

Formal Semantics and Pragmatics in Sign Languages

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Preface

This book was written with two aims for two separate audiences, and having done this will likely fall short for each audience in different ways; it is hoped that the advantage of bringing these audiences together, however, will outweigh the disadvantages. The first audience for this book is intended to be sign language researchers and the Deaf signing community. People who know the most about sign languages may encounter research talking about how sign languages are discussed in the field of formal semantics and want to learn more to follow that research. To this audience, I hope that this text provides an overview and reference of what is being said about sign languages by researchers in formal semantics and related work in pragmatics and syntax. The paramount goal of this book is to break down barriers between research published on the formal semantics of sign languages and the community that the language belongs to. I'm sure I speak for many in the field of semantics in hoping that this will lead to significant update and revision to what is presented in the following pages, as that would be the best indication of progress.

The second audience for this book is the community of formal semantics/pragmatics researchers as well as those in adjacent fields such as philosophy (especially logic and philosophy of language) and psychology (especially psycholinguistics, psychology of language, developmental and cognitive psychology). Usually if pushed, all of these groups acknowledge the importance of building theories of language that take sign languages into account, and yet many researchers in these fields hesitate to include sign languages in their work through lack of familiarity with glossing conventions, lack of basic training in the terminology and ideas, and difficulty envisioning what sentences look like and what are possible parameters of variation. To this audience, I hope that this book will provide references to existing work within the field and a sense of sign languages as described within the formal semantic framework. It is a secondary goal of this book to make sign languages more familiar for those working on formal semantics, and to hopefully provide enough basic knowledge of sign languages within the framework that such researchers without any previous ties to sign languages will reach out to scholars in the community for more collaborations and mutual support.

To both audiences, the book should provide a sense of what has been claimed regarding formal semantics and pragmatics in sign languages, and provide guideposts to many major outstanding questions in the field. The assumed background is an introductory linguistics course.

I am a hearing person who learned American Sign Language as an adult. Given this, I lack the deeper knowledge that members of the Deaf community have about sign languages, and so my perspective in this book is that of an academic: the kind of outsider knowledge that has historically been privileged but which should not be confused with lived experience when it comes to authority on the language itself. On top of that, language is always changing and varies across people, time, and contexts, so in the spirit of linguistic analysis, nothing in what follows should be understood as prescriptive, or what *should be*, but rather descriptive, only what *seems to be* given what we know about natural language semantics in both spoken and signed languages. Moreover, theoretical linguistics is a young field and sign language linguistics is even younger, so perhaps the next generation of such an overview will rewrite much of what is contained here; certainly the goal for this book will have been met if this provides an accessible introduction to the current state of theoretical thinking to the widest range of readers, with hopes of progress and revision to come.

Each chapter attempts to begin with a general introduction to the topic in semantics (work that has often but not always focused on written English), and then reviews the main ways in which the topic has been studied in sign language linguistics. Chapters conclude with both concrete examples of semantic analysis of particular phenomena, as well as future oriented possible directions, both of which are intended to support further work.

In general within formal approaches to sign language linguistics, semantics has been a relatively understudied field until quite recently, but there are predecessors to this text that anyone interested in this topic should be sure to consult if they are interested in complementary readings. The first is Sandler and Lillo-Martin (2006) who provide for generative approaches to phonology and syntax what this book aims to provide for formal approaches to semantics of sign linguistics, working within a framework that assumes similar ingredients at more abstract levels combining across language modalities. A concise introduction to sign language linguistics more broadly can be found in Hill et al. (2018). Schlenker (2022) provides a broader introduction to semantics as applied to many domains inside and outside of language which includes several areas of focus on sign languages. Finally, there are many dissertations that go more in depth on some of the topics here while also presenting widely accessible introductions to aspects of formal semantics; an excellent example for dynamic semantics is Barberà (2015) and for information structure is Kimmelman (2014).

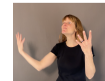
Acknowledgements Any academic work is in many ways the result of a group effort. The first thanks go to my own mentors, who all provided support and direction, especially Ivano Caponigro, Rachel Mayberry, David Barner, and Diane Lillo-Martin and the language/psych/cogsci communities at UC San Diego, UConn, and Yale. At Harvard, I owe many thanks to all of the members of the M&M lab, especially Annemarie Kocab, Dorothy Ahn, Gunnar Lund, Kate Henninger, Nozomi Tomita, Chrissy Zlogar, Aureore Gonzalez, Hande Sevgi, Shannon Bryant, and Yuhan Zhang all for collaboration on projects that directly influenced the way that ideas are presented in this book, Ronice Müller de Quadros, Deborah Chen Pichler, Andrea Sims, and Laura Wagner for collaborations that influenced this writing, Gennaro Chierchia for co-teaching a course that influenced the anaphora chapter, Dora Mihoc for so much early lab support, our departmental administrators Helen Lewis, Kate Pilson, and Victoria Koc, Andrew Bottoms for collaboration on everything ASL at Harvard, and the Linguistics Department and LangCog, Logic Group, and MBB communities on campus for wider perspective and inspiration. Of course, none of these people are responsible for any mistakes in what follows, which are all mine. This project was supported in part by a grant from the National Science Foundation, BCS 1844186: Experimental pragmatics and semantics in visual language. Finally, my most enthusiastic thanks go to Jessica Tanner, who modeled the ASL filmed for this book. Once when we were both on a stage at Yale, Jessica gave a presentation that highlighted the artistic beauty inherent in sign languages, arguing that they are more powerful than word-by-word text, able to paint a whole picture and make a story come alive. Formal linguists notoriously focus on [what to some are] the “boring” parts of a language, ignoring a language’s beauty in a prioritization of scientific credibility. I hope that this text manages to do some justice to both parts.

1

Meaning and language

How do we know what other people “mean” when they share ideas using language? What is “meaning” in human language? And for that matter, what counts as “language”? Answers to these kinds of questions are foundational and far-reaching, far more complex than any single research program or single discipline can handle, potentially encompassing social meaning and identity, actions and intentions, philosophy of language, psychology of mental representations, language development, actions and persuasion, and cross-linguistic variation and typology, etc. That said, there has been enormous advancement in the last few decades regarding how certain kinds of meaning work in both signed and spoken languages from multiple perspectives. In this book we are going to focus on at least two different kinds of meaning that can be expressed through natural language, although these shouldn’t be taken to be exhaustive. Furthermore, the approach will not be to argue in favor of prioritizing one kind of meaning over the other, but rather take as given that both capture true aspects of linguistic meaning, and that to understand language meaning requires understanding both parts and how they interact.

One kind of meaning can be thought of as the “picture in your head” of some event or situation that you want to share with someone else (as the language producer) or that you want to comprehend (as the language receiver). Imagine that I am describing a rainbow in the sky on a beautiful autumn day in New England, describing the colors, the shapes, the arc of the rainbow, the feel of the wind, etc, in great detail. Increasing the details that I use will helpfully add to the vivid mental model you may be building as I try to share the experience with you, either by using highly



vivid words (e.g. perhaps *windswept* if I’m using English, in ASL) or depictions (e.g. gesturing the expanse of the tree line, or at the gentle fall of a leaf). Neither the producer nor the comprehender needs to actually

have experienced such a moment directly, but the idea is that we can use language along with other communication systems like painting, enacting, etc. to try to share something like a specific image/episode of it with you, for example what it is like to be in New England on such a day, what my birthday party was like when I was 10, or what it was like to watch bees make honey that day at the fair, etc. We can remember and reason about (at least some aspects of) experiences in the absence of language; what we share about experiences need not depend on language, but it seems that they can certainly be influenced by language, as when I use language to share a new experience I had with you.

If you ask most people, the kind of “share the picture in your head” meaning might be the first thing that comes to mind when they think about the meaning of a sentence, but linguists working within the **formal approaches to semantics and pragmatics** focus on a different aspect of meaning, the fact that we can raise and answer questions in order to share information that might not even be able to be encoded as an experience of any kind. Examples of this are the information we share when we say *I’ve never seen a rainbow* or *None of the students can identify the queen bee*, or even the content of generalized declarative memory like *Boston is the capital of Massachusetts* or *penguins lay eggs*. These are not necessarily linked to any particular event experience, but rather play an important role in supporting reasoning over alternatives, i.e. whether you have or haven’t seen a rainbow, which city is the capital of Massachusetts, which animal kingdom penguins belong to, etc.

An important motivation behind formal approaches to semantics is that we can reason over not only what was said, but also use logic to reason about what else follows from what was said. For example, even though it is hard to imagine a particular experience tied to *I’ve never seen a rainbow*, we can infer many things if someone says that sentence, such as the fact that the speaker specifically didn’t see a rainbow last week, or the week before. We can similarly infer from *None of the students can identify the queen bee* that there is a unique queen bee, and that if Nick is a student, then Nick hasn’t identified the queen bee. This information is represented not as specific experiences but as generalizations across scenarios in which various facts are true, that we seem to be able to reason about in regular ways. Statements like these and the deductions we can make from them are a way we can learn, for example, that *bees make honey* (even if we’ve never witnessed that process and can’t imagine what it would look like), that *Boston is in Massachusetts* (even if we’ve never been there), that *I love science fiction* (even if you’ve never witnessed me enjoying it), and even understand me if I say *I’ve never a rainbow* when there is no particular event that I am describing but rather a lack of them.

One foundational idea in this book is that language can be used for both of these functions of meaning: we can use language to evoke particular event

experiences for our interlocutor, and we can also use language to share information that allows our interlocutor to reason over alternatives. When it comes to language, some pieces of language contribute only to one of these, some only to the other, and some to both. To take a familiar example to see how they can work together, imagine we are reading a children's storybook that contains both text and illustrations. The illustrations provide evocative details about the events that make up the story, while the text can convey information that reinforces the illustrations as well as other information which might be impossible to depict but allows us to rule out or rule in certain information, such as *I've never seen a rainbow*, or *all penguin species lay eggs*. In semiotic terms, illustrations convey meaning iconically via depiction, while the words convey meaning symbolically via description (Clark, 1996). We will see ways in which the compositional properties of these kinds of meanings differ, yet both are integral to understanding meaning in language broadly, across all language modalities including writing, speaking, and signing (Dingemanse, 2015; Clark, 2016; Hodge and Ferrara, 2022). One of the theoretical aims of this book is to investigate how iconic and symbolic representations interact in human language, with a special focus on symbolic representations as analyzed using formal semantic models.

In investigating these kinds of interactions between depiction and description in meaning, the particular focus of this book will be on **sign languages as used by Deaf communities** throughout the world, for several reasons. First, one unreason: it is NOT because sign languages are mostly depictive! Just like spoken languages, sign languages are highly symbolic and compositional, and it is this aspect we will be emphasizing most of all, and that is the focus of most formal semantics. However, because they are less commonly written and less commonly presented as divorced from depictive aspects, sign languages force semanticists to embrace both aspects of their meaning, whereas the depictive aspects of spoken language communication tend to be either ignored, or treated as roughly equivalent to descriptive content. Moreover, sign languages have been understudied relative to spoken languages and thus it is worthwhile for all linguists to pay attention to them in order to broaden the study of linguistics, notably here semantics, beyond well-studied spoken languages like English. Another reason to look at these views of meaning in sign languages is that sign languages helps us dissociate the particulars of spoken language from larger conclusions we might want to draw about the human mind and meaning: when the manual/visual modality is utilized to its fullest extent for language, as it is in sign languages, we might ask what notable properties, if any, do human languages take on that is often missed when researchers only paid attention to speech, or (even more commonly) only to language as expressed in written text? And finally, we focus on sign languages here in order to encourage those who already know more about sign languages to consider questions of interest in formal studies on meaning: as will become apparent in the following chapters, the field of

sign language linguistics has been growing rapidly in recent years but the subfield of formal semantic approaches to sign languages is still primarily engaged with by people who came to the topic through a general interest in semantics more than those who came through an interest in sign languages, and it is a goal of this work to support bridging between the two.

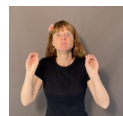
1 Event experiences

To clarify further the kinds of “meaning” that will be relevant in our study of sign languages, let’s consider each type in turn, first with a sentence of written English and then with a signed sentence in American Sign Language (ASL). The written sentence is in (1). This sentence has two components of meaning that will be relevant for us.

- (1) Ten students stood in a line at the library desk, but none of them had their library card.

First, it might evoke a kind of “picture in our head” of students near a desk, perhaps feeling a bit sheepish for not having remembered to bring their library cards. This is the representation one can have of the particular event being described, and the details can vary from person to person: I might imagine the students crowded in a line parallel to the desk, while someone else might imagine the students crowded in a line perpendicular to the desk, approaching one at a time; we may also differ in the attitudes we imagine for the students, if we imagine them holding any particular attitudes, perhaps based on our own experiences in such situations. This sentence is not especially vivid in its depiction so the image may be minimal, or even non-existent, while for others this sentence may evoke a rather vivid scene. When paired with a photograph or illustration, some aspects might become more vivid and detailed: perhaps we’d learn more about their attitudes, the arrangement of the students, and other features of the experience.

Looking at the ASL sentence in (2) we can reason similarly: it might evoke images and/or memories of libraries, desks, waiting, etc., and we might imagine attitudes of the students. In the case of the visually presented ASL sentence, the signer can also express her attitude about the content of the



sentence, as in the surprised expression on the sign `NONEsym` ‘none’. This sentence also conveys something about the shape of the students standing around the desk, which is clearly a single file line parallel to the desk,



expressed through the classifier expression $DS_4(\text{students in line, at a})$ ‘(upright figures) standing in a line’.

(2)

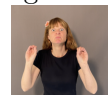


‘Ten students stood in a line behind/along the library desk. None of them remembered a library card.’

(Glossing for ASL examples primarily follow the ID-Gloss and SLAASh ID Glossing principles, Hochgesang 2020; Hochgesang et al. 2020.)

Thus, while there are clearly similarities in the kinds of events we would imagine based on the the English and ASL sentences we’ve seen, there are also differences. These are often the kinds of things that people who know both languages remark on as different, especially focusing on the expressive power of sign languages that are lacking in English, especially written English without intonation or gestures about the arrangements, etc.

In the approach we are taking in this book, we will lump together the content of depictions and expressive meaning, including the shape of the



students in line in $DS_4(\text{students in line, at a})$ and expressions on $NONEsym$ as both depictive. There are both scientifically motivated and practical reasons for doing this. Scientifically, both of these pieces of meaning seem able to share a format with the contents of our perception of the world itself, which isn’t to say it isn’t complex or abstract (Siegel, 2011), only that we can understand it via its correspondance to the world as we experience it, that is, we understand what it means because we can reason about it via stimulation and cause and effect, like when the signer’s expression means that the author is surprised (“natural meaning” in terms of Grice 1957), since based on our experiences out in the world that given expression is typically tied to the attitude. Practically, this is the distinction psychologists have already made (Clark, 1996, 2016).

Depictions are infrequently represented in written English and so they often do not play a large role in formal semantic theories of (spoken language) meaning, but in sign linguistics quite a lot of attention has been paid to the way that depictions convey meaning iconically as part of sign language discourse (Taub, 2001; Liddell, 2003; Emmorey, 2003; Perniss and Vigliocco, 2014; Ferrara and Hodge, 2018; Hodge and Ferrara, 2022). Many analyses make use of Cognitive Linguistics approaches to meaning, in which we reason about meaning through the way that we reason about and experience the world, and thus iconicity and its influences on meaning often takes center stage. We don't want to lose the insights into depiction in language we gain from this approach, but at the same time, one argument of this book is that it isn't enough. The remainder of this chapter focuses on insights from formal approaches to modeling linguistic meaning via propositions that we also need to capture in a full theory of sign language semantics.

2 Propositional meaning

Beyond whatever particular event or “picture in your head” that a piece of language might evoke, we use language to share extremely precise information about things that simply cannot be experienced. Let's return to the same example sentences from English/ASL about the library desk. The English sentence in (3) conveys not just some impression of what it might have been like to be there, but also the facts that there is a library desk, and ten students in a particular relation to that desk, and that there is not a single one of the students who brought their card. The latter of these is, of course, quite difficult to model as an experience, given that it is about what did not happen. Nevertheless we can reason productively over these utterances. For example, if we believe the speaker, then we can be sure that (a) if we ask one of the ten students in line, that student will not have their library card with them, and that (b) there are more than five students. Although neither of these facts were explicitly stated, we feel completely confident about them: there is no way that (a) or (b) can be false, if we accept the original claim in (3). We call this relation *entailment*: a sentence p entails another sentence q if for every circumstance in which p is true, q is also true. There is no scenario in which the main sentence in (3) is true but in which (a) or (b) is false, so the target sentence in (3) entails (3a) and also entails (3b).

- (3) *Ten students stood in a line at the library desk, but none of them had their library card.*

Entails:

- a. If we ask one of the ten students in line, that student will not have their library card with them.
- b. There are more than five students.

This captures something powerful about language: we can use language to convey information about our world to such a specific extent that we can learn and reason about things we did not actually see, and things and events that do not even exist.

The power of being able to reason with confidence over possibilities based on linguistic information has been the basis for modeling the informational component of meaning using logic, as conveying a set of possibilities in which it holds. This is one motivation for a **formal truth-conditional approach to semantics**. For example, we can think about our English sentence about students standing in line (3) as a function that sorts possibilities into those that are true and those that are false with respect to its content. For example, sentence (3) might be true in the following scenarios, or "ways the world might be" (imagine the multiverse!): $\{w_1, w_3, w_5, w_7, w_9 \dots\}$. In some of these possibilities the students are in a parallel line (let's assume these are $\{w_1, w_5, w_9\}$) while in others the students will be in a perpendicular line (e.g. $\{w_3, w_7, \dots\}$), since the English sentence in (3) doesn't discriminate between these arrangements, but in all of them there will be more than five students, and in all of them it will be the case that if you begin talking to one of the ten students, they won't have their library card with them. This is what it means to model entailment: if p entails q then the possibilities/worlds in which p is true are a subset of those in which q is true. For example, we can imagine that (3) is true in $\{w_1, w_3, w_5, w_7, w_9 \dots\}$, whereas (3a) is true in all of those worlds and then some others, perhaps the worlds in which that student didn't bring their card but some other students did, e.g. $\{w_1, w_3, w_4, w_5, w_7, w_8, w_9 \dots\}$.

Researchers in the field of "formal semantics" are interested specifically in how we make these kinds of entailment inferences: it seems that there are an infinite number of entailed sentences from any given sentence, including sentences we have *never heard before*. We must, therefore, have a way to reason about and express information across a variety of circumstances, and a way to express facts and generalities. Moreover, we must reason about them in a productive way, since we can understand entailments of sentences we have never even heard before. A helpful way to model this kind of propositional meaning and how it arises compositionally is by building on a logic over symbols, basically the same underlying notions used in symbolic computing. We'll take the view in this book that this meaning is complementary to the kind of evoked event experiences that can also result from linguistic expressions, that we focused on in the previous section.

Sign languages provide exactly the same sort of evidence for an underlying logic and symbolic computing. Consider the ASL sentence in (4).

