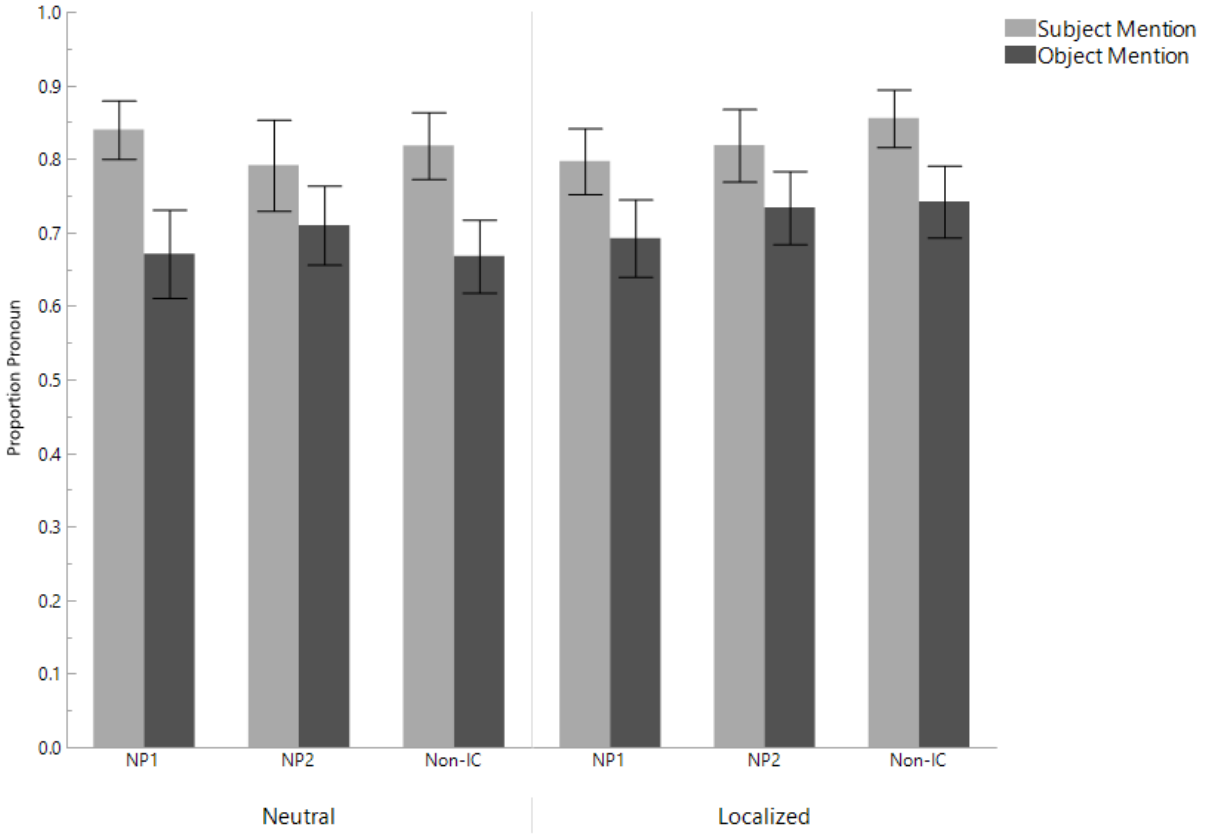

Figure 4.1. Proportion of null and overt pronoun references as a function of localization condition, verb bias, and next-mention

To assess whether null and overt pronouns have different preferences for the grammatic role of the antecedent, and whether overt pronouns are affected differently than null pronoun by referent localization, we next analyzed null and overt pronouns separately. We first asked whether the rate of overt pronominalization in ASL varies as a function of spatial localization, antecedent grammatical role, and verb bias. We predicted the following effects: 1) a higher rate of overt pronominalization in localized compared to neutral sentence contexts (i.e. a main effect of localization condition); 2) more pronouns used for object references compared to subject references (i.e. a main effect of grammatical role of the antecedent); and 3) the same rate of

pronominalization across different semantic contexts (i.e. no main or interaction effect of next-mention biases). Figure 4.2 shows the rates of overt pronominalization, as opposed to all other references (null pronouns, names, other), as a function of bias, localization and next-mention.

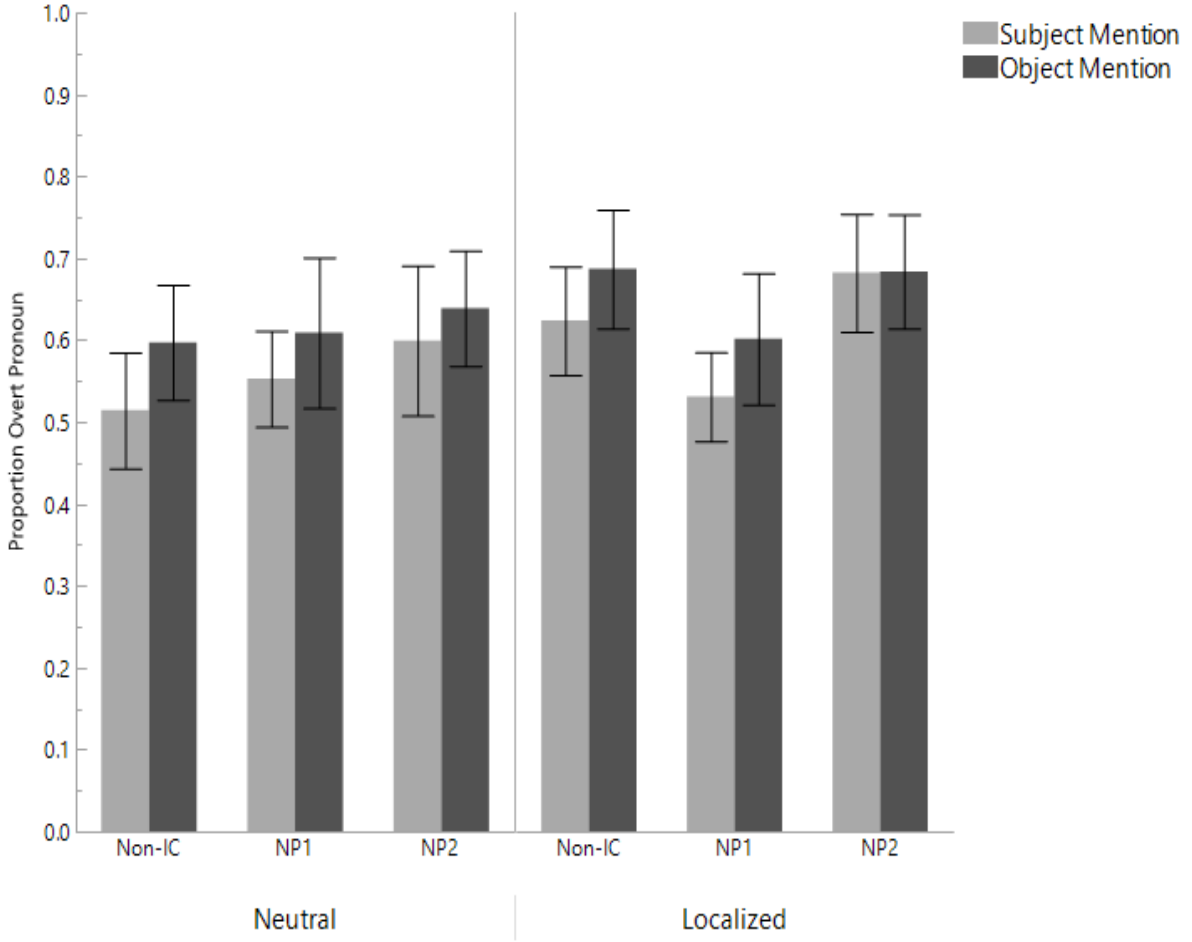

Figure 4.2 Proportion of overt pronoun references as a function of localization condition, verb bias, and next-mention

The analysis revealed a significant effect of localization condition (β=-0.21, p<0.05), with a higher mean proportion of pronouns when referents were localized (64%) than when they were

not (59%).[13] The mean proportion of pronouns was numerically higher for object references (64%) than subject references (58%), but the effect did not reach statistical significance (β=-0.36 p=0.29). With respect to verb types, the mean proportion of pronouns was higher for NP2-biased verbs (65%) and lower for NP1 biased verbs (57%), compared to non-IC verbs (61%). Model comparisons confirmed a significant main effect of verb bias (comparing the full model to a model without a fixed effect of verb bias, p<0.05, 2 d.f.). Pairwise comparisons showed that the effect was driven by differences between NP1-biased and NP2-biased verbs (β= 0.425, p<0.05) and between NP1-biased verbs and non-IC verbs (β=-0.79, p<0.05), with no difference between NP2-biased verbs and non-IC verbs (β=-0.365, p<0.51). The comparison of models differing only in the inclusion of an interaction with the verb bias predictor was not significant (p=0.20, 4 d.f.). Thus, the rate of overt pronominalization is affected by whether or not referents are localized in space, and by verb bias, but not by the grammatical role of the antecedent.

We next compared null pronouns to all other references (overt pronouns, names, other), asking whether null pronouns are affected by bias, localization and next-mention in the same way as overt pronouns. The rate of null pronoun use is shown in Figure 4.3. Analyses revealed a significant effect of next-mention (β=-2.085, p<0.001), with more null pronouns being used for previous subjects (23.6%) than previous objects (6.65%), and no effect of localization condition (β= 0.199, p=0.426)[14]. Model comparisons revealed no main effect of verb bias (p=0.146, 2 d.f.) and no interaction (p= 0.225, 4 d.f.). Thus, the distribution of null pronouns is only affected by the grammatical role of the antecedent.