(4)

**Entails:**

- a. If we ask one of the ten students in line, that student will not have their library card with them.
- b. There are more than five students.

The ASL example, like the English example, evokes an image: a library desk, a bunch of students, and in this case a particular arrangement of a



line perpendicular to the desk, since DS_4(students in line, at a) ‘stand in line’ in ASL conveys, in its form, the arrangement of the line. Like the English example, this ASL example need not be especially vivid with respect to the attitudes of the students, and so we might imagine them with one attitude or another, or perhaps our mental image of the scene would fail to include any attitude of the students at all. It does convey some attitude of the speaker, as in



NONEsym ‘none’. In this way, the ASL sentence might convey an image of a particular scene that is quite similar to the English case, although with more detail in this case, for example about the arrangement of the students with respect to the desk, etc.

The ASL sentence also conveys a propositional meaning similar, but not exactly the same, as the English sentence. Many of the entailments are the same. For example, the target sentence in (4) entails that (a) if we ask one of the ten students in line, that student will not have remembered to bring their library card, and (b) there are more than five students. Thus we want to model several of the same mysteries: how is it that despite never seeing this sentence before, we know what it means to a detailed enough extent that we can be sure that given that (4) is true, then (a) and (b) are also true? Note that some of these inferences, especially (a), are difficult if not impossible to model as images/specific events, since (a) is about what would *not* happen, namely, that students would not have a library card. Thinking of this meaning in terms of underlying logical structures provides advantages

for modeling these kinds of inferences, especially negative ones. In doing so, important questions are raised for sign languages specifically, and for all languages in general. For example, what status should the representation of a particular event have with respect to our representation of a proposition? Recall the arrangement of the students around the desk is conveyed by (4) in ASL but not by (1), and so we want to restrict the possible scenarios in which (4) is true based on arrangement in a way we do not want to do for English. This means that we will want a way to refer to these events in the logical system in ASL (we will see more about this in Chapter 5). Moreover, beyond the spatial arrangements of the students, there seem to be other linguistic differences between the sentences. For example, the English sentence seems to presuppose a library desk as already existing or familiar in the conversation (“the desk”), while the ASL sentence seems neutral with



respect to whether the desk is familiar or new (TABLE ‘a/the desk’). These differences too we want to model as part of one or both of these aspects of meaning.

The schematic in (Fig 1.1) roughly outlines the approach we will be taking in this book regarding the study of these dimensions of meaning and their relations to spoken and sign languages. On the one hand, we are interested in meaning, which we will be representing in two complementary ways: the particular event kind (those “pictures in the head”) and the propositional kind (that symbolically encode information and compose with logical structures). However, we don’t have direct access to meanings in language. In fact, we only have *direct* access to the linguistic signal: for a spoken language like English this may include audio waves and visual waves, as exemplified in the lower left hand box in Fig 1.1. In a sign language, this information will be visual, as exemplified in the lower right hand box. In both cases, the signal gets processed by a phonological system that takes a continuous signal and encodes new levels of abstraction, which is processed by a system of grammatical and syntactic structures that do the same at a higher level of abstraction, etc., which then itself interfaces with a system for meaning that depends on these syntactic structures. There is ample evidence for all of the same complexities of structure and processing in sign languages as in spoken languages with regard to phonology, morphology, syntax, etc. (Hill et al., 2018; Sandler and Lillo-Martin, 2006; Valli and Lucas, 2000; Padden, 1988; Stokoe et al., 1976). When it comes to meaning, we’ll model the system as having (at least) two components, of the sort we have been discussing: representations of particular events that we can reason about through experience, and representations of propositions that allow us to reason over alternatives. A final assumption we will be assuming is that our representations of particular events can be influenced directly by the linguistic signal,

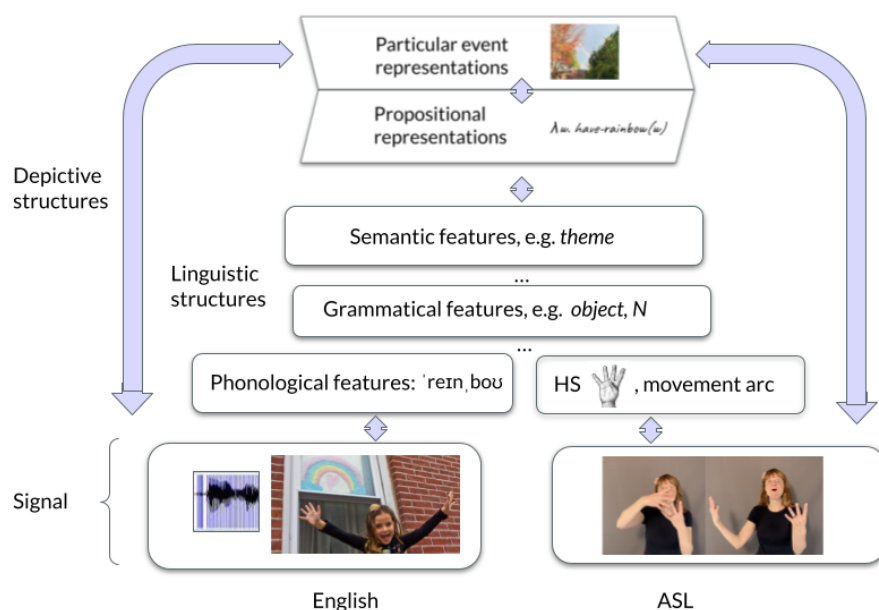


Figure 1.1: Descriptive/symbolic and depictive/iconic processing streams

e.g. the shape or orientation of a rainbow gesture, and that this is processed not through linguistic structures but through the process of understanding depictions, the result of which is explicitly not propositional (Fodor, 2007; Camp, 2018).

The study of meaning in general, and the study of meaning in sign languages in particular, is able to be divided roughly by the kind of meaning that they focus on and take to be core to language meaning. On the one hand, the perspective of **cognitive linguistics** tends to model the meaning of a sentence as the kind of event experience and/or simulation of the world that one shares with an interlocutor. Under this view, the goal of someone who studies semantics is to understand how language is used to share these experiences. On the other hand, the perspective of **formal linguistics** tends to consider the meaning of the sentence to be the propositional meaning, and so the goal becomes to understand the ways that sentences convey information via entailments and to understand the properties of whatever logical apparatus we have in our minds that permits this reasoning. We introduce this approach in greater detail in the next section.

3 Formal semantics: Basics

We take as our starting point the idea that the goal of the propositional meaning of a sentence is to share information by narrowing down alternatives. One way to think about propositional meaning/telling us the way the

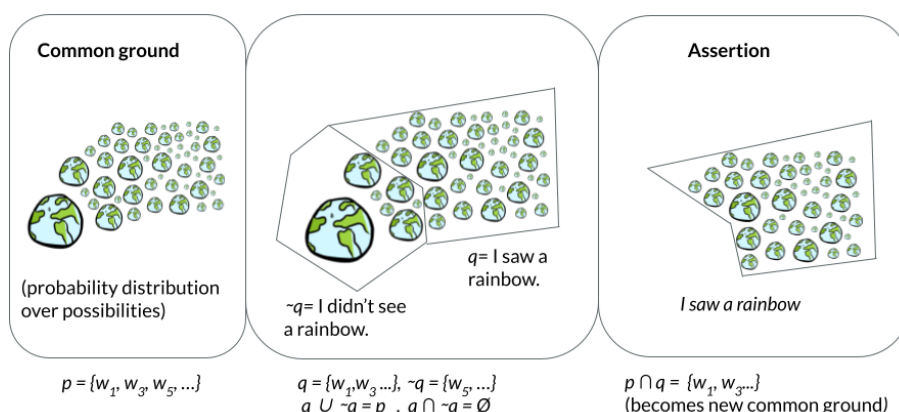


Figure 1.2: Assertion as narrowing possibilities

world is from a formal perspective is that propositional meaning narrows down the live possibilities that we consider as ways that the world might be. Under this view, when we assert a sentence, the goal is to keep some possibilities under consideration and to eliminate other possibilities (Stalnaker, 1978). This process is schematized in Figure 1.2, where we might begin with some set of possible ways that things might be. If we're inclined to think probabilistically, we might want to think about this infinite set as having a probability distribution over possibilities, some more likely than others. For example, if I don't know the weather in San Diego CA at the moment, then in some possibilities that I am considering it is currently snowing there and in others it is sunny, but those in which it is sunny are generally going to be much more likely than the snowing ones given climate properties of the region. This set of possibilities/possible worlds is a model of the knowledge that speakers in a conversation share, their **common ground**. If conversational participants agree that Boston is in Massachusetts, then in every one of these possibilities in their common ground, Boston will be in Massachusetts. If they don't know or agree about whether it is raining in Boston, then in some of these possibilities there will be rain in Boston; in others, there will not be rain in Boston.

How does the common ground change? Perhaps participants are interested in resolving an issue, for example, whether the speaker has or hasn't seen a rainbow. We can model this issue as a partition of all of the possibilities in the common ground into those in which the answer is yes (I did see a rainbow) and those in which the answer is no (I did not see a rainbow). An assertion then has the effect of eliminating possibilities, and a helpful assertion will eliminate possibilities in a way that aligns with this partition. For example, a sentence like *I didn't see a rainbow* has the effect of eliminating under consideration all of the possibilities in which the speaker did see a rainbow, and so by conveying this sentence we have narrowed down

our set of possibilities, as schematized in the three step-by-step frames in Fig 1.2. Thus, gaining information comes from eliminating possibilities.

The information conveyed by the pictures in Figure 1.2 can also be conveyed using a formal logical notation, as shown at the bottom of the figure. For example, we can start with a set of possibilities $\{w_1, w_3, w_5, \dots\}$, which we can call the proposition p ($p = \{w_1, w_3, w_5, \dots\}$). Then, we might partition this set of possibilities via a question, in this example *Did you see a rainbow?*, which we can (informally for now) think about as moving the discourse in two possible directions: to add the proposition $q = \{w_1, w_3, \dots\}$ (*I saw a rainbow*) or the proposition $\neg q = \{w_5, w_9, \dots\}$ (*I didn't see a rainbow*). In this case, the new proposition $q = \{w_1, w_3, \dots\}$ is added to the common ground by taking the intersection of this new proposition and the old common ground ($p \cap q$). Thus, by asserting *I saw a rainbow*, we add a new proposition q to our common ground, gaining information by narrowing possible ways that the world might be.

One objection often raised to this way of looking at information as “possibilities” or “possible worlds” is that it is computationally intractable for people using language to be actually thinking about infinitely many possible ways that things might be when they hear a sentence. Don't we just activate the picture in our mind, i.e. the representation of a particular event that we discussed above? Certainly it does seem that we can evoke a picture in our mind, but the claim here and in formal semantics more generally is that we also have a symbolic representation that is separated from any particular model of the world, and acts as functions over possibilities. This does not need to mean that we actively consider every possibility! (That sort of superpower seems undesirable if the multiverse as experienced by Michelle Yeoh's character in the (2022) film *Everything Everywhere All at Once* is any indication!) Instead we can reason symbolically. A useful analogy might be the concept of an *odd number*: we can understand this as a sorting function that considers each of the infinitely many integers and returns true if the number isn't divisible by two (that collection of numbers is the set of odd numbers), and false if it is divisible by two. We can understand the concept *odd number* without actively considering all possible integers in our mind at once. Similarly, a proposition like *I saw a rainbow* can be thought of as a sorting function that takes in a possible world/possible way that things might be and returns true if certain conditions hold (in this case, that I saw a rainbow in that world), and returns false if those conditions fail to hold. We can understand the proposition without holding all possible worlds in our mind, in cognitive scientific terms, as a function available for mental computations (Fodor, 2008) that takes possibilities as arguments. Conveniently, this makes negated sentences like *I didn't see a rainbow* just as natural to incorporate into our system: the proposition $\neg q$ is simply the complement set of worlds to q , an advantage for modeling human languages, all of which have expressions for negation.

Given this functional way of thinking about propositions, let's end this section by introducing a functional notation. Recall that we can think about the propositional meaning of a sentence like *I saw a rainbow* as a function that takes in possible worlds and returns true if some conditions hold (that makes up the set of possible worlds in which it is true). Let's write this explicitly by introducing a new bracket notation that is conventional in formal semantics, so that $\llbracket \cdot \rrbracket$ takes a piece of language (like the English sentence *I saw a rainbow*) and provides the propositional meaning of the sort we differentiated from the representation for the event we saw above. In equation form, we can read (5a) as saying that the propositional semantic value of *I saw a rainbow* is the set of possible worlds in which I saw a rainbow, or equivalently, the function that returns true for those worlds in which I saw a rainbow. Here q is the proposition that I saw a rainbow, to relate to Figure 1.2. The propositional value of a near translation equivalent in American Sign Language would seem, at least on first blush, to pick out the same proposition, (5b).

- (5) a. $\llbracket I \text{ saw a rainbow} \rrbracket = \lambda w.q(w) = \lambda w.I \text{ saw a rainbow in } w$
 'The function that returns TRUE for worlds in which I saw a rainbow, false otherwise.'

b.



$\llbracket \text{IX-1 SEE RAINBOW IX-a} \rrbracket = \lambda w.q(w) = \lambda w.I \text{ saw a rainbow in } w$

'The function that returns TRUE for worlds in which I saw a rainbow, false otherwise.'

If these two sentences are true and false in exactly the same scenarios as we suggested in the propositional meanings that we gave in (5) then we say that they are synonymous.

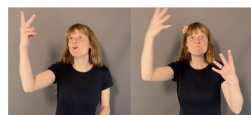
It has become conventional to use λ notation of the sort we show in (5) ($\lambda w.I \text{ saw a rainbow in } w$) because it makes explicit the compositional/functional properties of a propositional meaning. For example, we introduced the idea that a proposition is a sorting function over possible worlds. We can also model subparts of propositions as functions taking in different arguments, and the λ notation brings to the front of the equation information about the arguments that each kind of expression takes. In what follows we'll introduce this notation and its compositional properties via several examples.

One subpart of propositions are predicates, like *see a rainbow* or *happy*. These can be modeled as functions over individuals: English *happy* or ASL



HAPPY

sorts individuals into those who do and do not count as happy (whatever is relevant to being happy in that context), while *see a rainbow*



SEE

RAINBOW

and both sort individuals into those that do and don't see a rainbow (at some relevant context).

- (6) a. $\llbracket \textit{happy} \rrbracket = \lambda x.\text{happy}(x)$
 'The function that returns TRUE for individuals who are happy, false otherwise'

b.

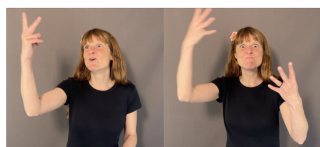


$$\llbracket \text{HAPPY} \rrbracket = \lambda x.\text{happy}(x)$$

'The function that returns TRUE for individuals who are happy, false otherwise'

- (7) a. $\llbracket \textit{see a rainbow} \rrbracket = \lambda x.\text{see-rainbow}(x)$
 'The function that returns TRUE for individuals who see a rainbow, false otherwise'

b.



$$\llbracket \text{SEE RAINBOW} \rrbracket = \lambda x.\text{see-rainbow}(x)$$

'The function that returns TRUE for individuals who see a rainbow, false otherwise'

Note that although the two forms are different in English (e.g. *happy*)



HAPPY

and in ASL (e.g. $\llbracket \text{HAPPY} \rrbracket$), the semantic values are the same, since these two words have basically the same symbolic meaning: they are functions that will return TRUE for individuals who are happy, and false otherwise. Often beginning formal semantic students who are thinking only about the




semantics of English get confused by the fact that ‘happy’ occurs both within the semantic value brackets and outside of them, i.e. on the left and right side of the equation in (6a). This can feel circular. But as soon as we use care to separate our object language that we are trying to model (English in (6a) and ASL in (6b)) from the metalanguage we use to talk about the sorting function (English mixed with mathematical notation, since that is the textual language of this book) then hopefully it is clear that it is not circular, but rather helps us make clear predictions for what linguistic expressions are and are not synonymous.

So far we have hardly motivated λ notation much, but let’s consider some linguistic expressions for functions that take in two participant arguments,





like English *see* or ASL *SEE*. These are typically used to talk about scenarios (in this case, seeing events) that have both an agent (the see-er) and a theme (what is seen). The propositional contribution can be modeled as a two-place function that looks for two arguments, first the theme and then the agent, which is represented in (8). The idea is that arguments are applied to the function expressed by λ notation in order from outside to inside, so that the first argument that we “feed” to the function in (8) will saturate the λx , replacing each occurring of x with the value of the argument that we feed it. Then, the remaining argument will be fed to λy , replacing any occurrences of y (this process is known as “ β -reduction”, see Heim and Kratzer (1998) for further introduction for linguists).

$$(8) \quad \llbracket \textit{see} \rrbracket = \lambda x \lambda y. y \text{ sees } x$$

To walk through an example, we’ll have to simplify a little bit at this stage, in particular, let’s imagine that the phrase *the girl* picks out a particular girl (this girl, ) , which we can represent on the mathematical side either using a picture of her  or a letter, say g . We can do the same with the phrase *the rainbow*, which picks out a particular rainbow (this one, ) , which we might also name with a letter, let’s say r . (What we are simplifying for now is the meaning of the English definite article *the*.) Under this view, the propositional meaning/semantic value of the English phrase *the girl* is a particular girl, not a function, which is a property of referential noun phrases (“referential” meaning that it picks out a particular thing), and similarly with *the rainbow*. This contrasts with a verb like *see*, which is a function still looking for arguments to saturate/fulfill it (that’s why the symbolic meaning for *see* has those lambda expressions, unlike the referential expressions in (9)).

- (9) a. $\llbracket \textit{The girl} \rrbracket = \text{img}_{\text{girl}} = g$
 b. $\llbracket \textit{The rainbow} \rrbracket = \text{img}_{\text{rainbow}} = r$

The interesting piece comes when they combine. We know from a long tradition of crosslinguistic work in syntax that objects combine with verbs before subjects, meaning that *see the rainbow* forms a unit; as semanticists, we will ask how we arrive at a meaning for this syntactic constituent. What we propose is that *see* regularly contributes a function looking first for an individual contributed by the object to take as an argument (that's what λx means, x is a variable over individuals people/places/things like girls, rainbows, etc.) (10a). Then its syntactic object *the rainbow* contributes its propositional semantic value which is an individual, (10b). When the value for *the rainbow* is fed into the *see* (two-place) function, it returns a (one-place) function *see the rainbow* which returns TRUE for individuals who see the rainbow r and false otherwise (10c). This then takes in one more argument, the subject of the sentence *the girl*, returning a proposition which is a function that takes in worlds and returns TRUE for those in which the girl g () sees the rainbow r () and false otherwise (10d).

- (10) a. $\llbracket \textit{see} \rrbracket = \lambda x \lambda y. y \text{ sees } x$
 b. $\llbracket \textit{the rainbow} \rrbracket = \text{img}_{\text{rainbow}} = r$
 c. $\llbracket \textit{see} \rrbracket (\llbracket \textit{the rainbow} \rrbracket) = \lambda x \lambda y. y \text{ sees } x (\text{img}_{\text{rainbow}} = r) = \lambda y. y \text{ sees } r$
 $\llbracket \textit{see the rainbow} \rrbracket = \lambda y. y \text{ sees } r$
 d. $\llbracket \textit{see the rainbow} \rrbracket (\llbracket \textit{the girl} \rrbracket) = \lambda y. y \text{ sees the rainbow } (\text{img}_{\text{girl}} = g)$
 $\llbracket \textit{the girl sees the rainbow} \rrbracket = g \text{ sees } r$

There are some levels of simplification here, but (10) exemplifies the basic idea of compositionality and function application behind much of the formal semantic approach to language. Advantages include showing how symbols combine in regular ways, such that we can convey new information about the world by just putting familiar symbols together in new ways, i.e. that language is systematic. One complication we introduced above is that the meaning of an assertion like *The girls sees the rainbow* is a function over worlds, and the right hand side of (10d) hardly looks like a function over worlds, but in fact it is one in disguise, it is simply the truth conditions given a particular world of evaluation: it will be true in any situation if g (that particular girl) sees r (that particular rainbow). If we want to give the more general meaning that this is a function across worlds, we add in our λw which turns this into a function over worlds (w is, perhaps unsurprisingly, a

variable used for worlds); this is often considered to be introduced at higher levels in the syntax (we will leave other complexities of the equation in (11) out for now, such as the model dependence of the meaning of each of the content words, and assignment functions that we will see more about in Chapter 4).

- (11) $\llbracket \text{the girl sees the rainbow} \rrbracket = \lambda w. g \text{ sees } r \text{ in } w$
 ‘The function which takes in worlds and returns TRUE for those in which the girl g sees the rainbow r and false otherwise.’

Focusing on the compositional aspects, we can follow precisely this same procedure with a sentence in a sign language. Let’s look at several component pieces from American Sign Language and how they combine, as exemplified in (12). In (12a), we see that the semantic value of the verb



SEE

is a function that needs first one individual argument (the theme) and then another individual argument (the agent). The semantic value for



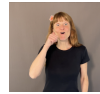
RAINBOW

is the rainbow (12b), and this composes as the theme argument



SEE


for (12c). Finally, the semantic value for



GIRL

is the girl, which composes as the agent argument (12d). The result are the truth conditions in a particular world, and we can define the proposition as the function over worlds in which those conditions hold (13).

- (12) a. $\llbracket \text{SEE} \rrbracket = \lambda x \lambda y. y \text{ sees } x$
- b. $\llbracket \text{RAINBOW} \rrbracket = \text{RAINBOW} = r$
- c. $\llbracket \text{SEE} \rrbracket (\llbracket \text{RAINBOW} \rrbracket) = \lambda x \lambda y. y \text{ sees } x (\text{RAINBOW} = r) = \lambda y. y \text{ sees } r$
- d. $\llbracket \text{SEE} \rrbracket (\llbracket \text{RAINBOW} \rrbracket) (\llbracket \text{GIRL} \rrbracket) = \lambda y. y \text{ sees the rainbow} (\text{GIRL} = g)$
- $\llbracket \text{GIRL} \rrbracket \llbracket \text{SEE} \rrbracket \llbracket \text{RAINBOW} \rrbracket = g \text{ sees } r$

- (13)  $\llbracket \text{GIRL SEE RAINBOW} \rrbracket = \lambda w.g \text{ sees } r \text{ in } w$
 ‘The function which takes in worlds and returns TRUE for those in which g (the girl) sees r (the rainbow) and false otherwise.’

We can of course also present the same compositional process using glossing of the signs instead of pictures, as in (14)- we will frequently see glossing used when pictures are not available, in this text typically when citing examples from previously published works. But, it’s always important to keep in mind that glosses represent the signs, so that (13) is a more direct representation of the endeavor (and hopefully highlights the non-circularity of this process, as a bonus).

- (14) a. $\llbracket \text{GIRL SEE RAINBOW} \rrbracket = \lambda w.g \text{ sees } r \text{ in } w$
 b.




Finally, let us consider this compositional approach in light of the approach to semantics that we are taking in this book, where we expect sentences to convey both representations of particular events and of propositions. The idea is that a sentence in English that we would write like *The girl saw the rainbow* or in ASL that we would gloss GIRL SEE RAINBOW can have the same propositional semantic value. Let’s look at the ASL sentence in (15), which has the propositional semantic value that we have been discussing as well as possibly the representation for a particular event, in this case a scenario in which a girl looks at a rainbow, pictured in (15) and notated with a double parents $\langle \rangle$ to evoke the notion of a camera taking a picture, although it’s going to be less helpful to think about it as a function of its pieces since the whole point is that it is not going to be compositional in the same way as the symbolic/propositional contribution. In terms of its content, note that this event has to include, say, the rainbow up in the sky and to the side (not, say, near the ground or in the center), since SEE depicts looking upward to the side. In the model of this sentence as it is presented so far, that is not a propositional contribution but it does seem to bear on the image/experience of the event.

(15) **Propositional representation:****Particular event representation:**

Finally, it is clear that we attempt to reconcile the results of these simulation vs. symbolic representations, as we generally do for other kinds of dual representations in the mind, so the kinds of particular events that a sentence evokes will influence the exact functions we take the symbols to denote, and in reverse, that the propositional representation certainly in turn influences and can in large part drive the way that we represent a particular event.

Why are we going through all of this trouble to differentiate the propositional contribution from representations of particular events? Could we try to think about these as part of the same kind of meaning, as most people do? It's certainly possible to try to encode the depictive details as parts of propositional meaning contribution. It's also possible to try to model propositional meaning through a kind of simulation/representation of an event. However, one kind of argument for not collapsing these two kinds of meaning into the same thing will come from Chapter 2, when we discuss the way that answers to questions and alternatives seem to be incompatible with depictive/iconic content. In addition, it allows us to simplify things at this point when we look at a sentence that involves a depictive component that adds or affects our representations of events, such as a different attitude, slightly different depiction/orientation of the rainbow, etc, but doesn't seem to change the propositional contribution in terms of which situations we are asserting as true. All sorts of things can affect a representation of a particular event, and they're certainly not limited to sign languages; many researchers have highlighted this kind of meaning in spoken language generally (Clark, 2016), spoken language ideophones specifically (Dingemanse, 2015; Kita, 1997) and sign languages (Ferrara and Hodge, 2018; Hodge and Ferrara, 2022). In addition, there seem to be all sort of things that affect a propositional semantic contribution without affecting our representation of



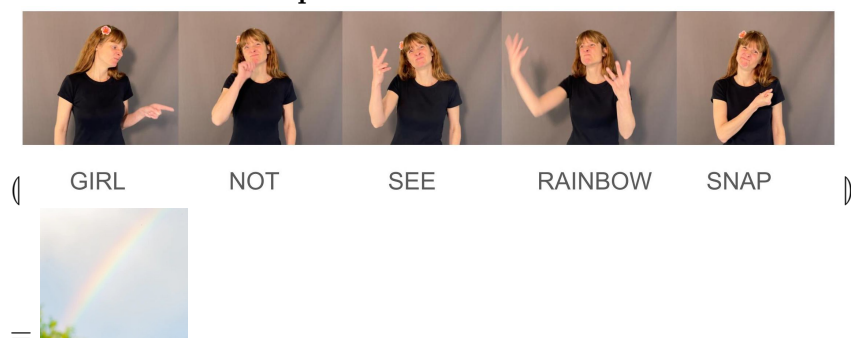
a particular event. Consider, for example, the sign . When negation like this is added to a sentence, we end up with completely opposite truth

conditions (16a), whereas our representation of a particular event seems to be affected very differently, and in fact may not convey any particular experienced-like event at all, since nothing is claimed to have happened. Alternatively, it might simply convey some aspects which are taken to exist, such as the girl and/or the rainbow (16b).

(16) a. **Propositional representation:**



b. **Particular event representation:**



At this point hopefully the approach is clear: we are interested in the propositional component of meaning in sign languages most notably for its compositional properties and how it allows us to reason about the world, while at the same time understanding how it interacts with the way that we represent particular events, which seems to be the target of so much of the depictive and affective content in human languages. The idea is that by tracking both together, we can understand the separate roles that they play, and, ultimately, understand the also numerous ways in which they are able to interact in different areas of human language in general, and in sign languages in particular.

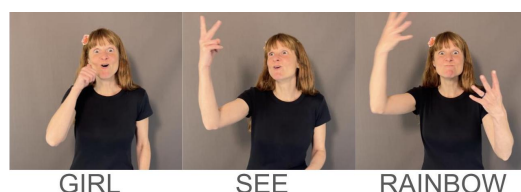
4 Information: entailment, presupposition, and implicature

One motivation for investigating propositional meaning in depth is the argument that it supports all kind of reasoning, most notably the entailments that follow from sentences. In this section we will focus on separating different kinds of inferences that arise in language and how to think about them

through this dual propositional/event particular lens.

Let's remember our earlier sentence (17). Under many circumstances, we tend to expect that the people we are talking to are telling the truth and mean what they say. So, imagine that someone signs (17). What are some possible things that we can conclude? For one thing, we can conclude that someone has seen a rainbow.

(17) a.



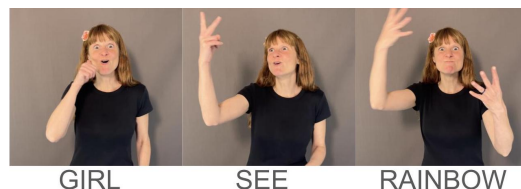
'The girl saw the rainbow'

Entails:

b. Someone has seen a rainbow.

In fact, this is a logical relationship: there is absolutely no situation in which the target sentence is true, but *Someone has seen a rainbow* is false. As we've already mentioned, we call this relationship **entailment**: sentence (17a) entails sentence (17b) because there is no situation in which (17a) is true but (17b) is false. There are several entailments of (17a); some others are in (18).

(18) a.



'The girl saw the rainbow'

Entails:

b. There was a rainbow somewhere.

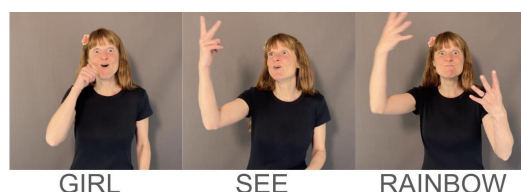
c. It is false that the girl didn't see a rainbow.

So, while (17a) tells us something rather specific, we can also conclude many other facts from this information. How are we able to do this? Formal semanticists are motivated by this kind of data in assuming that humans are using an underlying logical system in this kind of reasoning, and that it is the same one that allows us to understand the meaning of sentences that we've never encountered before.

We can also infer new information via **implicature**, a category of inferences that are cancellable, unlike entailment. Implicatures can arise based

on real world knowledge, as in the case in (19) which is based on the fact that rainbows are easier to see outside because they're up in the sky. This is an implicature and not an entailment because we actually can imagine a scenario in which the girl saw the rainbow but wasn't outside: perhaps she was looking through a window. Implicatures can also arise through reasoning about the amount of information that someone might share. For example, another implicature might be that the girl didn't cause or create the rainbow, because if she had made the rainbow herself (drawn it, made one in a lab using a crystal and light refraction, etc.) then we probably would have said that instead of just that she saw it. But of course, this is just an implicature and not an entailment: we can quite easily imagine a scenario in which she did create the rainbow and also saw it.

(19) a.



'The girl saw the rainbow'

Implicates:

- b. The girl was outside.
- c. She didn't create the rainbow.

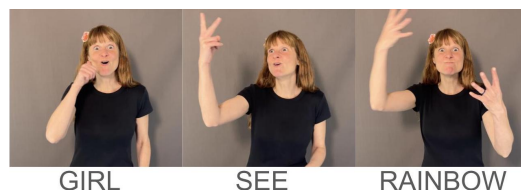
A third category of inference is known as **presupposition**, the information that not directly asserted but rather already presumed. For example, the English sentence in (20a) presupposes that there is a unique girl (and a unique rainbow) in the context that will be familiar to the participants in the conversation (20b). This is known as the uniqueness presupposition of the English definite article *the*. The ASL sentence in (21a) doesn't have a definite article, and seems to be able to be used in the English contexts as well as in contexts in which there is no girl already given in the context, but rather it introduces the girl to the discourse. We have not so far been focusing on this difference, but it is an example of the cross-linguistic differences that you can find between any two languages in something that seems to have similar assertive content, i.e. they have quite similar entailments but differ in presuppositions.

(20) a. *The girl saw the rainbow*

Presupposes:

- b. There is a unique girl

(21) a.



‘The girl saw the rainbow’

Does not seem to presuppose:

b. There is a unique girl

A notable feature of presuppositions is that their content seems to be unable to be targeted by logical operators, i.e. their meaning persists or “projects” past negation and in question and conditional statements. Consider, for example, the sentences in (22), which are known as the “P(-resupposition) family” of sentences: they involve the positive sentence (22a), its negation (22b), its polar question form (22c), and a conditional in which it is the antecedent (22d). Although these drastically change the proposition that is asserted (in fact, (22a) and (22b) are entirely complementary propositions), they all still presuppose that there is a unique girl for purposes of the conversation.

(22) a. *The girl saw the rainbow*b. *The girl didn’t see the rainbow*c. *Did the girl see the rainbow?*d. *If the girl saw the rainbow, she smiled.***These all presuppose:**

e. There is a unique girl

This resistance to being targeted by different logical operators (i.e. presupposition projection) is a hallmark of presuppositions, and differentiates them from both entailments and implicatures. Notably, however, the backgrounded nature of presuppositions (whether they need to already be known before the sentence is uttered) and their projectivity are dissociable features. You could, for example, convey new information in a form that projects past these same logical operators, such as in a non-restrictive relative clause: *The girl, who I am meeting tomorrow for lunch, saw/didn’t see the rainbow.* For more exercises on the differences between entailment, implicature, and presupposition, the reader is referred to Chapter 1 of Chierchia and McConnell-Ginet (2000) for more examples in English. These categories should be viewed as a helpful way to organize the inferences involved in sentence meaning, but not in a way that should be taken as exhaustive of

possible categories: many features of them can be analyzed independently, and this is part of an interesting area of research at the semantics/pragmatics interface in both spoken and in sign languages, as we will see.

In sign language linguistics, presupposition becomes relevant in discussions about iconic depictions because they, too, often seem to “project” past certain operators in patterns that are quite similar to classic presuppositions, both in co-speech gestures accompanying spoken language and in iconic aspects of sign languages (Schlenker, 2021; Tieu et al., 2019). Thus, a big picture question we will return to in the Conclusions chapter of this book is why and how we might want to think about depictions with respect to presuppositions. Several accounts are presented; the one we will tend to take in this text is that iconic depictions appear to project because they are not propositional, that is, they cannot be affected by propositional operators like negation or conditionals. In some sense, this makes their projection behavior less stipulative than many other presuppositions (such as, say, the definite article *the*) which otherwise seem to be stated as conventionalized fact, the lexicalization of which varies from language to language (some languages mark definiteness, others only specificity, others neither). We might even take the sign language patterns to suggest that we look for similarly explanatory answers in spoken language presuppositions.

5 Fieldwork and semantics in understudied languages

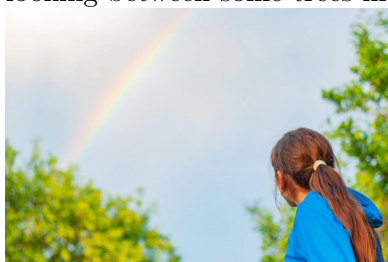
So far we have motivated our study of meaning by data from both English and American Sign Language, and so it is worth discussing the status of semantic data from different spoken and signed languages. For much of its history, the study of semantics in general and formal semantics in particular was focused on a very small number of human languages, notably English and German. Many features that are well represented in these languages have thus subsequently been well represented in literature on semantics. Classic examples are definite determiners (English *the*) or nominal quantifiers, which are not unique to these languages but are also not found in all languages of the world (Partee, 1995) and yet have been the focus of entire chapters in many introductory linguistic texts, and the subject of much of the most interesting semantic theorizing. This is in part for good reason: these topics are fascinating and provide excellent windows into semantic structure. On the other hand, there are surely topics that have been understudied because they appear less prominently in these well studied languages, such as noun class/classifier systems, the effect of discourse configurational word orders on semantics, adverbial quantification, the role of intonation, evidentiality, and many others. This is especially true in sign languages, in which it is often tempting to go looking for similar structures to spoken languages

instead of investigating the languages on their own terms.

Nevertheless, there have been major strides in work on understudied languages in semantics especially in the last decade or two, and efforts to increase knowledge for fieldwork by semanticists and semantics for fieldworkers. Bochnak and Matthewson (2015) provide detailed suggestions for doing semantics on understudied languages, most notably the elicitation of acceptability judgments for gathering semantic data. Since this is such a core notion to collecting semantic data, let us illustrate the idea here.

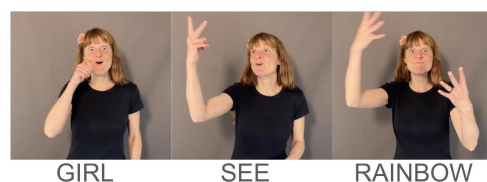
A basic acceptability judgement setup involves presenting a context in any multitudes of mediums: typically using language, but could also be a picture, or both. Then, a linguistic form is presented in this context, and members of the linguistic community are asked if the language utterance is acceptable in a given context. Let's exemplify an acceptability judgment in (23), which includes a pictured context and two sentences in ASL.

- (23) **Context (presented in English text and picture):** A girl is looking between some trees into the sky at a rainbow.



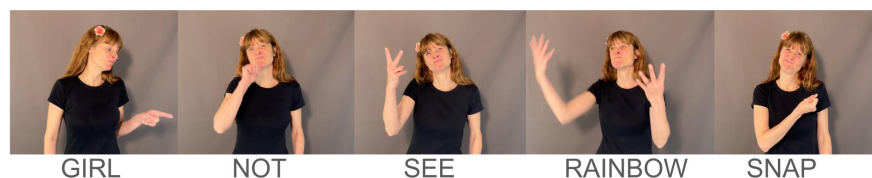
Target sentences:

a.



(acceptable in this context)

b.



(not acceptable in this context)

These are extremely simple (and quite obvious) examples, but the concept is that the sentence in (23a) is judged acceptable in the given context, while the same sentence with negation in (23b) is judged to be not acceptable

in the same context. This tells us that at a minimum, these two sentences differ in some meaningful way; knowing what we do about the language,



this should hardly be surprising since provides nearly the opposite meaning, but if we were wanting to investigate the meaning of this form from an absolute beginning starting point, this would be a great place to start.