[13] The maximal model did not converge. The final model excluded random slopes for participants and items.
[14] The final model excluded random slopes for participants and items

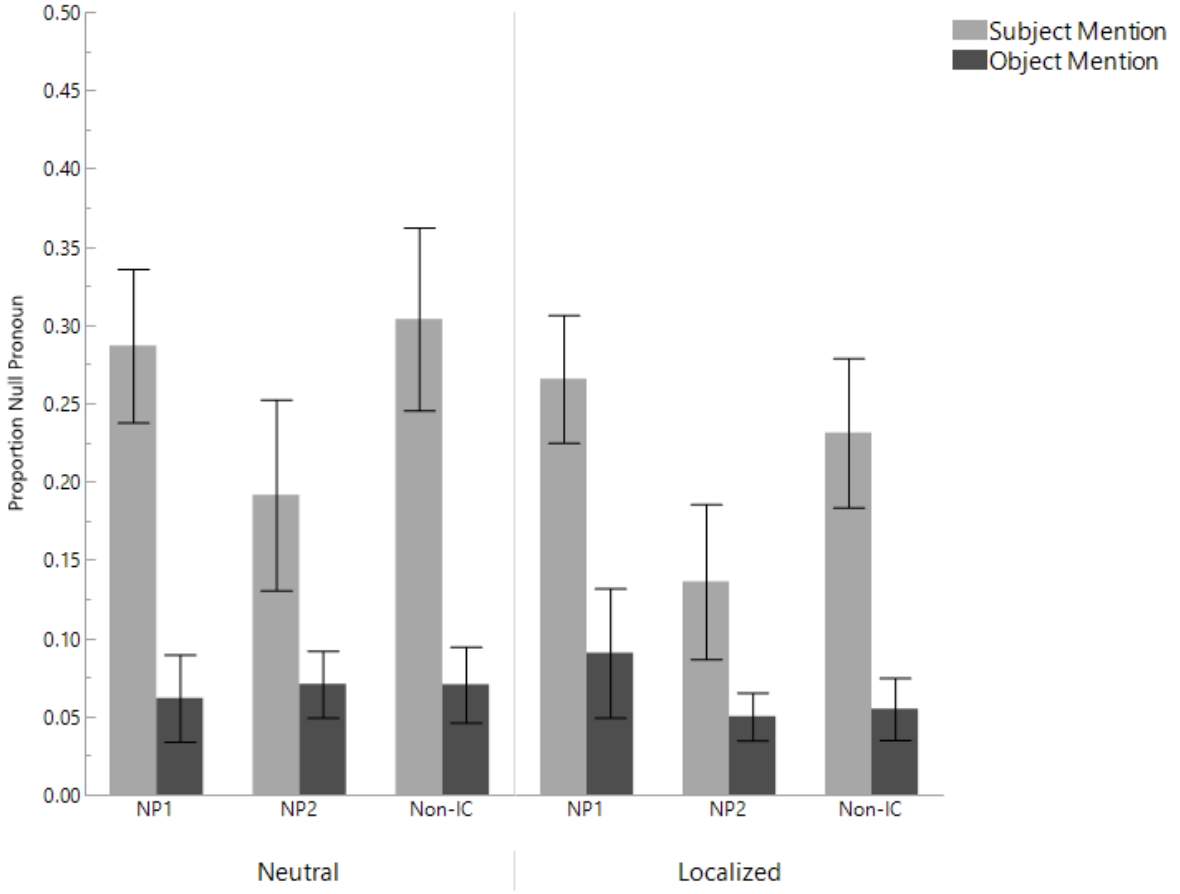

Figure 4.3 Proportion of null pronoun references as a function of localization condition, verb bias, and next-mention

Finally, we analyzed names compared to all other referring expressions. The proportion of name references as a function of bias, localization condition, and next-mention is shown in Figure 4.4. We found a significant effect of next-mention (β=-1.145, p<0.001), with more names for previous objects (28.57%) than previous subjects (16.68%), and a marginal effect of localization condition (β= -0.254, p=0.055), with more names in the neutral (24.44%) compared

to the localized condition (20.82%).[15] Model comparisons revealed no main effect of verb bias (p=0.5, 2 d.f.) and no interaction (p= 0.099, 4 d.f.). Therefore, the distribution of name references is affected by both localization and grammatical role, but not by verb bias.

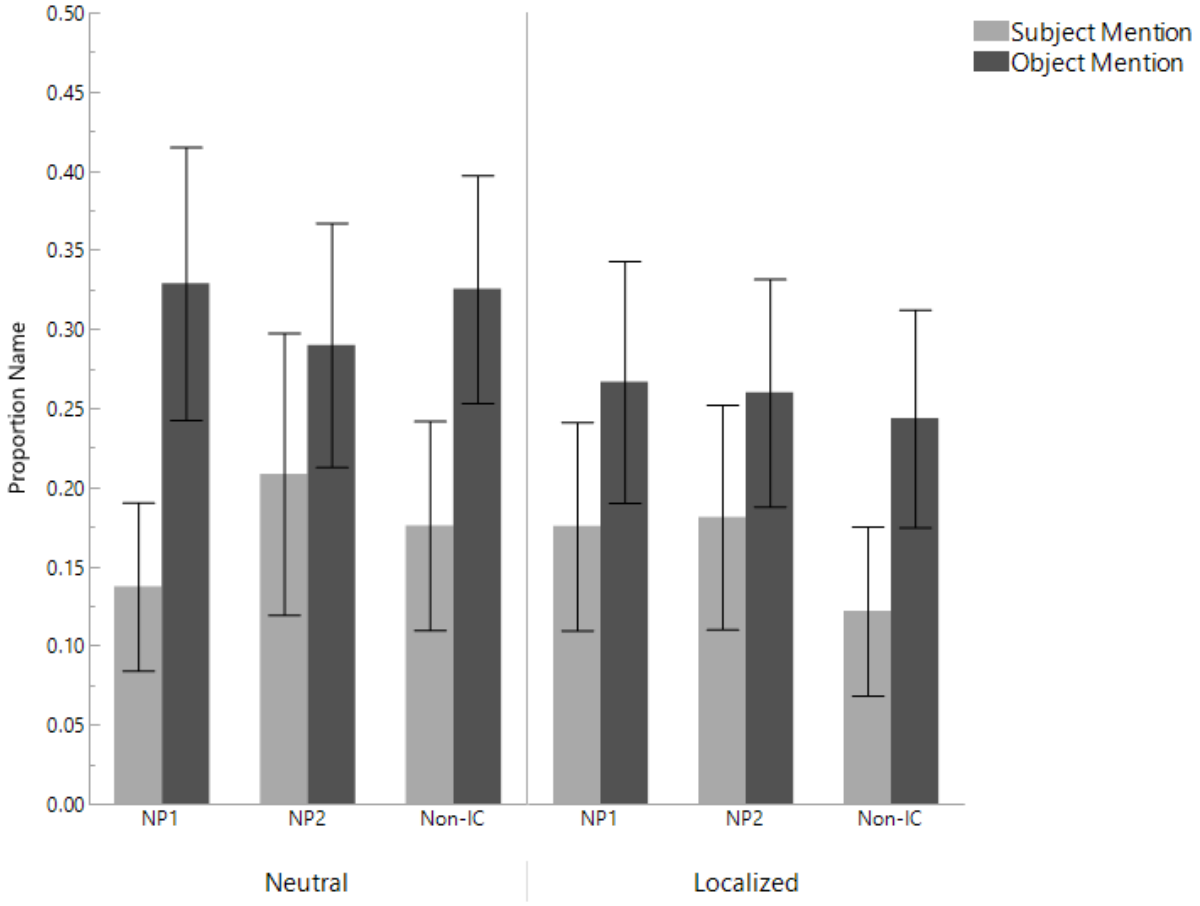

Figure 4.4. Proportion of name references as a function of localization condition, verb bias, and next-mention

Overall, these results show that the presence or absence of spatial referential loci in the context sentence co-determines how signers choose to refer, with overt pronouns being more

[15] The final model excluded random slopes for participants and items

likely when referential loci have been established than when they have not, and names being more likely when referents have not been localized, compared to when they have. Importantly, however, overt pronouns were the preferred referring expression in the localized and neutral conditions. This means that pre-established loci are not required in order for an overt pronoun to be licensed in ASL. These results indicate that signers can create discourse cohesion without using space. Nevertheless, signers prefer spatially localized referents, as shown by the high proportion of localization in both localization conditions, and by signers' frequent addition of localization where it was absent in the prompt. Verb bias also influenced the rate of overt pronominalization. Contexts with NP1-biased verbs led to fewer overt pronouns than did NP2-biased and non-IC verbs. Nevertheless, overt pronouns were the preferred referring expression for every verb type. Finally, the grammatical role of the antecedent also influenced choice of referring expression. While overt pronouns are the preferred referring expression for both subject and object referents, null pronouns are used more frequently for previous subjects than previous objects, and names are used more frequently for previous objects compared to previous subjects.

These results suggest differences in ASL compared to English and other languages in two areas. First, localization is an important predictor of reference type in ASL. This factor does not play a role for spoken language, because, of course, localization is not present in writing or speaking (without gesture). Second, the finding that overt pronouns were used similarly for previous subject and object referents indicates a somewhat different use of pronouns in ASL compared to languages like English and Greek. In these languages, pronouns are specialized for referring to one or the other grammatical role. Stevenson et al. (1994) conducted an experiment in English comparable to the one used here. In their task, participants chose who to refer to and how. Stevenson and colleagues found a preference for using a pronoun to refer back to the

previous subject, and for using a name to refer back to a previous non-subject. Miltsakaki (2007) found that Greek speakers preferred objects as antecedents for overt pronouns. In the present experiment, we did not find such a clear division of labor. Instead, overt pronouns are preferred for both types of referents. The analyses of how names and null pronouns are distributed, however, show that subject and objects are differentiated in by the use of other referring expressions in ASL, with null pronouns and names showing the opposite preferences.

At this point, an intriguing picture emerges of choice of ASL referring expressions. Null pronouns are used for previous subjects and are not affected by verb bias or localization. Overt pronouns are used more in the presence of referential loci and are affected by implicit causality biases, but not by the grammatical role of the antecedent. Names are used primarily for previous objects and are used more in the absence than in the presence of referential loci. Taken together, these findings indicate that on the production side, ASL referring expressions, and especially overt pronouns, are affected by both modality-specific and modality-independent factors. We next examine whether the same set of factors govern how ASL signers resolve overt pronouns.

4.2 Experiment 2

Experiment 2 investigated which factors guide resolution of ASL overt pronouns, and whether this is affected by referents that have been assigned referential loci in the input. Pronoun resolution in English relies on the likelihood that a given referent was the next-mention, together with the probability that the given referent was referred to with a pronoun, as shown by Kehler and colleagues (Kehler et al., 2008, Kehler & Rohde, 2013, Rohde & Kehler, 2014). If localization, when present, is the main driver of pronoun resolution, then we would expect the pronouns in such contexts to be interpreted in accordance with the referential locus they index.

Correspondingly, we would also expect that next-mention bias should not play a role, because spatial co-reference allows for unambiguous pronominal reference. This is similar to gender marking in English when the two potential antecedents are differentiated by gender. In a sentence such as 'Lisa annoys John because he…' we would expect the pronoun to be resolved to 'John' because of the gender marking, despite the fact that 'Lisa' is the referent congruent with the NP1-biased verb.