Acceptability judgements are not the only kind of data that we use in semantics; we can look at natural productions and assume that they are acceptable in their context (the downside is that sometimes natural productions don't include a nice minimal contrast like that in (23)). We can also ask for inference judgments, like whether we could infer (23b) from (23a) (we likely would not), or we could ask for an ordering of preferences for which forms are better/worse given a context. Some of these investigative means will be better or worse for different semantic/pragmatic phenomena, and for different data gathering contexts. For example, sometimes we might want to gather data from a wide range of participants through an online study/experiment, while in other situations we can focus more closely on the language of a very small number of language users. In general, we will not make a strong distinction between experimental and non-experimental work in this book, taking the view that it is a gradient notion especially within linguistics, where data collection of the minimal pair sort that we see in (23) is common even in "theoretical" papers, a kind of mini experiment (Davidson, 2020; Matthewson, 2022), so the goal will be to digest the literature out there to lay out the theoretical story. Underlying this is, certainly, a push for better and stronger data collection across all sign languages; for more resources on approaching this, the semantic fieldwork literature is a broadly very useful starting point (Bochnak and Matthewson, 2015; Deal, 2015), along with growing work on experimental semantics/pragmatics (Schwarz, 2014; Noveck, 2018; Cummins and Katsos, 2019).

6 On notation

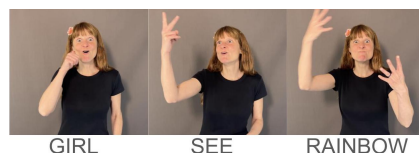
Human language has the potential to be produced and comprehended in many modalities: the text used to write or read this paragraph is one form of language, but this book will often be discussing language that exists in another medium: speech or sign. There are long used conventions for representing speech via text: I'll typically use English orthography as in (24a), but the International Phonetic Alphabet is another option to more accurately represent the form of the words in spoken English (24b). Although both are helpful and used in semantics (truthfully, English orthography is overwhelmingly used in formal semantics to represent English), neither rightfully

capture many properties of speech that we might be interested in for purposes of studying meaning, such as facial expressions, prosodic breaks, etc. They also, obviously, fail to capture co-speech gestures that often contribute to meaning in dialogues that are primarily based on spoken languages like English.

- (24) a. The girl saw a rainbow.
 b. ðə ɡɜːl sɔ ə 'reɪnbəʊ

A similar pattern holds true for sign languages, except that there is no clearly conventionalized orthographic representation for representing ASL to the same extent that there is for English. The most common method for representing ASL on the page are semi-conventionalized glossing into English of the sort in (25a), and we will make some use of these as well. When possible, for any glossing of examples presented anew in this text from ASL, I aim to follow the SLAASh ID glossing principles (Hochgesang, 2020) and employ conventionalized/searchable ID glosses for ASL from the ASL Signbank (Hochgesang et al., 2020). However, glossing from examples cited from other works are typically given in the forms that those authors used, especially in the case of other sign languages, in order to prioritize faithfulness to the original source. Most importantly, however, just like IPA is not the full picture of English but is much more faithful to linguistic forms than conventionalized English orthography, most sentences in this text also include still images of the signs used in each sentence, to more directly represent the forms used, as in (25b). Like IPA for spoken language this will not convey timing and other finer details, but it should give a much more clear and accurate sense of the object language than glossing alone, and hopefully allow us to focus on the sign language itself, and not the glosses, as the object of study.

- (25) a. GIRL SEE RAINBOW
 b.



In general, glosses capture symbolic/propositional content well, and struggle more with capturing depictive content. This is inherent in the form: text is intentionally symbolic, whereas pictures more often accurately convey depictive content in signed languages. Thus, instead of using too many glossing symbols which assume a symbolic analysis, this text will aim to use the simplest gloss possible and then illustrate further details of the form through

the pictures. For example, repetition can be glossed in symbolic ways (e.g. + + +) but this seems to assume a symbolic analysis; similarly, verbs that include quite a lot of depiction are sometimes glossed simply as if they are just as symbolic as a word (e.g. GIVE, MOVE). Since we are ultimately interested in how these symbolic and iconic components interact (and fail to interact), the pictures should be considered the ultimate reference for the sentence, with the gloss an additional, secondary source of information.

In the following chapters we will focus on different areas of research in formal semantics of sign languages and synthesize this research into as coherent a picture as possible. Instead of building up from the smallest pieces, though, we will start by investigating the largest pieces (questions in a discourse and their answers) and work our way down to smaller pieces that include sentences and their connectives, and eventually nouns and verbs and quantifiers, until we cut across other dimensions such as countability and intensionality, before returning at the end to the issues raised in this chapter: how sign languages fit into the larger picture of how we model meaning in human language.

2

Questions, answers, and information

We’ve talked about two ways that language can convey meaning, with the idea that one route functions to evoke a particular event experience, and the other is for resolving issues via propositions built from symbolic compositional structures. In this chapter, we’re going to dig into the latter to a much greater extent. The view we pursue follows classic work by Roberts (2012) (first published in 1996) in roughly taking questions and answers to be the backbone of the way that issues are resolved in a discourse, in order to model the backgrounding/foregrounding of information in language, often called the **information structure**. In sign languages, we can see reflections of the question-answer discourse structure in the form of some sentence structures, which we will showcase in this chapter. Moreover, questions and their possible answers (the latter of which which form **alternatives** to each other) provide a useful way to probe and categorize the kinds of linguistic forms that can give rise to propositional meaning (descriptions) from those that only bear directly on particular events (depictions).

In the previous chapter we introduced the idea that propositional meaning can be thought of as a function that divides the circumstances in which a sentence is true from those in which it is not. That is to say, we introduce a truth-conditional semantics for propositional meaning. This allows us to model the meaning of things that don’t happen just as easily as those that do (such as never seeing a rainbow), and also allows us to model entailments: one utterance entails another if in all situations in which the first is true, the second is also true. It also allows us to model new information as a restriction on the ways that the world might be that are in the common ground, so that we can view information exchange as eliminating possibilities. There is yet another advantage to this view of propositional meaning as possible worlds: it allows us to model *questions* as requests for particular ways of updating the common ground. Consider, first, a polar question (the

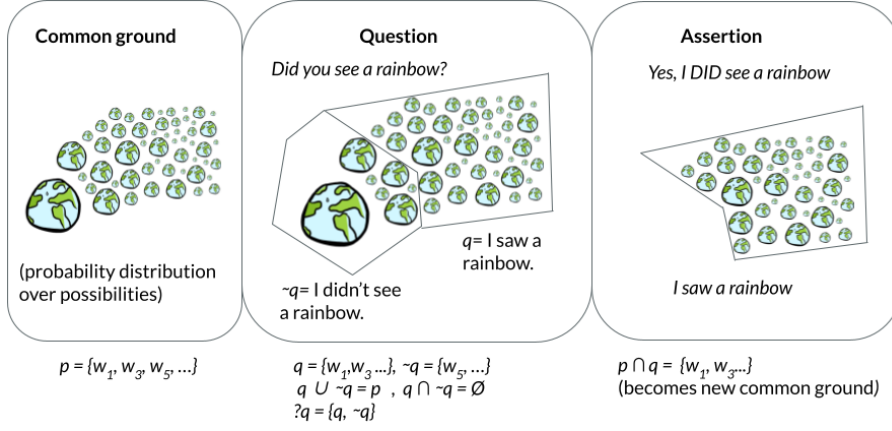


Figure 2.1: Narrowing possibilities via a polar question

kind of question to which you can answer *yes*, or *no*), such as *Did you see a rainbow?* From the perspective of propositional meaning, each polar question is a request for the interlocutor to determine which set of two (infinite) sets of possibilities might be right: either the worlds where the answer is YES (e.g. I DID see a rainbow) or the worlds in which the answer is NO (e.g. I DIDN'T see a rainbow). A visual schematic representation of this question-answering process and the associated narrowing of possibilities can be seen in Figure 2.1.

Although precise implementations differ, this general view of questions as a set of possible answers is commonly accepted in formal semantics as a way to model the behavior of questions not just when they are asked directly, but also indirectly as embedded clauses, e.g. *She wondered if you saw a rainbow.* (Hamblin, 1976; Karttunen, 1977; Groenendijk and Stokhof, 1982, 1984). The schemas used in Fig 2.1 reflect a particular implementation of this idea of questions as partitions on the set of possible worlds by Groenendijk and Stokhof (1984); in contrast, taking the question to be a set of propositional alternatives (e.g. $\{I \text{ saw a rainbow}, I \text{ didn't see a rainbow}\}$) builds from the work of Hamblin (1976) and Karttunen (1977). Although we won't go into the detailed semantics of embedded questions much here, this can be motivated also by unembedded questions: someone raises a question by providing a set of possible ways to update the discourse, and their interlocutor answers it by choosing from among those possible updates. In this kind of view, backgrounded information is what is already presumed by the combination of a common ground and its partition, while new, focused information is contributed by the answer (Roberts, 2012; Rooth, 1992).

The form of overt polar questions has been relatively well studied for some sign languages, in part because a robust pattern has been observed: the polar question typically differs from the corresponding assertion in its

suprasegmental features, i.e. sometimes there is no difference between the manual signs of the assertion and the polar question. Suprasegmental distinctions between polar questions and assertions are found spoken languages too, as in Italian (26a-b), where we can see that the words are the same for the assertive statement and the question, but the difference is expressed through intonation (reflected in the orthography only in the presence of a question mark).

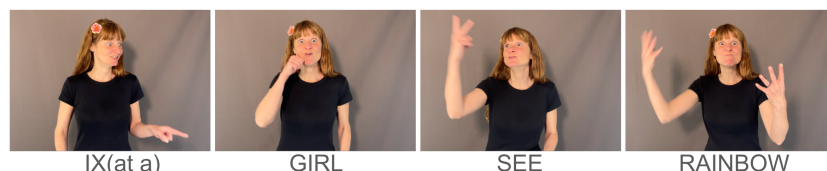
(26) (Italian)

- a. *Laura ha mangiato.* ‘Laura ate.’
- b. *Laura ha mangiato?* ‘Did Laura eat?’

While neutral questions in English frequently are marked segmentally with auxiliary inversion, e.g. *Did... ?*, prosody can also differentiate certain interrogatives from declaratives in English e.g. the rise at the end of a biased declarative question like *She saw a rainbow?* (Gunlogson, 2004).

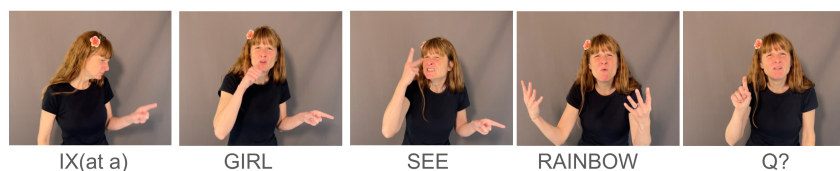
An example of the suprasegmental difference between the declarative question in ASL and the polar question can be seen in (27a)-(27b): the first has neutral expressions while the second is much more marked, especially via the eyebrows. Suprasegmental information in sign languages is conventionally called **nonmanual marking**, to distinguish it from the manual based signs. Nonmanual marking can be represented above the signs in which it appears, as in (27c-d), the glossed version of (27a)-(27b).

(27) a.



‘The girl saw a rainbow.’

b.



‘Did the girl see a rainbow?’

c. IX GIRL SEE RAINBOW

d. IX GIRL SEE RAINBOW ^{polar-q} Q?

(27b) and (27b) also exemplify the sentence-final question marker Q, which is optional in ASL. In terms of spoken language typology, question

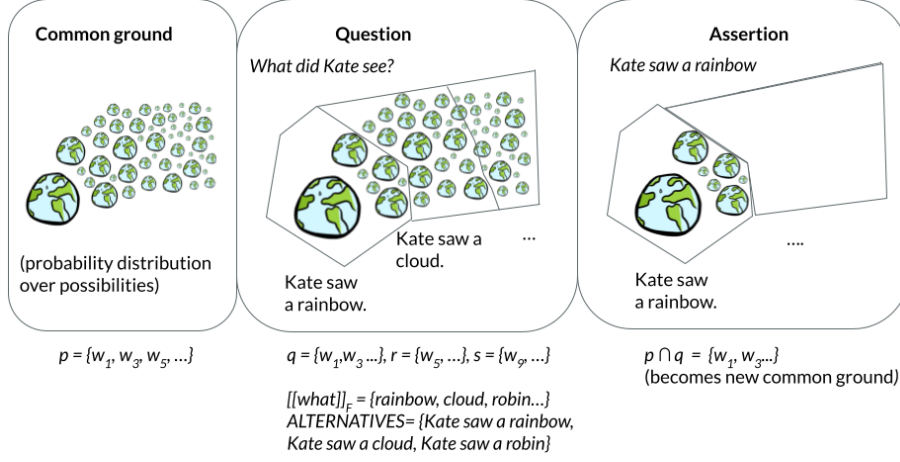


Figure 2.2: Narrowing possibilities via a constituent question

particle like this are the most common option for marking the declarative/polar question difference (Dryer, 2013). We see two strategies involved in polar questions in ASL, then, using nonmanuals and question particles, both of which are represented in (27) but notably one thing that ASL does not do is use auxiliary inversion of the sort familiar from English (*Did the girl...*), one of many places where these two languages differ in their structure.

Polar questions also raise interesting questions about the ways that they can be answered, i.e. the forms and meanings of different polar **response particles**. Negative polar questions made especially interesting test cases: asking *Is it not raining?* in English can lead to the felicitous response *No, it's not.* and also *Yes right, it's not.*; other languages make finer or different distinctions in the meaning of their response particulars (e.g. the French three-way distinction between *oui*, *non*, and *si*). Loos et al. (2020) provide a detailed investigation of possible polar response strategies in German sign language (DGS) and fit them into a larger typology of spoken languages while Gonzalez et al. (2019) investigate these distinctions in ASL.

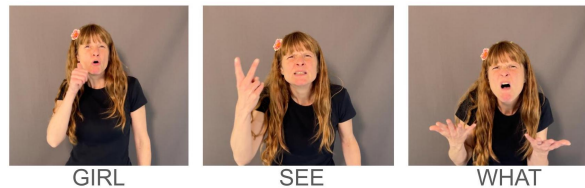
Polar questions aren't the only kind of questions, though: we can see another example of questions that function as a discourse organizer in constituent questions (sometimes called **wh-questions**, using *who*, *what*, *when*, *where*, *why*, etc.). We can model their semantics as an extension of the semantics we gave for polar questions, illustrated schematically in Fig. 2.2.

The wh-question provides a set of alternative ways to update the discourse, which are based on different answers, e.g. in this case things that Kate saw (due to the question, *What did Kate see?*). A possible partition is $\{Kate\ saw\ a\ rainbow, Kate\ saw\ a\ cloud, Kate\ saw\ a\ robin\}$, which would be the partition if we limited the possible objects seen to only these three

options, and also limited the seeing to a single object. We can imagine loosening both of these requirements so that the list of possible objects seen is much less constrained, and also allowing multiple possibilities, e.g. *Kate saw a rainbow and a cloud*, which would then count as its own answer (separate from the single answers *Kate saw a rainbow* or *Kate saw a cloud*). In other words, under this system we should view answers as **exhaustive**: if the answer is *Kate saw a rainbow* then it means the same thing as *Kate saw only a rainbow*, in response to the question *What did Kate see?*.

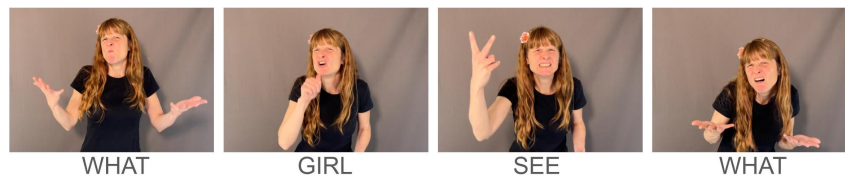
When it comes to the form of constituent questions in sign languages, it is a notable feature that many sign languages seem to also have required suprasegmental marking for wh-questions, as the nonmanual marking seen in (28) (for wh-questions in ASL, this is often described as “brow furrowing”, in contrast to “brow raising” often seen in polar questions). It has been a matter of much discussion in the literature on sign language syntax where exactly wh-words are permitted to occur in the word order of sentences in sign languages: see Petronio and Lillo-Martin 1997 and Neidle 2000 for overviews. Cecchetto et al. (2009) detail a way that the seemingly typologically unusual word order for questions found in sign languages of the world relates to the use of nonmanual marking: they note that sign languages frequently have sentence-final wh-words, while in spoken languages wh-words are frequently sentence-initial if they are not pronounced in their canonical position. From a pure syntax perspective, this is a major puzzle, with no obvious reason for a difference between signed vs. spoken modalities. However, Cecchetto et al. (2009) attribute this difference to the ability of the nonmanual marking to convey appropriate semantic/syntactic dependencies, i.e. to use nonmanual marking to convey the question status of an utterance and to relate any dislocated wh-words to the argument positions in which they are interpreted. We will not go especially deeply into this primarily syntactic issue, but we can see some evidence of that in a sentence like (28c), where the wh-word is sentence-final even though it queries the subject, which would typically be sentence initial in ASL. At the same time, we see a sentence-initial wh-word in (28b), despite the word querying the object, which typically follows the verb. So, there are ways that a wh-word may end up sentence-initially, or sentence-finally, in both cases potentially differing from the canonical position of the constituent it queries (the word order for the assertion is subject-verb-object, i.e. GIRL SEE RAINBOW).

(28) a.



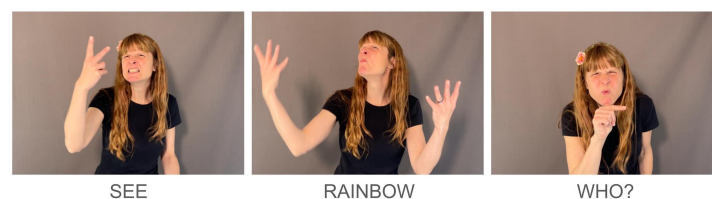
‘What did the girl see?’

b.



‘What did the girl see?’

c.



‘Who saw a rainbow?’

Regarding semantics and pragmatics, the point we have been emphasizing is that questions partition the common ground, and assertions that answers those questions can be modeled as narrowing information by eliminating possibilities, a way of organizing a discourse. This view of discourse as a series of questions and answers broadened its implications even further when it was extended by Roberts (2012) to model discourse when the question was implicit. Roberts argues that every statement is implicitly an answer to some Question Under Discussion (QUD), whether it is a very general question, for example, *How are things?*/ *What do you know?* or a more specific question, for example, *Should I bring an umbrella?* This has the advantage of accounting for information structural properties of sentences such as focus placement. For example, in the context of the question *What did Kate see?*, the sentence with focus on the object is acceptable (29a) but the same sentence with focus on the subject is not (29b), reflecting the requirement for question-answer congruence (Rooth, 1992).

(29) What did Kate see?

- a. Kate saw a RAINBOW. (acceptable answer)
- b. KATE saw a rainbow. (unacceptable answer)

Importantly, focus placement reflects QUDs even when the question has not been stated overtly. For example, the context in (30) doesn’t involve any overt questions, but it seems to raise the same question *What did Kate see?* implicitly, so that it has become the Question Under Discussion that ideally should be answered by the conversational participants. Thus, focus placement in the assertion should reflect its status as an answer to this question. There are many ways to add complexity to this picture, including sub

questions under discussion etc. (see Buring 2003 for an immediate extension to contrastive topics) but this rough outline forms a useful foundation for what follows.

- (30) Context: Kate returns from the window with a big smile on her face, saying *So beautiful!*. Someone close to the window announces to the rest of the room:
- a. Kate saw a RAINBOW. (acceptable continuation)
 - b. KATE saw a rainbow. (unacceptable continuation)

In the remainder of this chapter we will highlight specific ways that sign languages make use of the structure of a discourse and reflect it in linguistic forms, and how this interplays with other aspects of the language. The first section will discuss question-answer clauses in sign languages, a well studied area in sign language linguistics that becomes simpler when we think about it as an overt manifestation of this question-answer structure of dialogue and information packaging. We will then move on to more complicated discourse structures that allow for foregrounding/backgrounding information such the use of sentence final focus positions, and then topicalization. In the fourth and final section we will discuss the interaction of depictive content and questions, showing that alternatives are not compatible with depiction and representations of particular events, only propositional meaning.

1 Question-Answer clauses

We begin with a structure that follows quite naturally from the view of a discourse as structure by questions and their answers. In American Sign Language, one common way to express backgrounded/foregrounded information is actually through a sentence that contains what looks like a question-answer pair, as in example (31). A non-exhaustive list of other languages that have a similar type of sentence structure are the sign language of the Netherlands (Kimmelman and Vink, 2017), Russian sign language (Khristoforova and Kimmelman, 2021), South African sign language (Huddleston, 2017), and Hong Kong Sign Language (Gan, 2022).

(31)



‘What the girl saw was a rainbow’

We might naturally wonder: are these simply examples of someone asking a question in the way one usually does, and then **answering it themselves**, basically playing two different roles as in (32)? Or, is it a more conventionalized sentence structure, something like the English **pseudocleft** in (33)?

(32) Person A: What does the girl see?

Person B: She sees a rainbow.

(33) What the girl sees is a rainbow.

Both of these share an important pragmatic property with question-answer clauses, which is that they present the answer part (the rainbow) as new, focused information, and the question part (what the girl saw) as old backgrounded information. However, although similar in their pragmatic properties they differ quite a bit in their syntactic/semantic properties: the discourse question-answer pair in (32) involves two separate sentences, while the pseudocleft in (33) is a single unified clause with a main verb that is the copular verb *is*. Each has been suggested as an analysis of the sign language question-answer pair structure. Neidle (2000) propose that the ASL question-answer pairs are, underlyingly, just like questions and answers in a discourse between participants, except that one person is basically playing both roles. In contrast, Wilbur (1994) analyze the ASL version as in (31) as a pseudocleft, equivalent to English (33).

Let's first focus on the similarities, namely, what is backgrounded and foregrounded across the three structures (discourse question/answers, the QAC in ASL, and the English pseudocleft). In each the answer part (RAINBOW) is new and the question part (GIRL SEE WHAT) is old. We can see evidence that the same pragmatics govern question-answer dialogues, pseudoclefts, and ASL question-answer clauses by comparing their acceptability in the supportive context in (34), in contrast to a context with a different QUD, in (35).

(34) Context: a bunch of people are wondering what the girl saw.

a. Person A: What does the girl see?

Person B: She sees a RAINBOW. (acceptable)

b. What the girl sees is a rainbow. (acceptable)

c.



(acceptable)

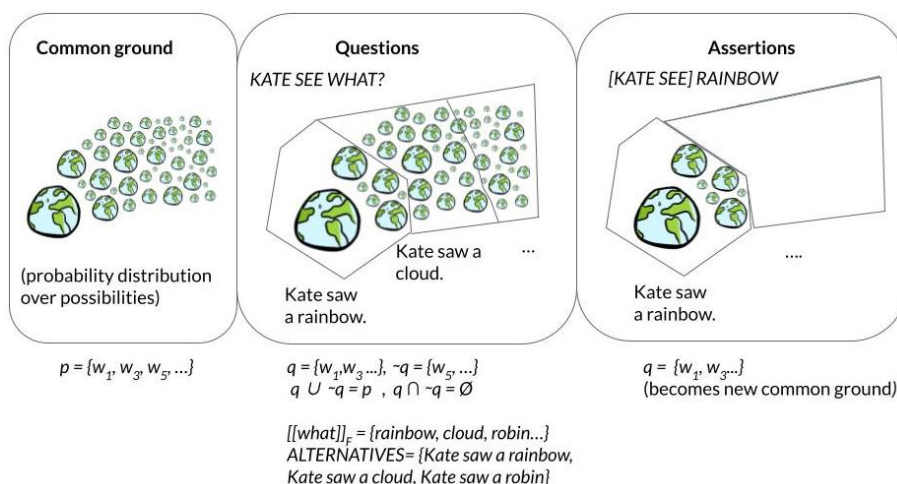


Figure 2.3: Narrowing possibilities via a question-answer clause

(35) Context: a bunch of people are wondering who saw the rainbow.

- a. Person A: What does the girl see?
Person B: She sees a RAINBOW. (not acceptable)
- b. What the girl sees is a rainbow. (not acceptable)
- c.









(not acceptable)

Taking pieces of both the discourse question answer pair structure and the pseudocleft structure, Caponigro and Davidson (2011) propose that the expression-types in (31)/(34c)/(35c) are a question and its answer in terms of their semantic/pragmatic contribution. We can think of this as in the schema in figure 2.3, where the question KATE SEE WHAT is raised, with the answer [KATE SEE] RAINBOW just as when there are two people in a discourse. However, their proposal is that the question and its answer are connected syntactically to each other in the same way as two parts of a pseudocleft are connected by a copula verb (*be* and its variants, which are often covert/unpronounced in ASL). Just like a copula verb in equative constructions can equate two things (e.g. [Mary] is [the winner of the game]), the copula verb in question-answer clauses in ASL can equate two things: the question clause, which has the semantics in (36), roughly [the answer to the question GIRL SEE WHAT], and the answer clause [GIRL SEE RAINBOW]. This

process is reflected in the compositional steps in (36), built upon existing work on the semantics of questions and answerhood operators proposed outside of ASL, e.g. Dayal (2002).

(36)

- a.  $\llbracket \text{GIRL SEE WHAT} \rrbracket = \lambda w. \lambda p [p(w) = 1 \wedge \exists x [p = \lambda w'. g \text{ sees } x \text{ in } w']]$
 $= Q_0 = \{p_0 = g \text{ sees rainbow in } w, p_1 = g \text{ sees bird in } w, \dots\}$
 ‘Takes a world and returns the set of propositions which are true in that world and which vary on what g sees’
- b.  $\llbracket \text{GIRL SEE RAINBOW} \rrbracket = \lambda w. g \text{ sees } r \text{ in } w$
- c. $\llbracket (be) \rrbracket = \lambda p. \lambda q [p = q]$
- d.  $\llbracket (be) \text{ GIRL SEE RAINBOW} \rrbracket = \lambda q [q = \lambda w. g \text{ sees } r \text{ in } w]$
- e. $\llbracket (Ans) \rrbracket = \lambda Q \lambda w ANS(w)(Q) \Rightarrow_{def} \lambda Q \lambda w \lambda w'. \forall p \in Q(w). [p(w') = 1]$
 ‘Takes a question and returns the proposition that entails all other true propositions’
- f.  $\llbracket (Ans) \text{ GIRL SEE WHAT} \rrbracket = \lambda w \forall p \in Q(w_0) [p(w) = 1]$
- g.  $\llbracket [(Ans) \text{ GIRL SEE WHAT}] (be) \rrbracket$
 $\llbracket \text{GIRL SEE RAINBOW} \rrbracket$
 $= \lambda w \forall p \in Q(w_0) [p(w) = 1] = \lambda w. g \text{ sees } r \text{ in } w$
 ‘The function that takes in worlds and returns TRUE only for the complete true answer to the question (What did the girl see?, in (36a)), is equal to the function that takes in world and returns true if the girl saw the rainbow in that world’

One notable aspect of this proposal is that much of the motivation behind the analysis presented in (36) was originally from analyses of spoken language pseudoclefts in English (Dikken et al., 2000; Schlenker, 2003). But, in fact, Caponigro and Davidson (2011) argue that there are several notable differences between QACs in ASL and pseudoclefts in English, suggesting that the given analysis which is along the lines of those proposed for pseudoclefts is actually much more appropriate for the QAC case than the pseudocleft case. This has implications for the analysis of English in return, of

course, for if the analysis is a better fit for ASL, then another solution will be needed for English to the extent that the two differ. And they do seem to differ. For example, there is a clear contrast between an English pseudocleft and ASL QAC in that pseudoclefts can't be formed with polar/yes-no questions (37). Another difference is that pseudoclefts require referential answers, whereas QACs can have quantificational/non-referential answers (38). Pseudoclefts can also only use a subset of possible *wh*-words in their language, but QACs allow any *wh*-word, including *WHICH* (39) (Caponigro and Davidson, 2011).

(37) a. *Does/Whether Alex sell books is no/yes.

b.



(38) a. ?What Alex sells is few books.

b.



(39) a. ?Which girl Alex likes is Mia.

b.



Each of these properties seems to involve a stronger restriction in the English pseudocleft than is seen in the ASL QAC, where instead the QAC patterns more like a question-answer pair in discourse; Caponigro and Davidson (2011) argue that they are a single clause based on, among other factors, their ability to be embedded as a single clause under attitude predicates.

While the above clearly differentiate English pseudoclefts and ASL QACs, the picture may more complicated, especially as we extend the inquiry beyond ASL to other sign languages. First, an intriguing idea by Kimmelman

and Vink (2017), extended by Hauser (2019), is that sign languages fall along a grammaticalization cline, with discourse question-answer pairs at one end and pseudoclefts at the other end, as in (40).

(40) Discourse Q & A's \rightarrow Embeddable QACs \rightarrow Pseudoclefts

This idea is further supported by findings in more sign languages, including Hong Kong Sign Language (Gan, 2022). That said, this perhaps raises even more questions, such as why polar questions would be lost for pseudoclefts. Moreover, when we look to spoken languages, the puzzle gets deeper: Korean, for example, seems to have a conditional-like structure that connects a question and its answer. Intriguingly, Korean QACs also permit (and in fact, favor) polar questions instead of wh-questions, ruling out a direct analogy with English pseudoclefts but suggesting a strong similarity with ASL QACs. This relates to another puzzle regarding nonmanual marking: in ASL conditional clauses are in fact marked with the same nonmanual marking seen in QACs (brow raising), which seems to further call out for a connection between the two. Further open questions involve whether a copula structure is the most plausible connection for these clauses, or if perhaps the clausal connecting structure in Caponigro and Davidson (2011) could be revised toward an analysis of the question and answer as connected via a conditional (e.g. *if... then*) semantic operator rather than a copula with an equative (e.g. *is equal to*) semantics. In any case, a major takeaway from QACs in general and their prevalence in sign languages of the world is in some sign languages they clearly use question-answer pairs (whether in clausal form or separate) to express focus by using an answer to a direct question, directly mirroring the structure of discourse proposed by Roberts (2012) as a method for directly reflecting information structure.

2 Sentence-final focus position

We saw in QACs that a question and its answer can be juxtaposed in a clause in order to focus the answer, placing the new information in a sentence-final position. This turns out to be a special case of a more general phenomenon of using the sentence-final position for focus in American Sign Language and seemingly many other sign languages too. In this section we zoom out to discuss a wider array of linguistic material that can appear at the end of a sentence: verbs, negation, and modals, all of which can appear sentence-finally for focus related purposes.

We saw above that negation can appear at the end of a sentence when there is a polar QAC, as in (41). In another expression that looks at least superficially similar, negation can also appear at the end of a sentence that is a simple negative declarative, as in (42). In this “doubled” negation version,

the main clause must already be negative, including with negative nonmanual marking (that negative nonmanual marking sets it apart in form quite noticeably from a QAC), and the first part is usually not seen as a question, but rather as a statement. In these cases, the sentence-final negation is “doubling” the negation in the main clause, not answering a question raised by that clause. The information structural effect is quite similar in the two constructions, though: both seem to focus the negativity/negative valence of the answer, as we can see in their acceptability in a context in which that is what is at issue (43).

- (41) a. $\overline{\text{MARY HAVE BOOK, NO.}}^{\text{br}}$ (Polar QAC)
 ‘Mary doesn’t have a book.’

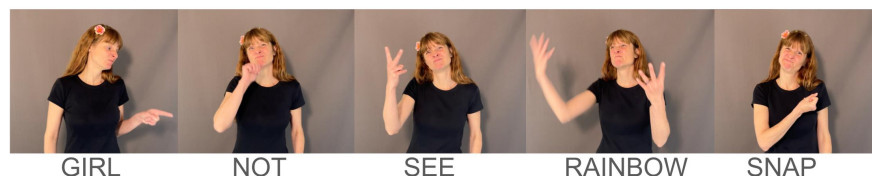
b.



‘Alex doesn’t sell books.’

- (42) a. $\overline{\text{MARY NOT HAVE BOOK, NO.}}^{\text{neg neg}}$ (Focus doubled negation)
 ‘Mary doesn’t have a book.’

b.



‘A/The girl didn’t see a/the rainbow.’

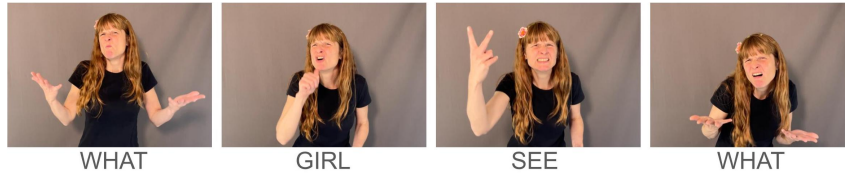
- (43) Context: A bunch of people are wondering whether or not Mary has a book.

- a. $\overline{\text{MARY HAVE BOOK, NO.}}^{\text{br}}$
 ‘Mary doesn’t have a book.’ (acceptable)
- b. $\overline{\text{MARY NOT HAVE BOOK, NO.}}^{\text{neg neg}}$
 ‘Mary doesn’t have a book.’ (acceptable)

These so-called “focus doubles” have received attention in the formal syntax/semantics literature in ASL (Petronio and Lillo-Martin, 1997) as well as in Brazilian sign language (Libras) (Lillo-Martin and de Quadros, 2004),

where they have been analyzed as markers of focus, with a dedicated focus syntactic projection that induces the focused constituent (in this case, negation) to be pronounced sentence-finally as well as optionally in its canonical position. This analysis is supported by the emphatic effect they seem to have, as well as parsimony with the other uses sentence-final position, which is also used for wh-words in ASL (wh-words in questions are considered to be focused); recall that wh-words themselves can be doubled in ASL (44).

(44)



‘What did the girl see?’

Davidson and Koulidobrova (2015) note that while verbs, negative words, and modals all share the sentence-final position, when it comes to what may and may not co-occur together in a sentence, the positive doubles are in complementary distribution with any forms of sentential negation. They take this to be evidence for doubling as a marker not of constituent focus but of polarity focus, building on work on polarity marking in sign languages by Geraci (2005). Under this analysis, when the issue at stake is about the truth of a sentence (i.e. when there is a polar QUD), adding a non-negative double is licensed when the answer is positive, whereas if the answer is negative then adding a negation (internally to that sentence only, or internally and via a double) is allowed.

At this point, the picture of discourse structure in ASL is the following: QACs instantiate part of the QUD-answer discourse structure. Doubles are used when the polarity of a clause is under discussion (i.e. when the QUD is a polar question). This raises a natural question about what happens when these interact: how do polar QACs work, i.e. what happens when negation is sentence-final because it is the answer to a QAC? Especially, what happens when the “question” part before the negation is both a question and has negative polarity? In this case, the whole thing is interpreted as a negative QAC, as in (45).

(45) $\overline{\text{MARY NOT HAVE BOOK, NO.}}$ ^{br neg}
 ‘Mary doesn’t have a book.’

Gonzalez et al. (2019) investigate these particular structures in depth in ASL, finding an interesting pattern: a negative answer to a negative question is always interpreted as disagreeing with the negative polarity, i.e. expressing a positive polarity. In other words, a negative answer to a negative QAC

can't be interpreted as agreeing with the negative polarity expressed in the question, i.e. expressing the negative version, even though this is possible for question-answer pairs in a discourse (e.g. across two participants) in ASL (just as in English). This restriction is illustrated in (46), which involves a claim and then a disagreement with that claim via QAC, used to support making the negative QAC appropriate in terms of its information structure.

(46) (ASL, Gonzalez et al. 2019)

Context:

Amy claims: ZOE PLAY VIDEO-GAMES $\overset{\text{headshake}}{\text{NEVER}}$
 'Zoe never plays video games.'

a. *Zoe responds:* [$Q\text{-constituent}$ $\overset{\text{headshake}}{\text{IX}_{\text{Zoe}} \text{ PLAY VIDEO-GAMES } \overset{\text{brow-raise}}{\text{NEVER}}}$],
 [$A\text{-constituent}$ $\text{NO ONCE-IN-A-WHILE}$]
 'I do play video games once in a while.'

b. *Zoe responds:* * [$Q\text{-constituent}$ $\overset{\text{headshake}}{\text{IX}_{\text{Zoe}} \text{ PLAY VIDEO-GAMES } \overset{\text{brow-raise}}{\text{NEVER}}}$],
 [$A\text{-constituent}$ NO NEVER]
 (Not acceptable, would mean: 'I never play video games.')

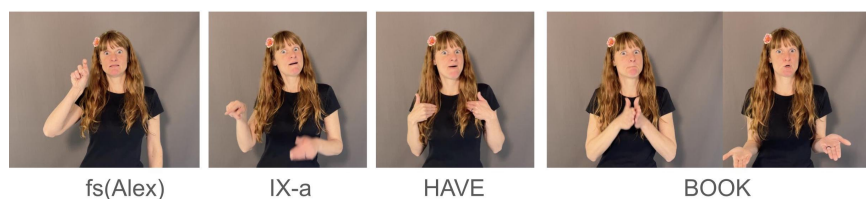
One reason for this pattern could be that negative doubling (of the type seen above in (42)) blocks the negative polarity-agreeing polar QAC: both serve the same purpose of expressing the statement with negative polarity, focusing on the negative polarity in that sentence-final position. Given that the structure proposed for doubling is structurally simpler than the syntactic structures proposed for QACs (doubles involve just a single clause, while QACs are multi-clausal), it could be that QACs are ruled out on the grounds that the speaker should use the simplest structure that does the job between these two possible focusing options (sentence-final focus and QACs). Clearly, there is interesting psycholinguistic predictions to be made here about choices in language production, and more investigation to determine how robust these patterns are crosslinguistically.

3 Topicalization

We have so far covered the notion of *focus*, a notion that is often discussed in opposition to the concept of *topic*. We might, for example, want to think about the question portion of a QAC as its topic, especially when it is given and backgrounded, taken for granted by participants and providing an organizing structure for the answer. In general, it seems to be common for sign languages to orient their word order so that topics precede focus, and to the extent that these information structural notions organize the word order,

we might say that sign languages are influenced by **discourse configurational** constraints. One strategy of overtly forcing topics to precede focus is to move the topic to a sentence-initial position: we can see an example of this in the paradigm in (47a-c), which all have the same subject (fs(Alex)), verb (HAVE), and object (BOOK), yet exhibit different orders, with BOOK being marked as a topic in (47b) and fs(Alex) being marked as a topic in (47c).