A key question is how pronouns are resolved in contexts where referents have not been associated with loci but are articulated in neutral space. We hypothesize that such pronouns will be resolved in accordance with the verb bias. Specifically, pronouns should be resolved to the causally implicated referent more frequently than to the non-causally implicated one. Thus, we expect pronouns in the localized condition to be interpreted in accordance with spatial co-reference. In addition, we expect pronouns in the neutral condition, but not the localized condition, to be interpreted in accordance with the verb bias.

Methods

Participants

Fifteen Deaf, native ASL signers (11 female, mean age: 30.4, range: 29-44) participated in the experiment in return for monetary compensation. All had been exposed to ASL from birth by two Deaf parents, except for one participant who whose parents were hearing and learned ASL and whose older sister was Deaf as well. The participants' average ASL self-ratings on a 10-point scale, where 10 indicates the highest level of proficiency, were 9.73 for production and 9.93 for comprehension. All signers were familiar with written English. Their average written English self-ratings were 7.67 for production and 9.27 for comprehension. On average,

participants rated their use of spoken English as 0.64 (where 0 is never and 5 is daily). One additional signer was tested, but their data were excluded, as they did not follow the experiment instructions.

Materials and Procedure

Experiment 2 used the same procedure and the same type of sentence continuation task as Experiment 1. For this experiment, the sentence fragment included a pronoun, e.g. 'NAME-1 VERB NAME-2 WHY? IX…'. Thus, the task is focused on which referent the signer assigned to the pronoun. For the critical stimuli, 72 different verbs were used in the sentence fragment. We used a subset of the verbs from Experiment 1; 24 verbs were NP1-biased, 24 were NP2-biased, and 24 were non-IC verbs. Each group of verbs consisted of an equal number of agreeing and non-agreeing verbs. We also included 24 filler items (e.g. 'CAR WASH WITH'). The signers saw all items both in the neutral condition, and in the localized condition, for a total of 192 items (144 critical stimuli) per signer. The referent names were chosen from a list of 96 fingerspelled English four-letter names (48 typically male and 48 typically female names). Each name occurred once as the subject and once as the object. In the localized condition, we balanced trials in which reference to the subject or the object referent was articulated on the right/left of the signer. We also varied whether the pronoun indexed the referential locus associated with the previous subject or object. The experiment took 30-50 minutes.

Coding, Evaluation and Analysis

A Deaf, native ASL signer transcribed the video recorded responses and coded the next-

mention in the signer's continuation, and the referring expression used for the next-mention.[16] The coder also noted whether and how spatial localization was used in the signer's copy of the prompt. For purposes of reliability, a second Deaf, native ASL signer coded the next-mention from three randomly chosen subjects (20% of the dataset). The two coders agreed on 92.9% of next-mentions (Cohen's Kappa = .89), and on 98.1% of referring expressions (Cohen's Kappa = .97). In cases of disagreement, the first coder's judgment was retained.

Our analyses focused on responses that had a pronoun as next-mention. Excluded were 39.6% of the total data which were primarily continuations starting with: Name = 15.6%, IX+ Name = 13.7%, and Ø = 8.6%.[17] We also excluded 7.8% of the critical trials because no response was given or the signer interpreted the verb differently than intended (2.6%), the next mention was both referents (3.6%), the next-mention was not one of the referents mentioned in the prompt (1.4%), or the response was unclear (0.2%). We then modeled the remaining clear responses (n = 1135) with respect to how localization and verb bias influenced interpretation of the pronoun (as subject or object) using fixed-effect predictors for localization and verb bias, and the interaction between them.

Results and Discussion

As in Experiment 1, we first asked whether signers followed the spatial layout presented in the prompt. Our analysis examined whether the presence or absence of manual referent

[16] In this experiment, we generally use next-mention to mean the referent of the pronoun. However, we included referring expression in our coding because participants sometimes began their continuations with a referring expression other than an overt pronoun.

[17] The excluded responses were distributed as follows: 54% were trials in the neutral condition. Across localization conditions there were more references to the object (58%) than to the subject (42%). The mean proportion of object references was 64% in neutral trials and 53% in localized trials, which is comparable to the distribution in the included data points.

localization was predicted by localization condition (neutral vs. localized). The results showed a significant effect for manual localization by condition (β=1.5584, p<0.001). The mean proportion of manual referent localization was 57% in the neutral condition compared to 82% in the localized condition. We also examined the sole use of non-manual markers to localize referents. In the neutral condition, non-manual localization was present in 29% of the responses compared to 12% in the localized condition. We finally examined the rate of overall localization by adding together manual and non-manual localization. The mean proportion of responses localized either manually or non-manually was 86% in the neutral, and 93% in the localized condition. There was no significant effect of localization condition on the mean proportion of localized responses (β=0.6902, p=0.15).

Based on these analyses, it is not entirely clear that the localization conditions can be differentiated based on use of space. Additional factors may create differences between the two conditions, however. First, signers' interpretation of the pronoun may be influenced by the presence or absence of localization in the prompt, irrespective of how space was used in the signer's prompt copy. We cannot directly determine the effect of this factor. Second, pronouns in the prompts in the localized but not the neutral condition were designed to refer to either the subject or the object independent of the verb type. Thus for the localized trials, we can assess whether signers generally followed the prompt with respect to the intended referent of the pronoun. Across all localized trials, signers resolved the pronoun to the object on average 59% of the time, despite the fact that only 50% of the prompts indicated the object referent.[18] The mean proportion of object mention was 41% in trials where the prompt pronoun indicated the subject, and 78% when it indicated the object. Modeling next-mention with the indicated referent as a

[18] Note here that the mean rate of object mention in the excluded responses was 64%. Therefore, the higher rate of object mentions in the included localized responses was not driven by a high rate of subject mentions in the excluded responses.

centered fixed-effect predictor showed a significant effect of indicated referent (β=2.2615, p<0.001).

To summarize, most of the evidence is in favor of signers following the prompt: the mean proportion of manual localization was significantly lower for the neutral compared to the localized condition, although overall localization was not. The results further show that the referent indicated in the prompt predicted the signers' choice of next mention in the localized condition. In other words, signers largely adopt the reference of the pronoun provided in the prompt. Thus, we include localization as a predictor in the following analyses. The important questions of the potential influence of non-manual localization on trials in the neutral condition, and the overall preference for interpreting pronouns as objects, despite the equal distribution in the prompts, will be taken up in the discussion below.

For our main analysis, we first asked whether pronoun resolution (to the subject or object referent in the previous clause) varied as a function of localization condition and verb bias. As discussed above, the prompts in the localized condition were designed such that the pronoun, by virtue of spatial co-reference, referred unambiguously to the object in half the trials and to the subject in the other half. If localization is the primary factor in pronoun resolution, we would expect similar rates of subject and object next-mentions in this condition, keeping in mind that the prior analysis showed pronoun assignment to be 59/41% to the object/subject referent instead of 50/50%. The hypothesis here is that pronouns in the localized condition would be resolved without reference to verb bias. In the neutral condition, by contrast, no spatial co-referential information was provided in the prompt. Consequently, we expected signers would resort to resolving the pronoun in accordance with the next-mention bias, that is, to the subject in NP1-biased trials and the object in NP2-biased trials. This hypothesis predicts an interaction between

localization and verb bias. Figure 4.5 shows how pronouns were resolved across verb types and spatial conditions. For clarity, the following figures show only object mentions. In the analyzed data, pronoun resolution is always a binary choice between subject and object. Consequently, the proportion of subject mention is the inverse of the proportion of object mention.

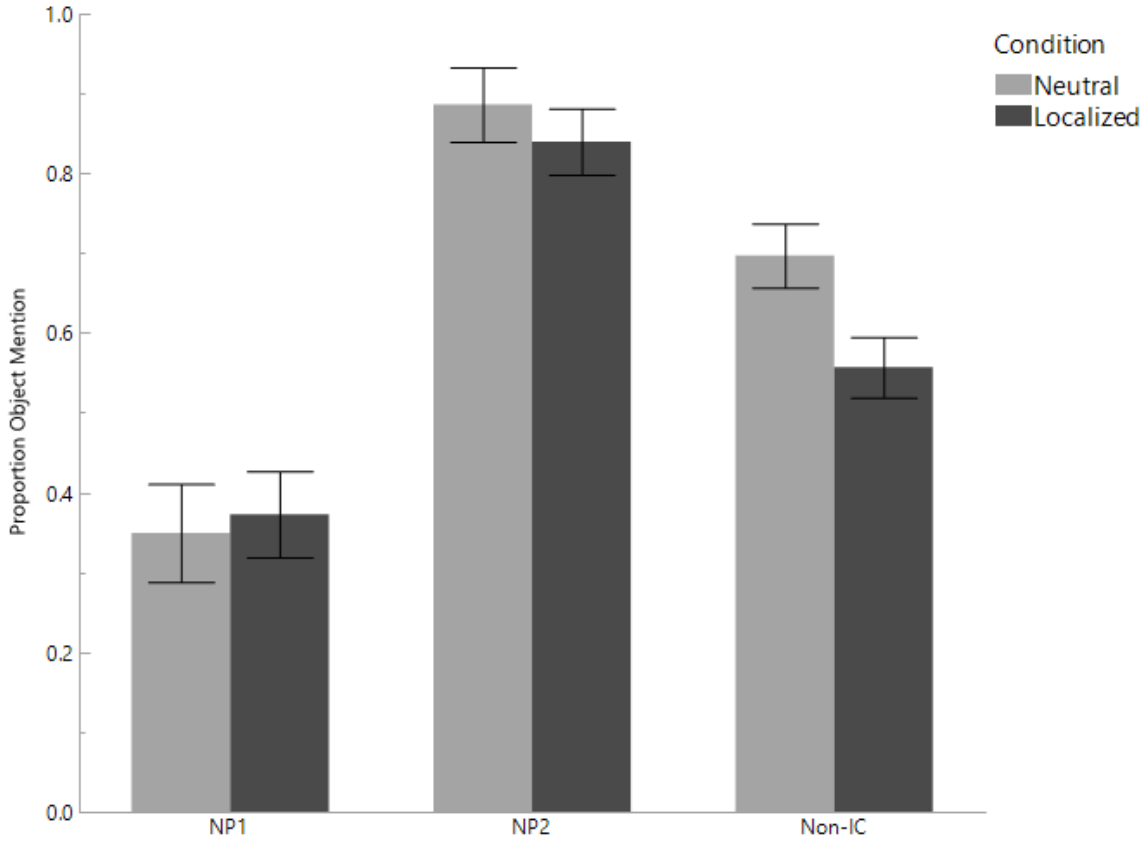

Figure 4.5 Proportion object mention by verb bias and localization condition

Across verb types, the rate of object pronominalization was 64% in the neutral and 59% in the localized condition with no main effect of spatial condition (β=-0.30, p=0.39). Likelihood-ratio tests revealed verb bias as a significant predictor of next-mention (p<0.0001, 2 d.f.), and no