(47) a.



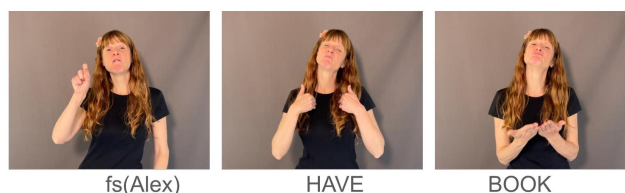
‘Alex has a book’

b.



‘Alex has a book’

c.



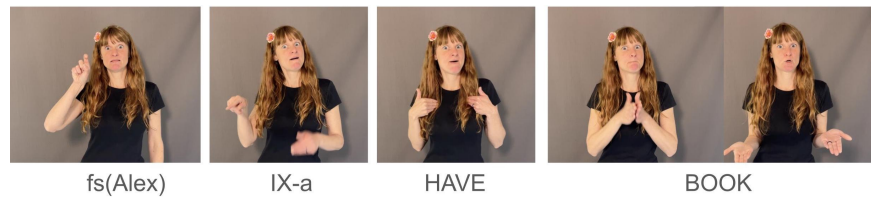
‘Alex has a book’

The propositional information that is conveyed in each of these sentences is the same: remember that one way to think about the meaning that a sentence conveys, is to think about what it tells us about the way that the world is, or more importantly, what kinds of possible worlds that we can rule out. These sentences all rule “in” the same worlds (where Alex has a book), and out the same worlds (where Alex doesn’t have a book), but do so from different perspectives. Example (47b) takes the book as a given, and tells us something about it. In contrast, example (47c) takes Alex as given and tells us something about her. Unlike focus, it’s not quite as clear that these pragmatic differences clearly pull apart through an acceptability judgment given a context, or what the contexts are which pull them apart,

but we can see one kind of example in (48) where people give somewhat different responses for differently topicalized sentences in the same context.

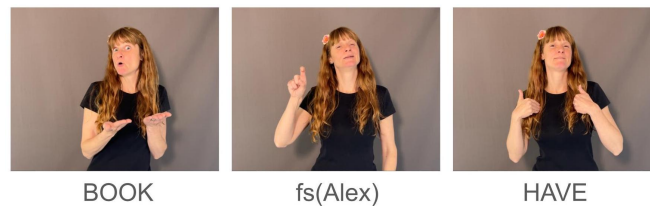
- (48) Context: Participants in a conversation had previously been wondering where a lost sweater was, and they recently found it with Marie. Now, the speaker wants people to shift their attention to a missing book (in doing so, raising the QUD *Where is the book?*), and to point out that Alex has it.

a.



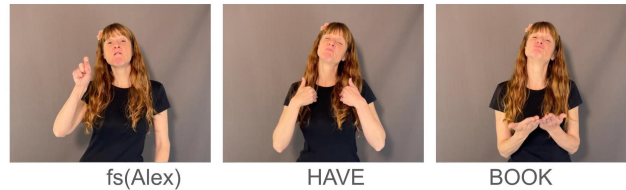
‘Alex has a book’ (questionably acceptable)

b.



‘Alex has a book’ (acceptable)

c.



‘Alex has a book’. (not acceptable)

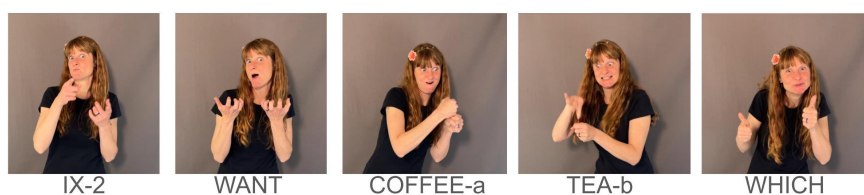
Given the differences in acceptability in this context, there certainly seems to be a semantic/pragmatic effect to topic-hood in ASL. Kimmelman and Pfau (2016) describe in careful detail the different things that topics can mean, both functionally and syntactically, and the ways that they can appear in sign languages. One of the most interesting points to emerge is the interaction between manual and nonmanual components. For example, we can see in the examples above that the moved topic is accompanied by *brow raising* nonmanual marking, which also accompanied the question in QACs, as well as the antecedent of conditionals. How can we think about the contribution of this suprasegmental marking as compared to manual signs? Most other discussion in the sign language linguistics literature on topics is

focused on their syntax: in syntactic theory topics can be moved from a position closer to where they are interpreted, or they could be “base generated” in the sentence-initial position, without any special relationship to the semantic argument position. Wilbur (1994), Wilbur and Patschke (1999), and Wilbur (2011) provide clear proposals for the interaction of syntactic position and prosodic marking. From the semantic/pragmatic perspective, there has been much less work done on the notion of topic-hood in sign languages. In spoken languages, topics are known to affect anaphora, indexicals, and other expressions in a sentence, but these remain largely unexplored in the sign linguistics literature as far as I am aware.

4 Contrast

So far in this section we’ve covered several aspects of *focus* and *topics*; a third important information structural notion is that of *contrast* (see Repp 2016 for overview of contrast in spoken languages). Wilbur and Patschke (1998) describe in detail the use of body leans in American Sign Language, most notably the forward and backward body leans, which they propose mark contrast in interesting ways: leaning backward marks exclusion, and forward inclusion. A second way to mark contrast involves equal alternatives, which are often expressed through the use of a partitioned horizontal spaces (Wilbur and Patschke, 1998). For example, the alternative question in (49) presents coffee and tea as parallel/equal alternatives, and in doing so assigns them to the ipsilateral area of signing space (e.g. *a*) and the contralateral area of signing space (e.g. *b*), respectively.

(49)



‘Which do you want, coffee or tea?’

The role of horizontal space for contrast is connected tightly to many other topics in sign languages: information structure, on the one hand, and anaphora, on the other hand: the answer to the question in (49) can involve pointing to one of the areas of signing space (e.g. *a*) to indicate that one prefers the drink that was signed in that space (e.g. coffee). We will investigate this use of space for anaphora in more depth in Chapter 4, where the important takeaway from contrast is that the use of horizontal signing space for establishing contrast may play a role in determining when space is used for linking a pronoun with its antecedent in the discourse. Work

by Pfau and Quer (2010) and Wilbur and Patschke (1999) provide further important reading especially on the interaction of syntax with nonmanual markings in marking contrast in sign languages.

When it comes to understanding why the use of horizontal signing space is used for expressing contrast, we may gain insight by considering non-propositional meaning. Lakoff and Johnson (1980) discuss the well-used metaphor SIMILARITY IS PROXIMITY, which we might expect to be active in the creations and comprehension of depictive structures (Casasanto, 2008). In this case, we may expect that space is used to reflect conceptual distance, so that conceptual contrast leads to use of different sides of signing space, but not in a way that we need encode in the propositional contribution.

5 Embedding diagnostics

Information structure is important in sign linguistics not just for the view it provides on various word orders, nonmanual markings, and pragmatics, but also as a diagnostic of general clausal structure. To take one example, Davidson and Caponigro (2016) ask whether polar questions can be embedded in American Sign Language. In other words, English allows for one declarative sentence to embed another (50a), as well as a declarative sentence to embed a polar question (50b), and a declarative sentence to embed a constituent/wh- question (50c). In English, one can usually tell the difference between a declarative clause and an interrogative from structural differences, like so-called “do support” (compare: *She bought a book/Did she buy a book?*). However, embedding makes things a bit trickier: in English, the embedded clause (*Her sister bought a book*) looks the same on the surface (e.g. (50a-b)); whether it is interpreted as a question or not depends on the verb in the main clause.

- (50) a. Mary thought that [her sister bought a book].
(embedded proposition)
- b. Mary wondered whether [her sister bought a book].
(embedded question)
- c. Marie asked [who bought a book].
(embedded question)

In American Sign Language, a similar pattern arises. An unembedded declarative clause looks different on the surface from a polar clause, although in ASL this isn’t through “do support” or any other word order differences, but rather nonmanual marking: a polar question has brow raising nonmanual marking, as illustrated in the difference between polar question and declarative in (51).

(51) a.



‘My sister has a book’

b.



‘Did my sister buy a book?’

As in English, though, this difference disappears in embedded contexts, where the main clause brow raising nonmanual marking for polar questions is replaced instead by a nonmanual marking related to the main verb’s attitude, in this case THINK (52).

(52)



‘Alex was thinking about whether her sister bought a book’

The erasure of the one signal, nonmanual marking, that differentiated the embedded from unembedded polar question makes it more difficult to diagnose the presence of an embedded polar question. However, foundational work on syntax in American Sign Language has provided diagnostics for embedding generally in ASL that can be quite straightforwardly extended (Padden 1988, Liddell 1980). Padden (1988) discusses the use of **subject pronoun copy** in ASL, which involves repeated a pronoun that refers to a subject again in the sentence final position. This can be the subject of the main clause, as in (53a) where the first person features on the sentence final

pronoun match those of the subject of the main clause (IX-1). It can similarly copy the subject of an embedded clause, as in (53b), where the subject copy features match those of the embedded subject (IX-a). In contrast, it cannot copy the features of an object, as in the children in (IX-arc-b). Padden (1988) argues that it really is subjecthood and not distance or number features or other potential confounding factors which is accounting for the pattern of the sort seen in (53).

- (53) (ASL, Padden 1988)
- a. IX-1 DECIDE IX-A SHOULDA DRIVEB SEE CHILDREN IX-1
 - b. IX-1 DECIDE IX-A SHOULDA DRIVEB SEE CHILDREN IX-A
 - c. *IX-1 DECIDE IX-A SHOULDA DRIVEB SEE CHILDREN-B IX-ARC-B
'I decided he ought to drive over to see his children.'

One helpful feature of subject pronoun copy for investigating structure in sign languages is that if a long-distance subject is able to be copied at the end of a clause, it provides evidence that a clause in between is truly embedded and not sequential. For example, we can feel confident that (53a) is not a sequence of two sentences (e.g. *I decided. He ought to drive.*) because of the copying of the subject of the first sentence at the end. Padden (1988) uses this argument to show that ASL does allow clausal embedded, in contrast to claims made in the literature at that time that it might not (e.g. Thompson 1977). We can similarly use it to show that ASL permits embedding of polar questions as well (Davidson and Caponigro, 2016). This can provide a means for future work on other sentence structures in ASL and in other sign languages to diagnose clausal structure, especially distinguishing between embedding and parataxis/multiple sequential clauses without a hierarchical relationship.

6 Incompatibility of depictions and alternatives

Recall that in Chapter 1 we emphasized two aspects of meaning, the propositional and the experienced event. One might have noticed that this chapter has focused nearly entirely on propositional meaning, with little discussion of depiction. This is not an accident, and in this section we'll focus on why: it seems that the question-answer organization behind information structure is particularly incompatible with propositional content, such that the sorts of things that questions are made of ("at issue" alternatives) seem to be largely incompatible with the sorts of meaning that we get from depictions.

The first nugget of evidence along these lines comes from a paper by Kita (1997) in which he introduces the paradigm in (54). In (54a), a "mimetic" expression describes *and depicts* the movement of a heavy round object with continuous rotation. If this mimetic expression *gorogoro* worked in the usual

way of other non-depictive modifiers, we might expect that the propositional meaning of this sentence would be something like a function takes worlds and returns TRUE for those in which a ball rolled in the *gorogoro* way, and FALSE for those worlds in which that does not happen. In that case, negation should simply apply, and return the complementary set of worlds; intriguingly, Kita (1997) reports that a negation with a mimetic is not well formed (54b), despite a parallel sentence with negation being well-formed with a descriptive/non-depictive modifier like *sizukani* ‘quietly’ (54c).

(54) (Japanese, Kita 1997)

a. **Depiction, no negation**

tama ga gorogoro to korogat-ta no o mi-ta
 ball Nom Mimetic roll-Past Nominalizaer Acc see-Past
 ‘(One) saw a ball rolled *gorogoro*’
 (*gorogoro* = movement of a heavy round object with continuous rotation).

b. **Depiction, with negation** (not acceptable)

**tama ga gorogoro to korogat-ta no de wa*
 ball Nom Mimetic roll-Past Nominalizaer Cop Focus
na-i
 Neg
 ‘It was not the case that a ball rolled *gorogoro*.’

c. **Descriptive modifier, with negation**

tama ga sizukani korogat-ta no de wa na-i
 ball Nom quietly roll-Past Nominalizaer Cop Focus Neg
 ‘It was not the case that a ball rolled quietly.’

The takeaway from (54) seems to be that negation resists depictive content, in this case exemplified by Japanese “mimetics” like *gorogoro*. In fact, we find similar evidence when we look at depictive elements in English: a depictive onomatopoeia that’s perfectly well-formed in (55a) becomes ill-formed under negation (55b), while a descriptive modifier conveying purely propositional content is perfectly fine under negation (55c). (Of note: the ill-formed nature depends on the meaning: it’s possible to give a meaning to this which involves “metalinguistic” negation, in other words, when it means that a better expression should have been used, but this isn’t the meaning expressed by negation in the non-depictive case.)

(55)

(English)

a. **Depiction, no negation**

The bird was chirrrp-chirrrping[expressed in a sing-songy manner] on her perch.

b. **Depiction, with negation** (not acceptable)

*The bird wasn't chirrrp-chirrrping[expressed in a sing-songy manner] on her perch.

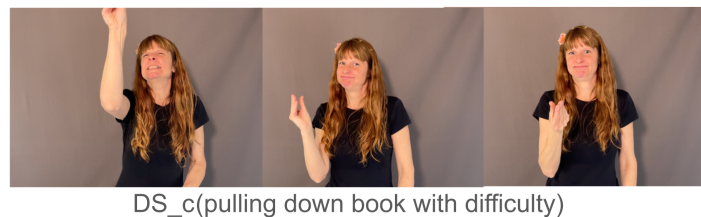
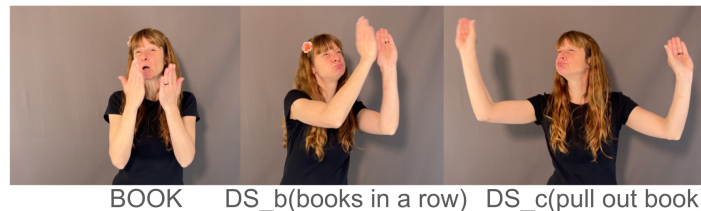
c. **Descriptive modifier, with negation**

The bird wasn't chirping loudly on her perch.

These interactions between negation and depictive modifiers in Japanese and English are relevant for sign linguistic data because sign languages, like spoken languages, support a great deal of expressivity through depiction. Take a depictive classifier (a topic we will have much more to say about in Chapter 5) in (56). In a positive sentence, the classifier depicts the (difficult) manner of retrieving the book (56a). Just like in the Japanese and English cases, this is no longer well-formed under negation (56b), despite a parallel sentence with similar meaning being well formed if only a descrip-



tive/symbolic modifier is used under negation (56c).

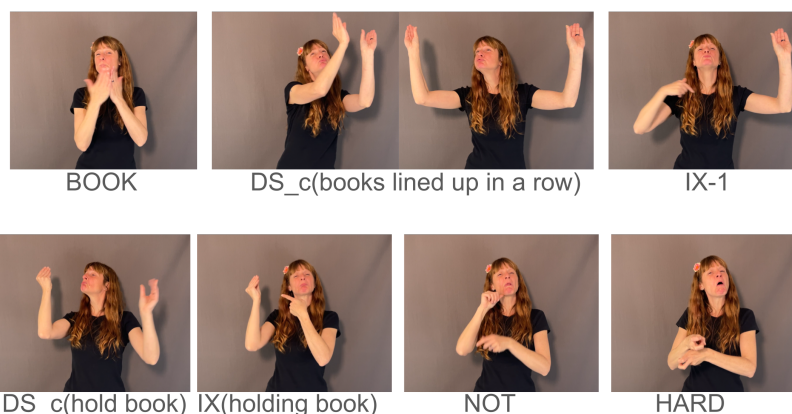
(56) a. **Depiction, no negation**

‘Of all the books in a row, it was difficult to pull one down’

b. **Depiction, with negation** (not acceptable)

*BOOK DS_c(books lined up), NOT DS_c(pull down w/difficulty)
‘Of all the books in a row, it wasn't difficult to pull one down’

c. **Descriptive modifier, with negation**



‘Of all the books in a row, it wasn’t difficult to pull one down’

An explanation for this incompatibility between negation and depiction comes from the notions we explored in Chapter 1, that representations of meaning can involve both propositions and representations of particular events. In a positive sentence like (56a), a proposition is conveyed from the descriptive components, a function that returns exactly those worlds in which there are a bunch of books in a row and someone pulls one down. At the same time, this also evokes a representation/image of the event,



to which the depiction adds more detail about the pulling action by depicting/enacting the action. In a negative sentence like (56b) we might imagine that this should mean something like (56c), but it cannot. We might imagine this is because depictions are functionally at odds with generalizing over details, given that they must evoke a particular image/experience. Negation needs to act on a propositional



alternative (e.g. ‘hard’, as opposed to ‘easy’) which is a partition that generalizes over details, and so (56b) is ill-formed. This is further supported by the inability of these same kinds of depictions to be used in polar and *wh*-questions, both of which also depend on these kinds of alternatives/partitions, and which is also reported for Japanese ideophones by Kita (1997). The takeaway in particular for thinking about questions, answers, and the structure of discourse is that depiction, while important in many areas of sign linguistics, typically is involved in constructing representations of events which are separate from the kinds of semantics we focus on that explain the information structural moves involving questions and their answers, which we focused on in this chapter.

7 Conclusions

In this chapter we have focused on the relationship between questions (either overt questions or covert questions under discussion), their answers, and linguistic forms. The specific linguistic forms that relate to these questions were question-answer clauses, sentence-final focus position, topicalizations, contrastive uses of space, and subject pronoun copy. In the penultimate section, we then moved to trying to understand the way that different components bear on the use of alternatives in sign languages, with the takeaway that alternatives seem to require interpretation as a symbol, not as an iconic depiction. A consequence of this is that much of the depictive nature of sign languages happens in a way that is disjointed from much of the information structuring, and that both should be taken care to be considered when designing analyses for sign language semantics.

3

Logical connectives

The focus of this book is on formal approaches to modeling meaning in natural human languages in general, and signed languages in particular. There is an interesting parallel between the development of the field of formal semantics of human languages and the development of sign language linguistics that is highlighted in the study of logical connectives. At one point, meaning in human language (by which scholars thought about as only spoken language) was assumed to be much messier than the meaning that could be conveyed in artificial languages like logic. The idea was that logic was clean and unambiguous, because both the forms (syntax) and the meaning (semantics) could be defined in a way that was unambiguous and led to entirely predictable inferences like entailments. For example, in logic, one can define a syntax (rules for allowed and disallowed forms) that simply stipulates that if p and q are both forms in the language, and if they are combined by a logical operator like \wedge , that combination is also well-formed in the language ($p \wedge q$). A semantics can similarly be defined exactly, so that, for example, if p is true and q is also true, then (and only then) $p \wedge q$ is true too. The entailment that $p \wedge q$ entails p will thus always hold. But that's a simple logic we can design, for which we can stipulate the forms and meanings however we like to make entailments clear. What about human language: does it work the same way?

Building on foundational work by philosophers like Frege, Russell, and others, modern formal semantic work beginning with Montague (1973) has argued that the answer is, surprisingly, yes! In many ways, meaning in human language *does* work like logic. To take a striking example, Grice (1989) argues that despite the English connective *or* superficially looking quite different from logical disjunction, the logical inclusive disjunction is the underlying meaning of the human language *or*. Superficially, they appear to be different because logical disjunction ($p \vee q$) is defined as requiring a minimum of one disjunct to be true (p is true, or q is true, or both), whereas the English expression *or* seems to have stronger use conditions: we can use

it in cases of ignorance (*Alex had tea or coffee, I'm not sure which*) or in cases of choices (*Alex can choose tea or coffee*), and tends to be strange to use with an inclusive meaning (if Alex had tea and coffee, it's often considered strange to say *Alex had tea or coffee*). However, Grice (1989) argued that these differences make sense in light of the way that we use language to communicate, since in the case of, say, the inclusive meaning, if we knew both to be true we should have used a stronger description, *Alex had tea and coffee*, instead. The argument is that the meaning given to the logical expression like the connective \vee (inclusive disjunction) is actually the right model for English *or* (its *semantics*), just that the natural language expression seems to carry different meaning because of the way that humans use language and reason about expressive choices on top of their basic meaning (its *pragmatics*). This approach in the middle/latter half of the 20th century opened wide open the doors to using logic to model natural language, including logical connectives.

When it comes to correcting an outdated view that human language is somehow “less than” logic, the parallelism to outdated views of sign languages are compelling: just as spoken language was assumed to be more messy and inferior to logic, but was eventually found to have more in common than previously realized, sign languages were at one point considered impossible to analyze using logic, and yet that too has been clearly disproven: they contain all of the same logical structure as spoken languages. This in no way means that logic is all there is to either spoken or signed languages: meaning in human language is multi-layered and contains multitudes and no semanticist would argue that “meaning” should be completely reduced to truth conditions. Rather, those who work with truth conditions take them to be a valuable way to understand how we use language to communicate and learn about the world in both precise and abstract ways that account for the inferences we draw about the world from what we are told. Human languages in all modalities do this to a level that is unparalleled by other organisms (biological and artificial), and makes the investigation of this ability in sign languages especially worth understanding and appreciating. In this chapter we review findings related to the logical operators **negation**, **conjunction**, and **disjunction** in the semantics and pragmatics of sign languages.

1 Negation

The simplest logical operation is negation (\neg): in logic, negation can be defined as a function that simply takes a single proposition and returns its truth conditional opposite. For example, take a proposition (e.g. *it will rain today*) that takes possibilities/worlds and returns those in which it is true (e.g. the worlds in which it rains today: $\lambda w.it \text{ rains today in } w$). Negation

applied to this function will return the complement set of worlds (λw .doesn't rain today in w , i.e. a function that takes in worlds and returns those in which it doesn't rain today). Put in slightly more functional notation, if $p(w)$ = it rains today in w , then $\neg p(w)$ = it doesn't rain today in w , and thus more generally for any proposition p and world w , if $p(w) = 1$ then $\neg p(w) = 0$.

The English word *not* seems to frequently have this effect that we described above for the logical operator \neg , so that we might want to define its semantics as a function that takes propositions and switches their truth value: $\llbracket \text{not} \rrbracket = \lambda p. \neg p$. So the meaning of *It will not rain today* is the basic proposition *It will rain today*, with the addition of a negative operator: (not)(It will rain today). We can build a mini-compositional account for this step:

- (57) *Context: Discussing the current weather before going outside*
Answer: It will not rain today
 $\llbracket \text{It will not rain today} \rrbracket = \llbracket (\text{not})(\text{It will rain today}) \rrbracket =$
 $\llbracket \text{not} \rrbracket \llbracket \text{It will rain today} \rrbracket$ assuming compositionality
 $\llbracket \text{not} \rrbracket = \lambda p. \neg p$ proposed meaning
 $(\lambda p. \neg p)(\lambda w. \text{it will rain today in } w) =$
 $\lambda w. \text{it will not rain today in } w$

Sometimes doing compositional semantics like this can appear circular when our object and our metalanguage overlap, as when both use English in (57) above. However, we can more easily see the value of this kind of analysis when we turn to other languages. This is especially true for sign languages, an area where the study of negation has been an active subfield full of insights, many arising from the interplay of manual and nonmanual expressions. For example, in American Sign Language the differences between a positive statement (58a) and a negative can be the addition of a nega-



tion sign NOT and nonmanual headshake *hs* (58b) or just the nonmanual headshake (58c).

- (58) *Context: Discussing the current weather before going outside*

a.



'Today it is going to rain.'

b.



‘Today it isn’t going to rain.’

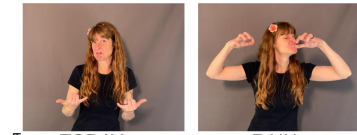
c.



‘Today it isn’t going to rain.’

A preliminary takeaway from the paradigm in (58), and especially (58c), is that the nonmanual headshake seems to be a way to express the negation operator that we defined above, that switches the positive proposition to its complement. We can then give the negative headshake a similar function to the English negation: $\llbracket (hs) \rrbracket = \lambda p \neg p$.

- (59) *Context: Discussing the current weather before going outside*
Answer:



$$\llbracket \begin{array}{cc} \text{TODAY} & \text{RAIN} \end{array} \rrbracket = \llbracket (hs) (\overline{\text{TODAY}} \text{RAIN}) \rrbracket =$$

$$\llbracket (hs) \rrbracket \llbracket \begin{array}{cc} \text{TODAY} & \text{RAIN} \end{array} \rrbracket$$

assuming compositionality

$$\llbracket (hs) \rrbracket = \lambda p. \neg p$$

as proposed

$$(\lambda p. \neg p)(\lambda w. \text{it will rain today in } w) =$$

$$\lambda w. \text{it will not rain today in } w$$

The key observation to make about the analysis proposed in (59) is that the functional meaning of headshake is the same as the functional meaning of *not* in (58). This highlights one natural question that arises in the study of negation in ASL and other sign languages: should English *not*,



ASL *NOT*, and ASL *hs* nonmanual marking all have the same semantics,

or should we think about them as making quite different contributions to the propositional meaning? It's not obvious one way or another at first, even just given the simple set of sentences in (59). For example, consider that both headshake and negation occur together in (58b). If we equate each of these negative components to the negative operator, then we'll end up with the two negations cancelling each other out, something like 'Today it isn't not going to rain', which is a fine sentence in English but simply the opposite of what the ASL sentence in (58b) means. We might reasonable



choose instead to give the manual sign the meaning of the English word *not*, and say that the headshake just comes along for the ride, following the manual sign (say, the negative manual sign brings along the nonmanual headshake), but this would leave us with a serious question about how it is that (59c) comes to have a negative meaning and not a positive meaning! At this point, it is hopefully already clear how the study of negation in sign languages, like the study of negation in general crosslinguistically, is not a straightforward extension of English, and worth significant investigation across sign languages, especially with the additional complexity of determining the relationship between nonmanual (suprasegment) markings and manual signs.

In fact, it is well known that many spoken languages display variation in precisely this area, namely, that sometimes, two negative elements are interpreted as a single semantic negation, while other times/in other languages they are interpreted as two separate logical negation functions. Consider, for example, the English example in (60); there are two interpretations of this sentence, one that is considered the interpretation in "standard" English (60a), and another that is common in many other varieties of English, which is completely the opposite meaning (60b). These two possible ways to interpret two negations are found in different languages and language varieties across the world, and one can find either one being considered the "standard" interpretation. For example, in "standard" Italian, the negative form *nessuno* is negative on its own (61a) (like English *nobody*) yet when combined with sentential negation leads to a single negation "concord" interpretation (61b), just like (60b).

(60) *Alex doesn't want nobody to call.*

- a. Alex will be glad if at least someone calls. (double neg reading)
- b. Alex will be glad if no one calls. (concord reading)

(61) a. *Nessuno ha telefonato*
 N-body has called
 'Nobody called'

- b. *Non ha telefonato nessuno*
 Neg has called n-body
 ‘Nobody called’ (concord reading)

Languages/dialects in which two negative expressions are interpreted as a single semantic negation are said to exhibit **negative concord**. In the semantic/syntactic study of sign languages, it has been a matter of significant interest how sign languages fit into this categorization, and it intersects with discussions about the role of suprasegmental forms and language modality, namely, do non-manual expressions “count” as a negative element, or are they in some sense just reflecting the negation expressed by another negative element elsewhere in the sentence.

One further complication to this question is that there seems to be variation closely related to this exact point within sign languages, namely, whether nonmanual expressions like the negative headshake seen in (58) counts as contributing semantic negation. On this semantic/cross-linguistic variation point, some extremely interesting generalizations have been put forward about sign language negation. In a typological study, Zeshan (2006) categorizes some sign languages as **nonmanual dominant**, like American Sign Language, in two respects: (a) that expressing negation requires a negative nonmanual, and (b) that the nonmanual is able to express negation on its own. For example, an important thing to note about ASL is that it is usually claimed that (58b) is not well formed without the headshake nonmanual, i.e. the manual negation on its own is not acceptable without headshake nonmanuals. In contrast, Zeshan (2006) categorizes other sign languages like Türk İşaret Dili (TİD, Turkish Sign Language) as **manual dominant**: this category of sign languages (a) always requires a manual sign like NOT to express negation (we can see this unacceptability in (62a)), and (b) if a manual negation is present (as in (62b)) then the nonmanual negation is optional.

(62) (TİD, Zeshan 2006)

- a. $\frac{\text{neg}}{*IX_1 \text{ UNDERSTAND}}$
 ‘I don’t understand’
- b. $\frac{\text{neg-tilt}}{IX_3 \text{ SIGN UNDERSTAND-NOT}}$
 ‘They (singular) didn’t understand the signs.’

The claim, then, is that the requirement for nonmanual marking correlates with the ability of nonmanual marking to serve as a negation on its own, across sign language varieties. In terms of frequency of one category over another, Zeshan (2006) reports that the non-manual dominant sign languages are more common in her language sample: 26 out of 37 surveyed sign lan-

guages permit a purely nonmanual expression of negation, as in the ASL examples in (58b); the others do not, as in TĪD.

In terms of how we might want to analyze the contribution of negative nonmanual marking and manual signs, we see that the semantics we may want to give to manual vs. nonmanual markings of negation may differ between sign languages. If we begin with ASL, we might be inclined to more closely model the headshake nonmanuals as expressing propositional negation in the form of the logical operator \neg , i.e. simply taking a proposition and returning its negation. This is the case with the simple example (58c), in which it seems that the meaning ‘it is going to rain’ is negated by the negative nonmanual marking. We can think about this as the basic negation that reverses truth values.

In addition to sentential negation words like *not* or ASL NOT or negative headshake, there are also negative expressions such as *nobody*, Italian *nessuno*, or ASL NO-ONE, NONE, CAN’T, etc, which express quantification along with negation in a single lexical form. In classically non-manual dominant sign languages like ASL, it has been claimed that these negative signs need to be accompanied by a negative nonmanual across the whole sentence as well, i.e. a combination of sentential negation and a constituent negation (63). In contrast, the basic observation is that in non-manual dominant sign languages, negation depends on the obligatory manual sign, and non-manual marking corresponds closely to the scope of that sign, as can be seen from the Italian sign language (LIS) examples from Geraci (2005) in (64).

(63) (ASL)

- a. $\frac{\text{br}}{\text{TODAY}} \frac{\text{hs}}{\text{NO-ONE 3-EMAIL-1}}$
 ‘Today no one emailed me.’
- b. $\frac{\text{br}}{* \text{TODAY}} \text{NO-ONE 3-EMAIL-1}$
 ‘Today no one emailed me.’

(64) (LIS, Geraci 2005)

- a. $\text{PAOLO CONTRACT SIGN } \frac{\text{hs}}{\text{NON}}$
 $\frac{\text{hs}}{* \text{PAOLO CONTRACT SIGN}}$
 ‘Paolo didn’t sign the contract.’
- b. $\text{CONTRACT SIGN } \frac{\text{hs}}{\text{NOBODY}}$
 ‘Nobody signed the contract.’

This raises the important issue of how and whether the extent of nonmanual marking corresponds to its semantic scope, i.e. the size of the proposition that it negates. Under a theory in which the semantic scope corresponds

to syntactic position, the syntax/semantics interface of negation becomes highly relevant, and in fact this has been an area with quite a bit of work in sign languages. For American Sign Language, Wood (1999) provide the most extensive overview. Geraci (2005) investigations LIS in more details, and Quer (2012a) provides a view of this issue in many other sign languages of the world.

On the question of possible negative concord in sign languages, Kuhn (2020) observes that very few sign languages show the negative concord patterns of the Italian sort we saw above in (61) in which two separate negative words (e.g. *not* and *none*) appear together but are interpreted as a single negation. He offers the example of the unacceptability of (1a) in LSF.

(65) (LSF, from Kuhn 2020)

- a. *MY BIRTHDAY, NONE OFFER NOTHING
- b. Nobody gave me nothing for my birthday.

There are a couple of things that are interesting about the negative concord situation, or lack thereof, in many sign languages. First of all is the unacceptability itself, which contrasts with non-concord languages in which sentences with two negative expressions are not unacceptable but rather interpreted with two separate negations. We can see this in the English example in (b), which is interpreted in standardized English as double negation, e.g. as saying that everyone brought something. For many speakers of other varieties of English, (b) can also have a concord reading, in which nobody brought anything, but for neither group of English speakers is (b) unacceptable like it is in LSF. Another property of the categorization of sign languages that is unusual in terms of negative concord is that, as we saw, there are certainly often multiple expressions of negation in the same sentence, but only if nonmanual marking is included. In fact, as Kuhn (2020) notes, if we consider nonmanual marking, then sign languages typologically fall into the *concord* category, since a nonmanual expression of negation and a manual sign are interpreted as a single negation, as in (57b). What to make of this?

Kuhn (2020) provides a suggestion to tie together both the manual specific components and broader language constraints, using roughly two modality-specific pressures on sign languages and one general principle. The first modality-specific constraint he suggests is that the use of space in sign languages should be used only in cases of existence, for iconicity reasons. As we have seen and will see elsewhere throughout this book (especially in Chapter 4 and 5), signers use space in ways that very often make use of iconic depictions of events in the world. Associating a discourse referent to an area of space then naturally implies existence of its referent as a participant in the event, if not in the actual world then in some experience in a

dream/desire/other event that is being depicted. This same kind of constraint seems to be active in the contrast between the use of an overt index in (66). In (66a) we see that overtly associating the politician to a location *a* is judged as more illformed presumably because of the implied non-existence of such a politician, compared to the same sentence with the same intended meaning but no overt use of space to associate to the politician in (66b). Notably if NO is replaced by ALL, both are fine.

(66) (ASL, from Abner and Graf 2012)

- a. % [NO POLITICS PERSON]-a TELL-STORY IX-A WANT WIN
- b. [NO POLITICS PERSON] TELL-STORY WANT WIN
'No politician said he wants to win'

Kuhn takes this pattern as well as other behavior of overt indices with disjunctive referents as an argument in favor of iconic pressures on the use of spatial loci only in cases of some kind of existence, even these rather abstract spatial loci. This seems plausible, and in line with the idea that the use of loci are motivated by depiction (Liddell, 2003), even when they have a very abstract meaning. The second modality difference that Kuhn notes related to negative concord is the use of nonmanual marking to express negation. This ties into a language-wide pressure he argues in favor of expressing negation redundantly, based on the abundance of negative concord between multiple negative words in spoken languages. Tying these together, he argues that the pressure to express negation redundancy is covered by nonmanual marking in sign languages, while the (iconic) pressure against using space in cases of non-existence means that a manual sign (typically associated to space) will be unlikely to be used to express the second negation. He emphasizes that these are just tendencies, and provides the example from Russian sign language, which does seem to have negative concord based on two *manual* signs.

(67) (RSL, from Kuhn and Pasalskaya 2019)

- NOBODY NOTHING GIVE-1 NOT
'Nobody gave me anything.'

A picture that emerges from the typological picture presented by Zeshan (2004) regarding nonmanual marking and the view presented by Kuhn (2020) on negative concord is that much of how we analyze negation in sign languages hinges on our understanding of nonmanual negation. We might wonder, how much variation between nonmanual marking patterns are truly cross-linguistic and vary from sign language to sign language, versus from signer to signer? And how should we best model nonmanual marking in our semantics: as a contributor of negation, expressing a negative operator itself, or as a reflection of negation that originates elsewhere, and does

this vary across contexts, across signers, and/or across sign languages? If we take nonmanual marking to be a separate negator, then sign languages frequently exhibit negative concord; on the other hand, if we focus on manual signs only, then negative concord is much more rare, perhaps due to depictive pressures on associating discourse referents to space. Related to this question, Henninger (2022) has identified many examples of negation expressed in ASL without negative nonmanual marking, and even more surprising, negation expressed *only* by nonmanual marking, in its own timeslot, making an even stronger case for a separate semantic contribution from nonmanual marking. Moreover, it shows that there is more complexity to the pattern when it comes to natural production than most of the semantic work has appreciated so far, and a further indication that nonmanual expressions probably should be considered to contribute a negative function on their own, as we modeled above in (59).

Another open question in this area relates to the possible scope for negation in sign languages. We saw above that even in language varieties without negative concord, like the “standard” English interpretation of (1b), if two negative expressions can appear in the same sentence then they are simply interpreted as separate negators. Why does this seem to be unacceptable, with or without negative nonmanuals, in sign languages like LSF and ASL? One key might be to better understand the scopal properties of negation in sign languages and how they relate to information structure. For example, Geraci (2005) discusses multiple syntactic sites for negation in LIS; the same questions arise with other sign languages and whether they must scope over/negate just a verb phrase, the entire clause, or both.

Gonzalez et al. (2019) investigate this question by investigating the use of negation as an answer in question-answer clause pairs. As we discussed in Chapter 2, this is a clause-type used in sign languages to highlight the question/answer nature of discourse structure in which the second “answer” clause is the focused constituent and must be an answer to the question raised in the first constituent. This is relevant to the question of double negation because we do see examples like (68), in which there is a negation in the question clause (I EXPERIENCE ^{brow-raise} NONE ‘Do I have no experience (with interpreting)?’), and then there is a negation in the answer clause (^{headshake} NO HAVE ‘No, I do have some’), with the overall interpretation of a positive.