interaction with localization condition (p=0.68, 2 d.f.). Pairwise comparisons showed differences between all verb types (NP1 vs. NP2, β=-3.201, p< 0.001; Non-IC vs. NP2, β=- 0.885, p<0.01; Non-IC vs. NP1, β=2.328, p<0.001). Signers showed a higher rate of object next-mention in the context of NP2-bias (86%) compared to Non-IC (63%) and NP1-bias (36%) independent of localization condition. The absence of an effect of localization condition could result from signers not clearly differentiating the localized and neutral conditions in their use of combined manual and non-manual localization marking. To rule out this possibility, we conducted an additional analysis of next-mention as a function of localization and verb bias. In this analysis, localized trials were those in which participants' responses (rather than the prompt) contained localization marking. The results were similar to the original analysis. There was no effect of localization (β=0.1711, p=0.79). Model comparisons showed a main effect of verb bias (p<0.001, 2 d.f.), and no interaction between verb bias and localization (p=0.25, 2 d.f.).

Given that verb type is now established as a significant predictor for next-mention, we finally asked to what extent next-mention in the localized condition was influenced by bias incongruency. Half the prompts with an IC biased verb contained a pronoun indexing the referent that was incongruent with the bias, that is, the subject in an NP2-biased context, and the object in an NP1-biased context. To answer this question, we examined how (in)congruency influenced choice of next-mention for NP1 and NP2-biased verbs. The mean proportion of object next-mention elicited by NP1-biased verbs was 39%, compared to 85% by NP2-biased verbs. The mean rate of object mention was 14% in congruent NP1-biased trials, that is, when the prompt indicated the subject. This was compared to 65% object-mention in incongruent NP1-biased trials, that is, when the pronoun indicated the object. For NP2-biased verbs, the mean rate was 72% object-mention in incongruent trials, that is, when the prompt indicated the subject. The

mean rate of object mention was 99% in congruent trials, that is, when the pronoun indicated the object (Figure 4.6). We modeled next-mention with indicated referent (again centered), verb bias and their interaction as fixed effect predictors.[19] Results showed a main effect of indication (β= 3.7007, p<0.05). Likelihood-ratio tests showed a main effect of verb bias (p<0.0001, 2 d.f) and no interaction between verb bias and indicated referent (p=0.1563, 2 d.f). It is noteworthy that the bias towards the object is stronger in ASL comprehension than the bias towards the subject: congruent trials lead to the causally implicated referent being mentioned in 99% of NP2 biased

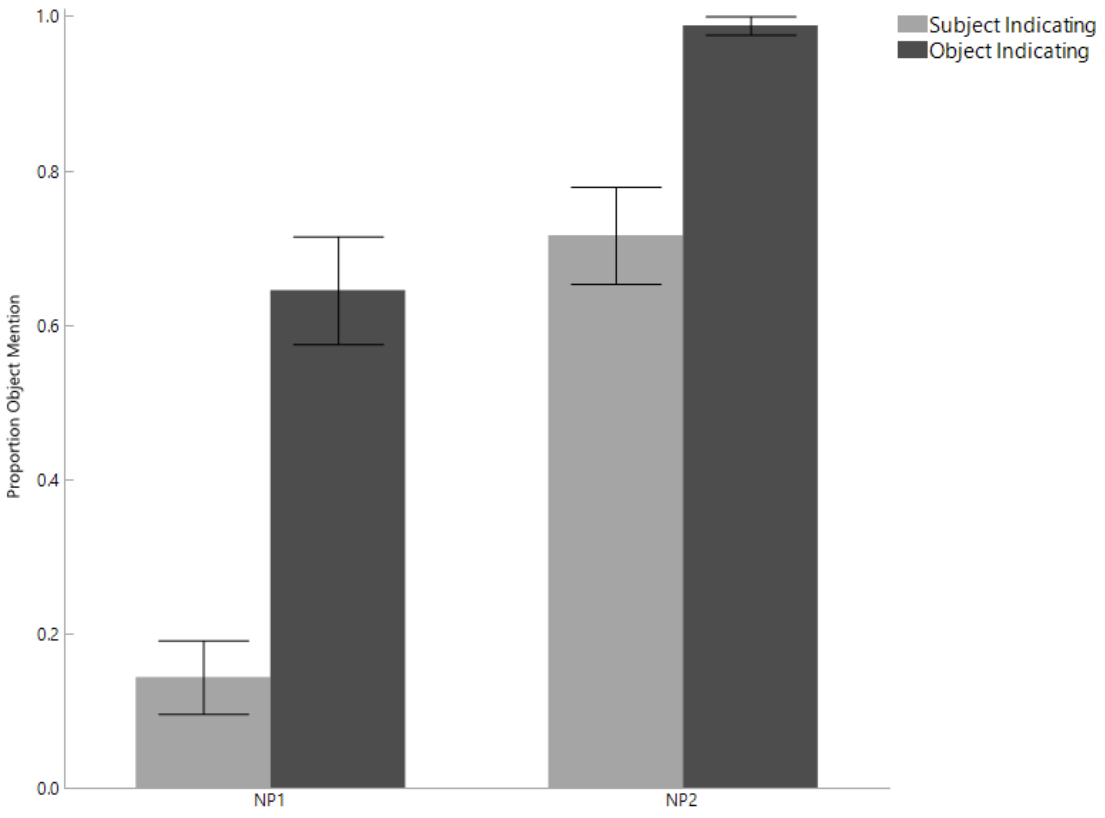

Figure 4.6 Proportion object mention in localized trials as a function of verb bias and indicated referent

[19] Both fixed effects varied within subject, with random slopes and intercepts; only indicated referent varied within items, and item effects were pruned to include random intercepts only.

contexts, compared to 86% of NP1-biased contexts. At the same time, the reduction in references to the causally implicated referent in incongruent trials is larger in NP1-biased contexts (reduced by 51 percentage points, from 86% to 35%) compared to NP2-biased contexts (reduced by 17 percentage points, from 99% to 72%). These results indicate that seeing a pronoun indexing the object locus had a stronger effect than seeing one indexing the subject locus. This suggests an overall preference towards interpreting a pronoun as the object referent.

Thus, our hypotheses of a main effect of localization and an interaction between localization and verb bias were not confirmed in the context of pronoun resolution in ASL. Considering how frequently signers localized referents in space in neutral prompts, the results indicate, in part, that the absence of a main effect of localization arises from the two conditions sharing a high rather than a low rate of localization. Therefore, in both localization conditions, the observed pattern replicates what has been reported for spoken language, namely that verb bias guides pronoun interpretation: the pronoun is more likely to be interpreted as the causally implicated referent than the non-implicated one. Nevertheless, signers were sensitive to the spatial co-reference information in the sentence fragment in localized trials. Their interpretation of the pronoun was influenced not only by verb bias, but also by the indicated referent in the prompt. Signers were the most likely to resolve the pronoun to the causally implicated referent when that referent was also the one indicated by the prompt. By comparison, a conflict between the indicated referent and the causally implicated one elicited less reference to the causally implicated referent. Thus, we find similar rates of object mention when we compare next-

mentions in NP1-biased contexts where the prompt indicated the object with NP2-biased contexts where the prompt indicated the subject.

Overall, these findings are remarkable. First, given the focus in the literature on the influence of referential loci, it is unexpected to find any influence of verb bias in ASL pronoun resolution. In addition, the results from the localized condition are noteworthy because they suggest that, although signers are sensitive to the co-reference pattern provided in the prompt, they frequently disregard it in order to achieve congruency with the verb bias. While a complete analysis of the strategies that participants employed to accomplish this is beyond the scope of the present paper, a brief discussion is in order.

1) ht-L
#JILL VIDEOPHONE #JADE WHY
IX-R WANT MAKE PLAN FOR WEEKEND

#JILL **VIDEO-CHAT-TO** **head-tilt-L** **#JADE**

IX-R

A limited examination suggests two different strategies were used to achieve congruency between prompt and bias. In Example 1), Participant_9 signed '#JILL VIDEOPHONE #JADE

WHY? IX-R WANT MAKE PLAN FOR WEEKEND', 'Jill video-phoned Jade because she (Jill) wanted to make plans for the weekend'. Here, the participant localized #JADE to the left by using a subtle head-tilt towards the left (ht-L) at the end of the verb and the beginning of #JADE. Her continuation then started with a pronoun indexing her right side.In the prompt, #JILL was located left and #JADE right, and the pronoun was spatially co-referential with #JADE, the object antecedent. The verb, 'VIDEO-CHAT-TO', however, is NP1-biased. Thus, by localizing #JADE left, the signer reversed the referential loci in the prompt, from #JILL-L and #JADE-R to #JILL-R and #JADE-L. In this way she achieved congruency between the pronoun (now indexing #JILL, the previous subject) and the NP1-biased verb 'VIDEO-CHAT-TO', at the cost of switching the referential loci compared to the sentence-fragment. In another example, the same signer instead faithfully copied the referential loci from the prompt ('#SEAN-R R-KISS-L #HOPE-L WHY? IX-L…') using verb agreement marking, but then changed which locus the pronoun was directed towards: '#SEAN R-KISS-L #HOPE WHY? IX-R LOVE IX-L', 'Sean kissed Hope because he loves her'. Thus, signers frequently disregarded or modified the spatial and co-referential setup of the prompt when doing so avoided incongruence between pronoun and verb bias.

4.3 Does Seeing a Pronoun Bias Signers towards Object Next-Mention?

We finally asked whether the presence of a pronoun makes signers more likely to mention a given referent next, as has been found for speech (Stevenson et al., 1994; Rohde & Kehler, 2014). In English, a pronoun can increase the rate of subject mentions with up to 35.2 percentage points (Rohde & Kehler, 2014). In the present study, we have seen more association of pronouns with objects than subjects (i.e. the mean rate of pronoun reference for objects vs.

subjects in Experiment 1 was 64% vs. 58%; and in Experiment 2, the overall rate of object next-mention was 59%). We consequently expected that any effect resulting from seeing a pronoun would be towards more mentions of the object. We conducted a comparison between Experiment 1 and Experiment 2, using the data from each experiment containing the same verbs. The data from Experiment 2 (1135 data points) all had pronoun prompts, and the data from Experiment 1 (1965 data points) all had free prompts.

Figure 4.7 shows the rate of object mention across verb types and localization conditions. We modeled the choice of next-mention with verb bias and localization as within-subjects fixed effect predictors and prompt type as a between-subject fixed effect predictor. As before, two-level variables (localization and prompt type) were centered, and verb bias was sum-coded.

The model showed no effect of localization condition on next-mention (β=-0.225, p=0.10), despite a higher rate of object-mention in the Neutral (61%) compared to the Localized (56%) condition. As before, likelihood-ratio tests showed a main effect of verb bias (p<0.001, 2 d.f.). We found no evidence of an interaction between prompt type and verb bias (p=0.156, 2 d.f). Pairwise comparisons showed significance for all verb type combinations (NP1 vs. NP2: β=-3.089, p<0.001, NP1 vs. non-IC: β=- 1.925, p<0.001, NP2 vs. non-IC: β=-1.164, p<0.001).

Prompt type was marginally significant in the model (β= 0.507, p=0.06), with pronoun prompts being associated with higher rates of object next-mention than free prompts in all verb bias contexts, in the neutral (35% vs. 28% for NP1-biased verbs, 89% vs. 83% for NP2-biased verbs, and 70% vs. 59% for non-IC verbs) as well as in the localized condition (37% vs. 24% for NP1-biased verbs, 84% vs. 83% for NP2-biased verbs, and 56% vs. 51% for non-IC verbs). This is despite the fact that the proportion of object reference in the localized condition in Experiment 2 is likely to be reduced due to the effect of the indicated referent in the prompt.

Thus, the comparison of prompt type suggests that ASL signers in fact prefer pronominalizing the object over the subject, although this grammatical role preference is by no

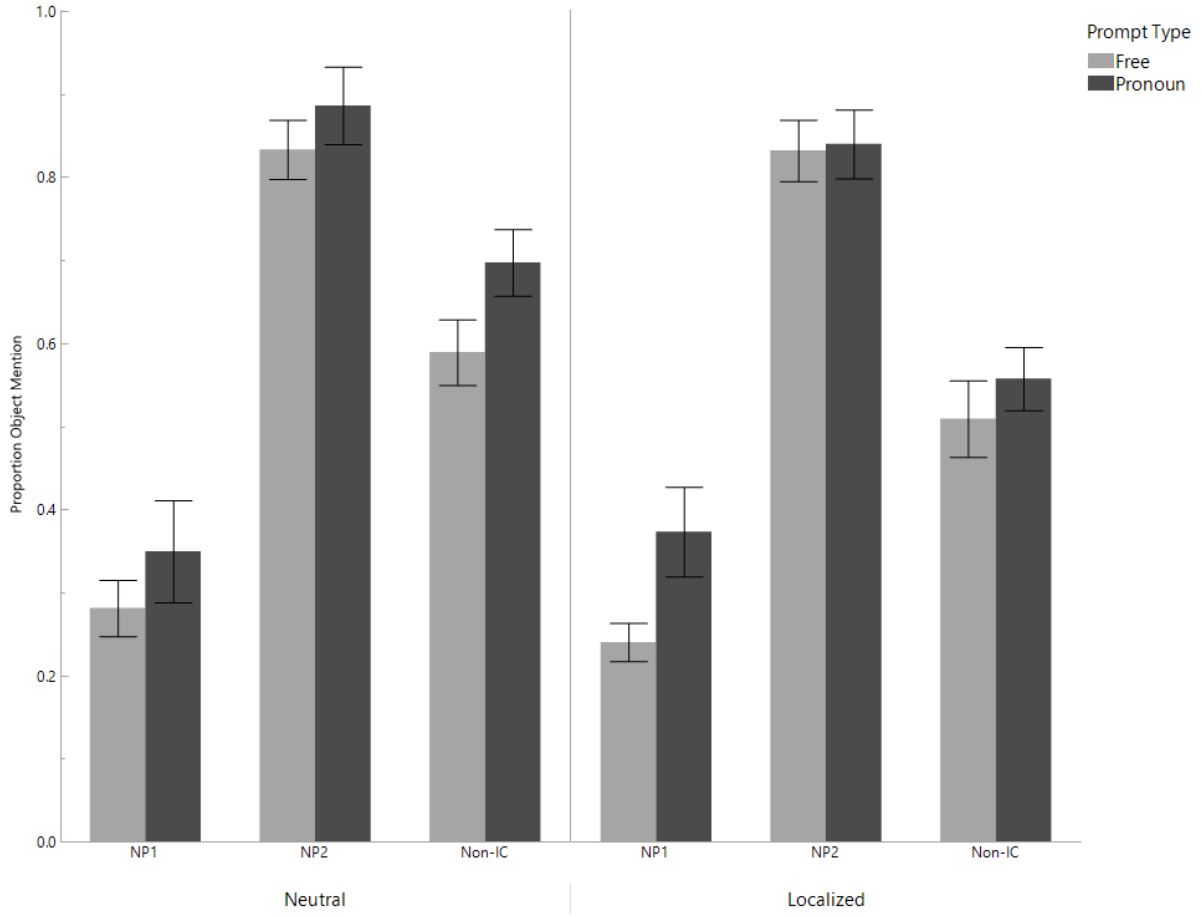

Figure 4.7. Proportion object mention as a function of prompt type, verb bias, and localization condition

means as clear as the subject preference is in a language like English. The existence of this preference is supported by the numerical production and comprehension results: while the effect of next-mention was a not statistically significant predictor of choice of referring expression in Experiment 1, signers used numerically more pronouns for object references (64%) than subject

references (58%), and when resolving pronouns in Experiment 2, signers chose the object referent at a rate of 59%.

5 General Discussion

The present study garnered the first evidence that ASL pronouns are subject to modality-independent as well as modality-specific influences. Unlike spoken language pronouns, ASL pronouns are thought to be unambiguous in the context of spatial co-reference. We asked how the availability of space as a resource influences how signers use and understand pronouns, and how this interacts with grammatical and sematic/pragmatic factors known to influence pronouns in spoken languages. Here we discuss what our results suggest about ASL pronouns as a system, where ASL is situated typologically among other languages, and how our findings inform models of pronominal reference.

5.1 Factors Affecting ASL Pronouns

Overall, the present results showed ASL overt pronouns are constrained by modality-specific influences, such as spatial localization, as well as modality-independent influences, such as grammatical role and verb bias. Our findings revealed an effect of verb bias that is present in production and more strongly in comprehension of ASL overt pronouns. The effect of verb bias was the same across localization conditions. For production, we found that more pronouns were produced in the context of NP2-biased verbs than NP1-biased verbs. However, as pronouns were the preferred referring expression across all verb type contexts, the effect is not one of a prevalence of pronouns vs. of other referring expressions, but rather of the strength of the pronoun preference. In comprehension, verb bias was an important factor for predicting whether

a pronoun would be resolved to the subject or object. The effect was the same independent of whether referents were localized in space or not.

We also found a limited effect of grammatical role on ASL pronouns. Signers numerically favored previous objects as referents in their production of pronouns. Similarly, they preferred to interpret pronouns as referring to previous objects. Evidence for this came from a numerical preference in the comprehension task, and from the fact that forcing continuations to begin with a pronoun led to more continuations about the object than the subject compared to free continuations.

It has been proposed that ASL indexical points may not be personal pronouns, but rather demonstratives (McBurney, 2002, 2004; Koulidabrova & Lillo-Martin, 2016). On the one hand, the findings from the present study would appear to support this conclusion, since, as we will see below, the preference of the ASL overt pronoun is similar to what has been found for spoken languages demonstratives. On the other hand, in languages with both personal and demonstrative pronouns, demonstratives often exhibit a strong object bias, whereas the preference of personal pronouns is less pronounced, although often for the previous subject (Kaiser, 2013). The fact that the ASL preference is relatively weak would support the conclusion that overt pronouns should not be considered demonstratives. Another possibility is that the object preference of the overt pronoun is actually stronger in ASL than the present study suggests. In our experimental design, pronouns in localized trial prompts were designed to refer to previous subjects and objects equally often. In the absence of experimental manipulation, ASL overt pronouns might show a stronger preference for object antecedents.

Previous work on ASL null pronouns in narratives (Wulf et al., 2002) has shown that while null pronouns are more frequent than overt pronouns in all grammatical contexts, the

proportion of null pronouns is higher when they are co-referential with the subject of the preceding verb than when they are not. The present results showed overall more references to previous subjects with overt than with null pronouns, but similar to previous work it also showed that signers' production of null pronouns is affected by grammatical role, that is, participants used comparatively more null pronouns for subject than for object antecedents. As other studies of ASL have found a prevalence of null reference in narratives (Swabey, 2002, 2011; Frederiksen & Mayberry, 2016; Reynolds, 2018), we attribute this difference to discourse genre, narrative vs. short unconnected discourses. Narratives are characterized by frequent use of constructed action, that is, stretches of discourse where the signer "takes on" the role of a character from the narrative and uses their body to represent what that character said or did (see Lillo-Martin, 2012 for an overview of constructed action). Possibly due to the rich referential context that this provides, null pronouns are preferred over overt pronouns in connection with constructed action (Wulf et al, 2002). Constructed action is less likely to occur in short discourses with multiple referents, because they afford limited opportunity to focus on one character. This may account for the lower frequency of null pronouns in the short discourses of the present study compared to that of Wulf et al. (2002).

Returning to overt pronouns, we found effects of referent localization in both production and comprehension. Past research in ASL has focused on how pronoun interpretation is affected by space. Extending the scope of this question into the effects of space on pronoun production is a major contribution of the present study. We find that signers produce more overt pronouns in localized contexts than neutral ones. Although descriptions of ASL overt pronouns in previous work have led to the implicit assumption that successful pronominalization hinges on the pre-establishment of referential loci, the present study is the first to provide evidence that the rate of

pronominalization is affected by the presence or absence of spatial referential loci. Crucially, however, the absence of referential loci did not result in an avoidance of pronouns in favor of other referring expressions, but rather in a weaker pronoun preference. Thus, results show that ASL overt pronouns can be used in the absence of referential loci. This means that ASL overt pronouns are, at least in some contexts, semantically underspecified, as are spoken language overt pronouns.

Our results further show that spatial co-reference contributes to comprehension of overt pronouns. Although there was no effect of the presence or absence of spatial referential loci in the prompt, the fact that the referent indicated by the prompt was a significant predictor of pronoun comprehension suggests that signers used spatial co-reference information in their interpretation of the pronoun. Additional evidence for the influence of spatial co-reference comes from the fact that signers regularly marked localization, even when the prompt they were copying did not include it. This was true for the production and comprehension experiments, with signers applying (manual or non-manual) localization to more than 60% of prompt copies in the neutral condition in Experiment 1, and to over 80% in Experiment 2. It is noteworthy that the lack of a main effect of localization condition in Experiment 2 is due to the two conditions sharing a high rather than a low rate of localization. This means that signers added spatial marking to responses in the neutral condition, and not, as one might have thought, that they failed to include spatial marking in responses in the localized condition. Also noteworthy is the finding that signers' responses differed in the two conditions with respect to reliance on manual versus non-manual marking. Non-manual marking is subtle, and signers may be less conscious of it. If so, the greater proportion of non-manual marking in the neutral condition may suggest that signers were sensitive to the task instructions, and followed them by limiting manual

localization when it was absent from the prompt.

Interestingly, there was a difference between the proportion of localization in the production vs. the comprehension data. We speculate that the smaller proportion in the production experiment may parallel the tendency to pronominalize the subject in English. Producers use this strategy, regardless of whether the resulting utterance contains an ambiguous pronoun or not (Rohde, 2008; Rohde & Kehler 2014). The reduced use of localization in the ASL production data corresponds to a greater proportion of ambiguous pronouns. From this perspective, the difference in proportion of localized trials in the comprehension compared to the production data can thus be interpreted to indicate a dissociation between the processes involved in production and comprehension of ASL pronouns.

Although signers were sensitive to the spatial co-reference information supplied in the prompt, we also observed that they regularly changed the reference of the pronoun in order for their utterance to be congruent with the verb bias. They accomplished this by producing modifications to the prompt's referential loci, or by changing which referential locus the pronoun indexed. Therefore, these modifications generally did not lead signers to disregard spatial co-reference.

Signers were able to produce such modifications because they were asked to copy the prompt before providing their continuation. As explained above, we adopted the prompt replication procedure for a variety of reasons including ensuring that signers were sufficiently familiar with the initial sentence fragment, and that their pronominal references were interpreted based on the spatial framework they adopted. At the same time that our procedure served this purpose, it also enabled signers to modify the spatial setup in the prompt, which limited control of localization and of intended referent in the present study. While future studies will need to

replicate this result without the prompt copy, it is nevertheless important to emphasize that signers' modification of the prompt is in itself a significant source of evidence for the importance of verb biases for ASL pronouns. This is so because the modifications occurred mainly when the indicated referent was incongruent with the verb bias.

Findings from ERP and self-paced reading studies help contextualize the participants' tendency to rearrange space to achieve congruency between pronoun and verb bias. As discussed in the introduction, previous work shows that listeners' and readers' processing is affected when the pronoun is incongruent with the verb bias. Similarly, Rohde (2008) found that verb bias-pronoun incongruency led to a reduction in the proportion of the preferred coherence relation in sentence continuations. In her study, the incongruency between pronoun and verb bias was achieved by using a male and a female referent and a gendered pronoun. The pronoun reference in Rohde's experiment was therefore unambiguous, just like localized pronouns in ASL. Rohde's experiment, however, did not contain a connective (e.g. because), which forces an explanation relation. Unlike the participants in the present study, her participants were therefore able to resolve the incongruency between the pronoun and the coherence relation by changing the coherence relation.[20] In the present experiment, participants instead resorted to changing the reference of the pronoun in order to achieve bias-pronoun congruency. However, the similarity between the results of these studies shows that English and ASL share a dispreference for incongruent pronoun-coherence relations. The results also suggest that the two languages differ in how verb bias-pronoun incongruence can be resolved. Future studies will have to confirm whether this is in fact the case.

Finally, most studies of pronouns and coherence relations have been conducted in the

[20] It is also noteworthy that the idea that participants might misinterpret the pronoun was not entertained as an option in Rhode's (2008) study, and indeed studies show that English speakers use gender marking as a cue for pronoun resolution when it is available (e.g. Crawley et al., 1990; Arnold et al., 2000).

written version of a spoken language (with exceptions, such as Arnold, 2001, and particularly eyetracking and ERP studies, e.g. Arnold, Eisenband, Brown-Schmidt & Trueswell, 2000; van Berkum et al, 2007; Järvikivi et al., 2017). Conducting experiments in writing is not an option for sign language research, so future research should aim to tease apart the extent to which variation in results across languages is a result of methodological differences in using writing vs. speaking/signing.

5.2 ASL Pronouns in a Typological Perspective

Some properties of ASL pronouns are attributed specifically to the visual-manual modality. Aside from these, however, ASL appears to be typologically similar to languages like Greek and Finnish.

We hypothesized that ASL overt pronouns would favor object antecedents, because of the tendency for null pronouns to favor subject antecedents. It is important to note, however, that languages with different types of pronouns do not necessarily exhibit a complementary distribution (known as *division of labor*, e.g. Carminatti, 2002) between forms as a function of grammatical role or other factors. For example, previous comprehension studies of Korean and Japanese report that null as well as overt pronouns are subject-biased (Kim et al., 2013; Ueno & Kehler, 2016). However, a preference for having overt pronouns refer to object antecedents has previously been found for written Greek (Miltsakaki, 2007). Greek, like ASL, allows null subjects, and the Greek free overt pronoun is considered a demonstrative. Given recent proposals that ASL indexical points may not be personal pronouns, but rather demonstratives (McBurney, 2002, 2004; Koulidabrova & Lillo-Martin, 2016), the comparison with Greek is especially relevant. Greek null subjects must pick out the most salient antecedent, while strong pronouns

must pick out a non-salient antecedent (Miltsakaki, 2001). Subject antecedents are usually considered more salient than object antecedents. As discussed above, previous work on ASL pronouns has shown a similar tendency. The proportion of null pronouns in ASL is greater for subject antecedents and reduced for object antecedents in favor of overt pronouns. Thus, ASL and Greek share a number of properties of the pronominal reference system. Miltsakaki (2007) found an overwhelming preference for interpreting a demonstrative pronoun as referring to the previous object in agent-patient sentences. Her study showed an increase in object reference of 43 percentage points between free continuations and pronoun prompt continuations. By comparison, the present study found an increase in object mentions of 11 percentage points between free continuations and pronoun prompt continuations in the context of non-IC verbs. Non-IC verbs provide the best comparison to Miltsakaki's agent-patient structures because agent-patient verbs are not clearly biased in either direction. Despite a smaller effect in the present study, the similarity between these results is clear and suggests that pronoun resolution in ASL is typologically similar to Greek with respect to the effect of grammatical role.

While Greek pronouns are obligatorily marked for gender, the present study included unmarked ASL pronouns. It is informative to draw comparisons to languages such as Finnish which has overt, 3rd person singular pronouns that are unmarked for gender (both personal and demonstrative). Such pronouns are similar to ASL pronouns in contexts without spatially anchored referents.[21] Studies of Finnish suggest that the personal pronoun is preferentially resolved to the subject antecedent (Halmari, 1994; Järvikivi et al, 2005) and the demonstrative is resolved to the object antecedent (Kaiser & Trueswell, 2008). Both pronoun types are resolved to the causally implicated referent in the context of IC-verbs (Järvikivi et al, 2017). Thus, in Finnish

[21] ASL distinguishes null vs. overt (demonstrative) pronouns, while Finnish has a personal vs. demonstrative pronoun distinction

as in ASL, the weaker pronominal option is subject biased (the null pronoun in ASL and the personal pronoun in Finnish), and the stronger option is object biased (the overt pronoun in ASL and the demonstrative in Finnish. Thus, in spite of the modality-specific nature of ASL pronouns, they are subject to many of the same influences that affect pronouns in the oral-aural modality. Consequently, ASL pronouns are typologically similar to pronouns in languages such as Greek and Finnish.

5.3 Implications for Existing Models of Pronoun Production and Comprehension

Studies of different languages have suggested that not all pronouns are created equal. Specifically, pronoun comprehension studies have found variation in sensitivity to grammatical, semantic and pragmatic factors for different pronoun types within and across languages (Kaiser and Trueswell, 2008; Kaiser, 2011; Ueno & Kehler, 2016). In the present study, we observed a strong effect of verb bias on ASL pronoun comprehension. This effect is in line with findings from spoken language research. It is less clear how to interpret the main effect of verb bias on production of overt pronouns. Previous work has mostly found no effect of verb bias on pronoun production (Kehler et al, 2008; Rohde, 2008; Kehler & Rohde, 2013; Rohde & Kehler, 2014; Kehler & Rohde, 2018). According to the strong version of the Bayesian model proposed by Kehler and Rohde, semantic and pragmatic factors influence pronoun comprehension, but not production.[22] The predictions of the model are supported by studies finding effects of verb bias on pronoun comprehension but no main or interaction effects of verb bias on pronoun production (Rohde, 2008; Rohde & Kehler, 2014). However, a study of Mandarin suggests that semantic

[22] It should be noted that where the strong interpretation of the model predicts complete insensitivity to semantic/pragmatic biases on the part of the production bias, the weak interpretation only predicts that pronoun interpretation should follow Bayesian principles.

factors can affect the production of pronouns in spoken languages, too. In a free continuation task, Zhan et al. (2016) found that the main predictor of pronominalization (either overt or null) was grammatical role, with an additional effect of verb bias. NP2-biased verbs elicited more pronouns than NP1-biased verbs.[23] The Mandarin result collapses across null and overt pronouns. In the present ASL findings, the effect of verb bias is observed only on the production of overt pronouns.

The assumption of the Bayesian model that producers are insensitive to pragmatic biases stands in opposition to more traditional accessibility models (e.g. Chafe, 1976; Givon, 1983; Ariel, 1990; Gundel, Hedberg & Zacharsky, 1993), which implicitly hold that pronoun production and comprehension are mirror images of each other. However, despite observing a sensitivity in production to semantic/pragmatic biases, a main effect of verb bias cannot be taken to support the more traditional accessibility models. Neither the results of the present study nor those of Zhan et al (2016) found that pronominalization favored the causally implicated referent, which would be expected if production mirrors comprehension. Rather, there was a reduction in the overall preference for pronouns as referring expressions in NP1-biased contexts (null and overt pronouns combined in Zhan et al., 2016, overt pronouns in the present study). Thus, more work is needed in order to determine the significance of a main effect of verb bias on pronoun production.

6 Conclusion

In two psycholinguistic experiments of pronouns in American Sign Language, we examined for the first time how factors specific to the visual-manual modality and factors that

[23] Similar to the present study, however, this effect did not result in no versus all pronouns, but rather a slightly lower proportion of pronouns in NP1-biased contexts.

exist irrespective of modality jointly influence the production and comprehension of pronouns in American Sign Language (ASL). The specific modality-dependent factor investigated here was the use of spatial referential loci. Sign languages are known to make use of space for reference. In the case of pronouns, the use of space can disambiguate possible pronoun antecedents. This has been assumed to make signed pronouns unambiguous, unlike spoken language pronouns, which are linguistically underspecified. To date, sign language research has not looked beyond such effects to examine how factors that are not specific to the visual-manual modality might affect ASL pronouns. The present study tested the effects of two such factors, namely implicit causality biases and the grammatical role of the antecedent. Our results revealed that ASL pronouns are governed in large part by modality-general factors, such as grammatical role and semantic verb biases. These findings provide evidence that pronoun production and comprehension is similar not only across languages, but across modalities as well.

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Chapter 4, in full, is currently being prepared for submission for publication of all of the material presented here. Frederiksen, Anne Therese & Mayberry, Rachel I. The dissertation author was the primary investigator and author of this material

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CHAPTER 5

General Discussion

1 Overview

This dissertation investigated referential cohesion in American Sign Language (ASL). The goal was to better understand how referential cohesion is shaped by modality-specific and modality-independent factors, and in which linguistic domains these factors exert their influence. Previous work on ASL and other sign languages has primarily been concerned with describing how certain signed referring expressions, such as pronouns and classifiers, differ from expressions in spoken languages. Much less attention has been paid to how factors influencing spoken language referential cohesion affect the same processes in sign languages. The results of this dissertation, however, provide evidence that sign language referential cohesion is highly similar to spoken language referential cohesion.

Different aspects of referential cohesion were explored in the papers presented in Chapters 2-4. Three experimental studies looked at global (Chapter 2) and more local (pronoun production and comprehension) cohesion (Chapter 4) and explored how modality might influence referential cohesion beyond the actual production and comprehension of referring expressions (Chapter 3).

Chapter 2 showed that signers, like speakers, are systematic in their choice of referring expression, choosing more or less specific expressions as a function of referent accessibility. A deviation from expectation was the behavior of null arguments of classifier predicates. These zero anaphora were only used for the most accessible referents. This was despite classifiers containing more information about the referent, compared to zero anaphora from other predicates, which were used for both more and less accessible referents.

Chapter 3 documented for the first time that implicit causality (IC) biases exist in ASL. Implicit causality verbs are known to affect referential cohesion in spoken language. Specifically, comprehenders tend to resolve ambiguous pronouns in line with the IC bias. Bias direction, in turn, is based on realization of thematic roles in many verbs. Because the visual-manual modality has been assumed to restrict how thematic roles can be realized in lexical verbs in ASL, we hypothesized that the distribution of IC biases would be affected accordingly. While the findings of Chapter 3 confirmed a somewhat different distribution of biases in ASL compared to English, there was limited support for modality-specific constraints as the cause of this effect.

Finally, Chapter 4 presented the first evidence that modality-independent factors are as important as modality-specific ones for pronoun production and resolution in ASL. While contexts with clear spatial co-reference led to a higher rate of pronoun use compared to contexts with no spatial co-reference, pronouns were preferred over other referring expression in all contexts. When resolving pronouns, ASL signers primarily relied on IC biases, with additional influences from spatial co-reference and, to a lesser degree, the grammatical role of the antecedent.

Taken together, the work presented in this dissertation extends our understanding of referential cohesion in sign languages generally, and ASL specifically. The results show that the factors influencing a sign language like ASL are overwhelmingly similar to those at work in spoken language referential cohesion. The findings also emphasize that surface-differences between signed and spoken languages frequently result from language-specific rather than modality-specific variation.

The following offers a general discussion of the findings in the dissertation, as well as

concluding remarks and suggestions for future research. The general discussion discusses and contextualizes findings related to choice of referring expression first, and related to pronoun comprehension second. The discussion of choice of referring expression incorporates findings from Chapters 2 and 4. The discussion of pronoun comprehension incorporates findings from Chapters 3 and 4.

2 Choice of Referring Expression

There are several reasons why choice of referring expression for the purposes of referential cohesion might look different in a signed compared to a spoken language. As in many other domains of linguistics, existing theories and models were built on work in only a few spoken languages. Consequently, it is not always clear how such models can account for referential cohesion when it occurs outside of the spoken modality.

In the case of ASL, some referring expressions seem vastly different from those found in speech. For example, ASL pronouns might be used differently than spoken language pronouns. Whereas spoken language pronouns are referentially underspecified and require reference to the context to be interpreted, ASL overt pronouns can be fully specified. This is possible because their use of space allows them to uniquely identify their referent. This means that ASL pronouns could occur in different referential environments than spoken language pronouns. An overt pronoun that indexes a referential locus and thus uniquely identifies its referent could be used in ASL where users of other languages may resort to a more specific expression like a nominal instead. Conversely, an ASL overt pronoun that does not index a referential locus could be infelicitous, and therefore overt pronouns might not be used in the absence of referential loci. In

both of these cases, whether a pronoun is used or not would appear to depend on space, which is a factor specific to the visual modality.

Another example of a referring expression that is unique to sign languages is classifiers. ASL classifier predicates are verbal in nature and can therefore be used with null pronouns in ASL. Unlike other predicates, however, classifiers represent a salient characteristic of the referent in a visible manner. Consequently, they might be used with null arguments in contexts where null arguments of other predicates may be underspecific. It is not clear where classifiers fit into referential hierarchies, such as the accessibility hierarchy (Ariel, 1990). Because of their unique way of linking form and meaning, they could be used in a manner similar to overt pronouns, rather than zero anaphora.

These differences between sign and speech outlined above raise the question whether approaches such as the accessibility hierarchy are able to account for choice of referring expression in ASL. The main contribution of Chapter 2 of this dissertation is to show that, for the most part, ASL referring expressions behave in line with referential hierarchies. Specifically, signers use more informative expressions when referents are introduced (and thus new), and less informative ones for given referents. Additionally, by examining a wide range of referring expressions, this study also discovered surprising patterns that were not predicted by the referential hierarchies. Most notably, classifier predicates were used exclusively with referents that were highly accessible, despite their high degree of informativeness. In addition, signers used very few pronouns in their narratives. Given previous work showing that pointing signs are very frequent in sign languages (Morford & McFarlane, 2003; McKee & Kennedy, 2006; Johnston, 2012; Perniss & Özyürek, 2015), this finding was unexpected.

Infrequent pronoun use could be a language-specific strategy in referential cohesion. For

example, Clancy's (1980) findings from Japanese showed a very low proportion of pronouns in narratives. Thus, it could simply be that languages like ASL and Japanese have pronouns, but prefer nouns and null pronouns in their stead in narratives. However, we argue in Chapter 2 and Chapter 4 that the low proportion of pronouns should instead be attributed to the specific genre the data were based on. In narratives, signers often avail themselves of constructed action, that is, using their articulators to show what an entity did or how they acted. In this context, we found that signers used role-shifting, i.e. body-leans and body rotations to indicate spatial loci, as a way of indicating the referent. Arguably, this strategy achieves the same referential clarity as using a pronoun. This raises the possibility that pronouns serve an important function in ASL referential cohesion in general, but that their function is fulfilled by role-shifting in ASL narratives. Support for this possibility comes from Chapter 4, which found pronouns to be the preferred referring expression in short discourses, for both subject and object antecedents. Thus, pronouns in fact play an important role in ASL referential cohesion.

A particular contribution of Chapter 4 was the finding that that choice of referring expression is impacted by a modality-specific constraint on overt pronouns. When no referential loci were established, signers used fewer overt pronouns. Past work has described overt pronouns in a way that lead to the expectation that pronouns are infelicitous when referential loci are absent. However, the present work is the first to explicitly articulate this hypothesis and to investigate this assumption. That signers' choice of referring expression is affected by how space is used at the beginning of the discourse is unexpected from the point of view of theory based on spoken language and should be taken into account in future models of referential cohesion.

The production study in Chapter 4 also answered a question that was not addressed in Chapter 2, namely how the grammatical role of the antecedent affects choice of referring

expression. The results showed that null pronouns preferred subject antecedents, overt pronouns numerically preferred object antecedents. This means that in the context of short discourses, ASL overt pronouns are in mostly complementary distribution with null pronouns. The preference for object antecedents constitutes more evidence that ASL referential cohesion is different from Japanese. The two languages are similar in preferring null to overt pronouns in narratives, but where ASL pronouns show a slight preference for object antecedents, Japanese overt pronouns have been shown to prefer subject antecedents (Ueno & Kehler, 2016). Japanese null pronouns also prefer subject antecedents. Thus, in Japanese there is no clear division of labor between the two forms with respect to grammatical role as there is in ASL.

Finally, Chapter 4 found that ASL overt pronouns are affected by verb bias. Specifically, the proportion of pronouns varies depending on whether the verb is NP1-biased, NP2-biased or a non-IC verb. This means that a smaller proportion of referring expressions is pronouns in NP1-biased verbs compared with NP2-biased and non-IC verbs. Importantly, these patterns are not predicted by a model such as the Bayesian model (Kehler, Kertz, Rohde & Elman, 2008; Kehler & Rohde, 2013, 2018). The main tenet of this model is that pronoun production is insensitive to the semantic/pragmatic biases affecting comprehension. However, on its own, a main effect of verb bias might not be problematic for the model, as only the strong interpretation of its tenets predicts complete insensitivity to semantic/pragmatic biases on the part of the production bias. The weak interpretation simply predicts that pronoun interpretation follows Bayesian principles (see Zhan, Levy and Kehler, 2016).

3 ASL Pronoun Comprehension

A major focus of this dissertation was to examine implicit causality (IC) - its sources as well as its effects on pronouns in ASL. Previous work has suggested modality-specific restrictions on the realization of verb arguments in ASL. These restrictions are claimed to result in stimulus-experiencer verbs being unattested in ASL. Stimulus-experiencer verbs, however, are one of the strongest sources of NP1-biased IC verbs. An absence or low proportion of these verbs in ASL might lead to a distribution of biases that is different from other languages. With few lexical stimulus-experiencer verbs, the majority of psychological verbs would be biased towards NP2, and very few would be strongly biased towards NP1. The resulting lack of a contrast between NP1 and NP2-biases might mean that IC verbs are less informative for the comprehender's resolution of pronouns in ASL compared to other languages. On the other hand, it is not clear that IC-biases are expected to play a role in the resolution of ASL pronouns at all. Descriptions of ASL pronouns have focused on their ability to use spatial co-reference to uniquely identify their antecedent. As ASL pronouns are therefore unlike spoken language pronouns in being thought to be fully semantically specified, semantic biases could conceivably be unnecessary for pronoun resolution in ASL. Thus, two important contributions of this dissertation were to identify whether modality constrains the distribution of IC biases in ASL, and to examine the role of these biases in pronoun resolution.

In examining thematic roles and implicit causality verbs, Chapter 3 found a tendency towards fewer realizations as stimulus-experiencer in ASL verbs compared to similar verbs in English. However, there was limited evidence that this was a result of modality-based constraints. Many verbs that were expected to be stimulus-experiencer verbs based on their glosses were deemed unacceptable as transitives in ASL, and some were realized with

unexpected syntax-semantics mappings, including experiencer-stimulus structure. Past research has proposed that body-anchored psychological verbs require the signer's body to represent the experiencer. This would preclude the occurrence of stimulus-subjects in ASL. Consequently, verb meanings with stimulus-experiencer structure in other languages should be realized in ASL with experiencer-subjects rather than stimulus-subjects. For example, such verb meanings might be intransitive and more adjective-like (e.g. 'surprised' instead of 'surprise'), or have different argument realization (e.g. 'Lisa is surprised by Mary' instead of 'Lisa surprises Mary'). Chapter 3 indeed found that the majority of verbs judged unacceptable as transitives in ASL had stimulus-subjects in English. However, it is not clear that this was a result of body-anchoring as a modality-specific constraint, rather than simply being a language-specific constraint. Similarly, there was no evidence that body-anchoring is the determining factor for whether a verb is realized as a stimulus-experiencer verb (of which we found a handful of examples) or experiencer-stimulus. When we consider that spoken languages exist in which stimulus-experiencer verbs are as infrequent as in ASL (e.g. Mandarin, see Chen, 1996), an alternative explanation for the observed pattern is that the low proportion of NP1-biased verbs is a language-specific result, rather than a modality-specific one.

Chapter 3 utilized a novel experimental approach and produced several new insights into ASL and the universality of the relationship between verb bias and thematic role. As a novel experimental approach, we adapted a sentence continuation task used in spoken language research to sign language production studies. By using video recorded stimuli and adopting a prompt repetition procedure, we avoided using English writing in conducting the experiment. Further, this procedure ensured that participants were nevertheless sufficiently familiar with the sentence fragment to carry out the task. In this way, we were able to study a sign language using

a method that is frequent in psycholinguistic studies of spoken languages, and to produce results that are comparable between modalities.

Chapter 3 also offered the first norming data for implicit causality in a sign language, and linked claims from previous research on thematic roles and argument realization in ASL to question of distribution of implicit causality biases. The results showed that ASL has verb biases and they are distributed relatively similarly to the biases in spoken languages, though with more NP2-continuations overall than in English. Furthermore, there was evidence that some ASL verbs can be realized with a stimulus-subject, and that thematic role predicts bias direction in ASL psychological verbs, as it does in other languages.

Chapter 4 used the same sentence-continuation paradigm as Chapter 3 to investigate how implicit causality, along with spatial co-reference and grammatical role of the antecedent, affect pronoun resolution in ASL. As discussed above, Chapter 4 found that implicit causality biases affect overt pronoun production. The effect of these biases on comprehension is even more striking: whether or not referents were localized in space, signers regularly resolved the pronoun to the causally implicated referent, even when this meant disregarding spatial co-referentiality as presented in the sentence fragment. This result is not anticipated from previous sign language research. However, considering that implicit causality triggers a predictive language process, the result is perhaps less surprising. Predictive language processing means generating expectations about upcoming discourse based on prior context. This approach to language processing has been increasingly adopted across linguistic domains (see review in Kuperberg and Jaeger, 2016), including, notably, reference resolution (Arnold, 2001; Rohde, 2008; Kehler et al, 2008; Kehler & Rohde, 2013, 2018). Thus, when processing an ASL sentence such as ‘LISA-L LOVE MARY-R WHY? IX-L…’, ‘Lisa loves Mary because she (Lisa)…*’,* comprehenders are forming

expectations about who will be mentioned next. Crucially, this happens as soon as they encounter the verb. In contrast, the information contained in the referential loci does not become relevant until the occurrence of the pronoun. Using spatial co-reference for pronoun resolution is therefore mainly a reactive process, and it should not be expected to prevent the verb from engendering a predictive process at an earlier point in the utterance.

Overall, the findings from Chapter 4 highlight the importance and strength of semantic/pragmatic biases across languages. This is not to say that spatial co-reference is unimportant in ASL. In the comprehension experiment in Chapter 4, the proportion of pronouns interpreted as the causally implicated referent was the highest when that referent was also the one indicated by the pronoun's referential locus. Similarly, there were fewer references to the causally implicated referent when the pronoun indicated the non-implicated referent. Taken together, the results of Chapter 3 and 4 emphasize the universal nature of implicit causality biases, as well as their importance for the computation of the next-mention biases that are crucial for pronoun resolution.

Lastly, Chapter 4 also discovered pronoun resolution to be affected by the grammatical role of the antecedent. Seeing a pronoun prompted the signers to more likely continue talking about the previous object. Under the assumption that pronoun comprehension relies jointly on production biases (the producer's tendency to pronominalize antecedents with a specific grammatical role) and next-mention biases (expectations about who will be talked about next), this finding suggests that ASL prefers object as antecedents for pronouns. While the effect of grammatical role was weaker than that of verb bias, its presence nevertheless constitutes another example of a modality-independent process affecting ASL pronouns.

4 Conclusion and Future Directions

Developing a comprehensive model of how language is produced and understood by humans is an important goal for linguistics. Psycholinguists have been particularly interested in discovering universal principles to account for referential cohesion, particularly pronouns. This dissertation has advanced the field's progress towards this goal by furthering our understanding of referential cohesion in sign languages and ASL. By examining referential cohesion in a sign language in order to assess the role of modality-independent and modality-specific influences, this work informs the development of a universally valid model for referential cohesion.

The studies of this dissertation have shown that referential cohesion is overwhelmingly similar in ASL to spoken languages. Minor differences were observed, however, especially related to the contexts in which signers choose to use classifiers, as well as the influence of spatial co-reference in pronouns. However, given the scarcity of work examining both speech and gesture, it is not clear whether even these minor differences may disappear if we take into account the contribution of co-speech gesture to spoken language referential cohesion. Therefore, future research should aim to develop a comprehensive understanding of referential cohesion that can capture sign as well as speech and gesture.

Another area for future research is the potential effect of bilingualism on ASL referential cohesion. Most Deaf signers know English and are bilingual to some extent, whether they are sign-text bilinguals, able to lip-read, or have some residual hearing. Thus, the results presented in this dissertation are not based on monolingual language data. Just as two languages influence each other in other kinds of bilingualism (see Kroll et al., 2015), English is expected to influence ASL. Differences related to English proficiency, daily language use, and attitudes towards English might account for some of the variation observed in the studies of dissertation. This is

particularly salient for acceptance of stimulus-experiencer structures and for preferences for grammatical role of the pronoun antecedent. Future research examining referential cohesion should explore the role of individual differences, particularly in factors related to English, and of possible historical changes to the ASL linguistic system as a function of language contact.

The studies in this dissertation inform theories of referential cohesion by showing that semantic/pragmatic factors are crucial in sign languages, as they are in spoken languages. It makes a particularly compelling case for the importance of these factors to find them in a language like ASL, in which the pronominal system has been described as unambiguous, and where there is therefore no a priori reason to expect such biases to contribute anything to pronoun resolution.

On the other hand, the present work also raises questions about what a universal modal of pronoun production must account for. The results of this dissertation highlight the fact that the use of space helps shape ASL referential cohesion in different ways. This means that our models, especially of pronoun production and resolution, must be able to include space as a factor in order to be universally applicable. Thus, another task of future work is to capture the effects of space and spatial coherence on production and comprehension of pronouns in a theoretical framework.

Finally, the present work offers support for the cross-linguistic validity of the Bayesian model. Modality-effects aside, the Bayesian model predicts ASL pronoun comprehension well: addressees use next-mention biases and grammatical role to reverse-engineer the producer's process, as expected. Overall, the model also predicts the production results well, with the exception of a small effect of verb bias on the strength of the preference for using an overt pronoun. A similar production effect was found in Mandarin Chinese by Zhan et al. (2016). The

strong version of the Bayesian model predicts that pronoun production should be insensitive to semantic/pragmatic biases. One area that future research can pursue in an attempt to reconcile model predictions is whether there are higher-level differences between linguistic systems driving the observed differences. In languages like English, Greek, and Japanese, pronoun production is insensitive to semantic/pragmatics, but this might be true only to a lesser degree for languages like ASL and Mandarin. ASL and Mandarin are similar in a number of respects: both have null and overt pronouns, have only few lexical stimulus-experiencer verbs, and thus few lexical verbs that are NP1-biased, and both exhibit an effect of implicit causality bias on pronoun production. Some or all of these language facts might have the same underlying cause. Future research will have to determine whether differences in referential cohesion processes result from systemic differences between languages.

As a final point, the work presented in this dissertation has potential consequences for Deaf education. The finding that ASL referential cohesion, and especially pronoun resolution employs many of the same principles as speakers use has implications for how Deaf children can be taught reading. ASL has no written form, so in order for Deaf children to succeed academically, they must learn to read and write English. In many cases, reading proficiency and ultimate educational attainment of Deaf individuals lags behind that of their hearing peers. The research presented in this dissertation suggests that in the area of reading comprehension, Deaf education can capitalize on the knowledge that Deaf children bring with them from ASL. Since the principles used in English anaphor resolution should be familiar from ASL, explicitly teaching these similarities might help Deaf children comprehend English text, which could ultimately help increase educational attainment in the Deaf population.

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