- (68) (ASL, Gonzalez et al. 2019)
- I EXPERIENCE ^{brow-raise} NONE , ^{headshake} NO HAVE.
- ‘I do have some experience (with interpreting).

It suggests one way that sign languages do seem to express something like double negation. As Gonzalez et al. (2019) point out, answers in question-answer clauses in sign languages generally seem to be restricted in their

semantics, yet, or perhaps because of this, negation in answers of QACs can provide an effective means for expressing double negation. As this pattern highlights, many questions remain, both about the study of negation and negative concord across languages, and the expression of negation in sign languages, especially as it comes to the clearly critical role of understanding nonmanual marking.

In this section we have focused on negation, which among the logical operators of interest is the only unary connective: it takes a single argument (and returns its opposite). In the next section we focus on two well-known binary connectives: disjunction and conjunction, and their expression and related semantic issues in sign languages.

2 Conjunction and Disjunction

One of the goals of formalizing the propositional aspects of natural language meaning is to account for entailments, inferences we make about the way things are based on the information conveyed in an utterance. So, for example, if I tell you *Today, it will rain*, that entails that *This week it will rain*, because the scenarios in which the first sentence holds are true in a subset of the scenarios in which the second sentence holds. In this case, there is an entailment because the meaning of *today* and the meaning of *this week* have a particular relation: one expresses a temporal subset of the other. In general, entailments are a significant motivation for modeling human language using logic, because logic provides the means of inferring things beyond what was actually discussed (i.e. the ability to generalize something about this week, after just discussing today). Some clear examples of entailments in natural language arise from expressions that seem on their face to have a lot in common with structures found in logic: words like English *and* and *or* (and *not*, as we have seen). An example can be found in the inference (known as disjunctive syllogism) presented in (69), where a disjunction and a negated disjunct lead one to conclude the second disjunct.

- (69) Alex had coffee or Alex made some tea.
 Alex didn't make some tea.
 → Alex had coffee.

These inferences go through just like inferences in a formal logic, where we define the meaning of $p \vee q$ (inclusive disjunction) as false when both p and q are false, and true otherwise. So if $p \vee q$ is true but p is false, then q must be true. We typically define conjunction $p \wedge q$ as true only if each of the conjuncts are true. Conjunction supports entailments like the one in (70), for example.

- (70) Alex had tea and Alex had coffee.
 \rightarrow Alex had tea.

There are many interesting questions regarding how all of these operators interact that have been raised in the cross-linguistic literature on spoken languages. For example, if we have a negation and a disjunction in English, there seems to be two possible interpretations: one in which it's either coffee or tea that he didn't have but he might have had the other, and one reading in which he definitely didn't drink either one. There has been discussion about whether this ambiguity is available in other languages, and arguments that they are not in other languages like Hungarian (Szabolcsi), and so the interaction of these operators remains an important question in crosslinguistic research.

- (71) Alex didn't have tea or coffee.
 a. He didn't have either one. ($\neg\text{tea} \wedge \neg\text{coffee}$)
 b. One of them he didn't have. ($\neg(\text{tea} \wedge \text{coffee})$)

Within the space of logical connectives, there also seems to be crosslinguistic variation in the pieces involved in logical operators in terms of which are basic and which are composed of smaller pieces. For example, English *and* and *or* seem to both be single independent morphemes, but other connectives contain multiple morphemes, like *and then*, or markers of disjunction in the Cheyenne language, which are complex expressions built from conjunction and other operators (Murray, 2017). Some have also proposed that even if the linguistic form is simple, as in the English *or*, the meaning can be complex. For example, Zimmermann (2000) has argued that the meaning of disjunction is the conjunction of possibilities: *Alex drank tea or coffee* is rather *It's possible that Alex drank tea and it's possible that Alex drank coffee*. Although these can both be used in certain scenarios, as in expressing uncertainty between these two alternatives, on the face of it they have an important difference: the latter allows for other possibilities (e.g. the possibility that Alex drank neither tea nor coffee but something else, e.g. Alex drank cider), while the former requires a true statement among the disjuncts. This should be kept in mind when we turn to these expressions in sign languages, where it is not immediately obvious what aspects of a meaning are productive/compositional and which are stored as a single unit.

When it comes to connectives in sign languages, one of the most striking observations parallels that for negation: that the expression of connective meanings like conjunction and disjunction very often involve a combination of manual and nonmanual components. Consider, for example, that one way to express conjunction and disjunction in ASL is to place the two options in two different locations in space (*a*, *b*), and to use different nonmanual

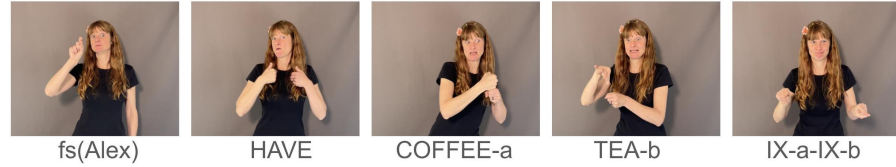
markings (roughly, head nodding compared to brow raising), and optional disambiguating particles like BOTH or the alternating pointing sign IX-a-IX-b (72).

(72) a.



‘Alex had tea and coffee.’

b.



‘Alex had tea or coffee.’

Davidson (2013) highlights these common expressions of connectives in ASL and analyzes the use of listing coordinates associated to areas of space as involving a “general use coordination” that collects the listed items into a set of alternatives {coffee, tea}, with the conjunctive/disjunctive force coming not from what is connecting the coordinates but from another source, such as the nonmanual marking, or the sentence-final disambiguating expressions like BOTH or IX-a-IX-b. In the examples above, the idea is that each sentence conveys two alternatives {Alex had tea, Alex had coffee}, derived compositionally in the same way as in the formation of polar questions, following Hamblin (1976) (73). Eventually, in the first case all alternatives must be true, while in the second case at least one of the alternatives must be true, so the addition of BOTH creates a conjunctive statement in (73b), a function which takes a world and returns only those in which all of the alternatives are true, whereas the disjunctive statement (73c) expresses the function over worlds which returns TRUE if at least one of the alternatives is true.

(73) a.



= {Alex had tea, Alex had coffee}

b. ALEX HAVE $\frac{\text{hn}}{\text{TEA-a}}$ $\frac{\text{hn}}{\text{COFFEE-b}}$ (ASL, conjunction)

‘Alex had tea and coffee.’

$\lambda w \forall p. p \in \{\text{Alex had tea, Alex had coffee}\} \rightarrow p(w) = 1$

- c. ALEX HAVE $\frac{\text{br}}{\text{TEA-a}} \frac{\text{br}}{\text{COFFEE-b}}$ (ASL, disjunction)
 ‘Alex had tea or coffee.’
 $\lambda w \exists p. p \in \{\text{Alex had tea, Alex had coffee}\} \wedge p(w) = 1$

On the one hand, this is a simple analysis that takes things at their face value, in some sense: it seems that there are many different ways to signal these meanings that are not dependent on the item doing the connecting (unlike *and* and *or* in English) and this is captured by an analysis that puts the conjunctive/disjunctive force outside of the formation of the set of alternatives. Yet it also raises questions about the language modality and expression of conjunction and disjunction: is the strategy of dissociating the force (conjunction vs. disjunction) from the syntactic connection of two coordinates especially more natural in sign languages than spoken languages? The data so far suggest that it is common in sign languages, and possibly less common in spoken languages, although there are clear examples of both options in each modality. Consider, for example, Japanese sign language (JSL) (Asada, 2019), which has a very similar structure to ASL in the disjunctive vs. conjunctive force being differentiated (only) by nonmanual marking in (74).

(74) (JSL, from Asada 2019)

- a. TAROO $\frac{\text{hn}}{\text{TEA}} \frac{\text{hn}}{\text{COFFEE}}$ BOTH DRINK
 ‘Taroo drank tea and coffee, both.’
 b. TAROO $\frac{\text{hn}}{\text{TEA}} \frac{\text{hn}}{\text{COFFEE}} \frac{\text{ht}}{\text{WHICH}}$ DRINK
 ‘Taroo drank tea or coffee, either one.’

Other sign languages appear to exhibit the same patterns (Legeland et al., 2018), such as Dutch SL (75) and Hong Kong SL (76), both reported in studies that didn’t focus directly on the issue of general use coordination but which seem to exhibit the same flexibility, and in Catalan SL (Zorzi, 2018).

(75) (NGT, conjunction: Pfau 2016)
 $\frac{\text{bl-3a}}{\text{MOTHER IX}_{3a}} \frac{\text{bl-3a}}{\text{MARKET IX}_{left}} \frac{\text{bl-3a}}{\text{GO}_{left}} \frac{\text{bl-3n}}{\text{SON IX}_{3b}} \frac{\text{bl-3n}}{\text{FRIEND IX}_{right}} \frac{\text{bl-3n}}{3b \text{VISIT}_{right}}$
 ‘The mother goes to the market (and) her son visits a friend.’

(76) (HKSL, disjunction: Tang and Lau 2012)
 $\text{IX}_1 \text{ GO-TO BEIJING, (pro}_1 \text{) } \frac{\text{hn+bt right}}{\text{TAKE-A-PLANE, TAKE-A-TRAIN}} \frac{\text{hn+bt left}}{\text{TAKE-A-TRAIN}}$
 ‘I am going to Beijing. I will take a plane or a train.’

- (77) (LSC, conjunction: Zorzi 2018)
- $$\frac{\frac{\text{hl+bl contral}}{\text{MARINA WIN}} \quad \frac{\text{hl+bl ipsil.}}{\text{JORDI LOSE}} \quad \frac{\text{re}}{\text{RIGHT?}}}{\text{'Marina won and Jordi lost, right?'}}$$

There are also spoken languages that seem to express a general use coordination. Gil (2019) describes coordination in Maricopa (a Yuman language spoken in Arizona, USA), which uses the same expression for both disjunction and conjunction, as seen in (78), in which the addition of an inferential marker leads a list to be interpreted as disjunctive, while in its absence the same list is interpreted as conjunctive. A similar pattern is confirmed by Ohori (2004) and Asada (2019) for spoken Japanese, which has several constructions including the basic list structure in (79) that can be interpreted as conjunction or as disjunction depending on the context (based on the assumption that one can visit multiple places but will choose to live in one place).

- (78) (Spoken Maricopa, Gil 2019)
- a. *John-s Bill-s v?aawuum*
 John-NOM Bill-NOM 3.come.PL.FUT
 'John and Bill will come' (conjunction)
 - b. *John-s Bill-s v?aawuumsaa*
 John-NOM Bill-NOM 3.come.PL.FUT.INFER
 'John or Bill will come' (disjunction)
- (79) (Spoken Japanese, Asada 2019)
- a. *Hanako-wa [koohii to koocha]-0 non-da*
 Hanakoa-TOP [coffee TO tea]-ACC drink-PST
 'Hanako drank coffee and tea' (conjunction)
 - b. *Hanako-wa [koohii to koocha]-0 osoraku ryooohoo non-da*
 Hanakoa-TOP [coffee TO tea]-ACC maybe both drink-PST
 'Hanako drank coffee or tea, maybe both' (disjunction)

If there is a tendency for sign languages to use such a strategy more than spoken languages, there could be many reasons why. For example, there seems to be something advantageous about associating coordinates to different areas of space in sign languages that makes this way of expressing coordination especially useful. Both the use of loci and the use of hand "buoy" (a list anchored by fingers on the non-dominant signing hand) to express coordination establish the alternatives to different locations in space, which then support reference going forward. In Chapter 2 we already discussed how this is a common way to express contrast, and we focus on the potential for anaphora using these spatial locations in Chapter 4. Another

possibility unrelated to the spatial nature of sign languages is the use of nonmanual marking: sign languages are typically not dissociated from the suprasegmental nonmanual marking that accompanies signs, while many spoken languages have their prosodic information removed in, for example, written form, and this lack in written language may have encouraged the development of segmental forms like *and* and *or* in some languages as opposed to conveying the semantic/pragmatic relationship between coordinates suprasegmentally. In the next section, we discuss possible pragmatic consequences of this way of expressing conjunctive and disjunctive meaning.

3 Semantics/Pragmatics interface: Implicatures

We began this chapter with the observation that human languages were originally compared unfavorably with logical languages, and an important turning point in the study of natural language semantics was the attempt to model human language as logical. This was made possible through an added twist of pragmatics: how people *use* their language to communicate may be the source of why they appear messier than logics. As argued by Grice (1989), a well known example is the analysis of *or* as inclusive disjunction \vee , even though in practice the linguistic expression of disjunction is rarely used when all of its disjuncts are true. This apparent discrepancy between meaning in natural language and logical meaning is explained through the notion of **implicature**: in a context in which we know that Alex had tea and Alex also had coffee, and both are relevant, we could have just as easily said *Alex had tea and coffee*, as we can say *Alex had tea or coffee*, and the first one would be much more informative, so we use *and* instead. The thinking goes, then, that in situations that we do say *Alex had tea or coffee*, we must have had a reason not to use *and*, and so it is unlikely that we know both to be true.

(80) *Context: We want to know what Alex had to drink, and we know the only options are coffee, tea, both, or neither*

Person A: Alex had tea or coffee.

Alternative possible answers:

Alex had nothing/ Alex had only tea/ Alex had only coffee/ Alex had tea and coffee

Person B thinks: If Person A knew that Alex had both, they would have said Alex had tea and coffee. Since they didn't say that, he probably didn't have both, so it must be the case that Alex had tea or coffee but not both.

Thus, Person B interprets Person A's statement as:

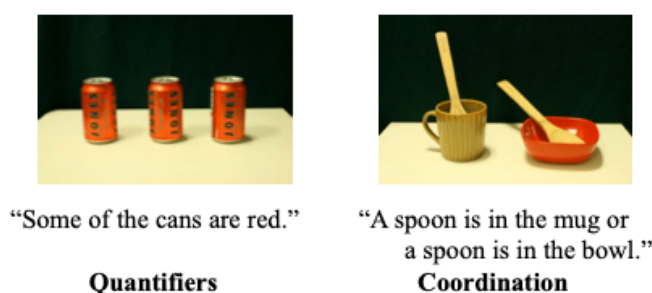


Figure 3.1: Descriptions using the “weak” scalar items *some* and *or* and accompanying pictures to test for scalar implicatures in Davidson (2013)

Alex had (only) tea or coffee (not both)
(pragmatically strengthened reading/scalar implicature)

Due to their use of general use coordination, sign languages like ASL present a somewhat different logical structure to investigate scalar implicatures than more well-studied languages like English. For example, does general use coordination count as involving different possible alternative answers for the purposes of the kind of reasoning in (80), or not? Davidson (2013) investigates this question by comparing scalar implicature-based interpretation of disjunction in ASL and in English, in order to understand how the different scalar structures in the two languages affect interpretation of the logical expressions. This experimental study compared scalar implicatures in two languages by comparing two participant groups: Deaf adult signers of ASL, and hearing adult speakers of English, with each group presented with sentences in their language (ASL or English, respectively) to test scalar implicatures. In this study participants were all asked judge the acceptability of a description of a picture, and the critical trials presented sentences using expressions of disjunction in contexts where conjunction could also be true (for example, the **coordination** case in Figure 3.1). If participants accept this description, they interpret it “logically” but not pragmatically; if they reject the description, they are interpreting it with the pragmatically enriched meaning. Participants’ responses on these trials were compared to trials in which descriptions matched, and also to trials of the same structure but with quantifiers (expressions using *some* where *all* could also be true).

The result of the study was that when it comes to a “typical” scale in both languages like the quantifiers, both ASL and English speakers react similarly, suggesting that both groups/languages had similar baseline expectations for calculating scalar implicatures. However, these two groups showed a difference on the coordination scale: while ASL uses nonmanual marking to distinguish conjunction from disjunction, English uses different

words (*and/or*). The structure of connectives in sign languages thus has pragmatic consequences worth investigating in other nonmanual domains (e.g. negation) and across other sign languages. More generally, it suggests that cross-linguistic investigations are a valuable source of understanding the kinds of scales that do and do not support such pragmatic inferences; other examples include languages with different modal scales, as in Deal (2015) for Nez Perce.

4 Coordination and information structure

Recall that in the previous chapter we discussed how sign languages tend to be strongly discourse configurational, in that the information structure (topic, focus, etc.) is a strong influence on word order. In this section, we discuss a place where discourse configurationality intersects with logical operators through the (sometimes lack of) parallelism imposed on coordinated structures. To be more specific, a well-known generalization based on spoken languages is that the word order of two coordinated clauses tends not to be independent. Syntax, semantics, and information structure constrain coordination to generally be as parallel as possible. For example, we can observe that parallel structures in (81a) are preferred compared to (81b), in which the prepositional phrase *to college* is topicalized in the second coordinate but the prepositional phrase *to school* is in its canonical position in the first coordinate.

- (81) (English, adapted from Hartmann et al. 2021)
- a. Mary is going to school and Vivian is going to college.
 - b. ?Mary is going to school, and to college, Vivian is going.

Zorzi (2018) provides a detailed analysis of information structure within coordinated phrases in Catalan sign language (LSC), arguing in favor of dedicated syntactic projections for information structural components. Hartmann et al. (2021) extend the study of coordination and information structure to sign languages by asking whether the same constraints that we see on information structure and coordination, like in (81), hold in sign languages. They review previously published literature, including sign language textbooks, and report overwhelmingly parallel examples on coordination in sign languages. They then turn to a corpus analysis from Dutch sign language (NGT) to investigate in more depth any possible exceptions to such constraints. One of the interesting findings of this work is that constraints on parallel word order reported in many spoken languages do not seem to be constraining NGT in the same way. For example, the disjunction in (82) contains one disjunct where the verb GO++ precedes the goal (hard of hearing school), and a second disjunct where the goal (hearing school) precedes

the verb GO_{3b}.

(82) (NGT, Hartmann et al.)

CI [GO++_{3a} $\overline{\text{S-H SCHOOL}}$ ^{bl-3a}] [$\overline{\text{HEARING SCHOOL GO}}$ _{3b}^{bl-3b}]
 ‘Because of the CI, (children) go to a hard-of-hearing school (or) go to a hearing school.’

The takeaway from their corpus study seems to be that although most examples do involve parallel syntax, semantics, and information structure, there are also genuine exceptions. It is not clear whether this rough ratio holds also in spoken language corpora, but it would be worthwhile studying whether these “constraints” are truly constraints on production or just tendencies in spoken languages, as it seems to be a tendency in NGT. Recall in the previous section that we saw both nonmanual marking and the use of space invoked as part of the explanation for the typological pattern of negative concord found in sign languages. It’s possible that the same factors play important roles when it comes to parallelism and information structure for coordination as well: we can see in (82) that space is used to contrast the disjuncts (loci *a* and *b*), and nonmanual marking in the form of brow lowering is likely relevant as well. Perhaps there is also influence on the use of space coming from metaphor, as we saw in our discussion of contrast: the two possibilities are depicted in different areas of space, following PROXIMITY IS SIMILARITY, suggesting that incorporating gestural elements would be critical for a full understanding of this contrast in spoken languages as well. Of course, this may also simply be a difficult question to answer when restricted entirely to a production corpus, although fieldwork and/or careful experimental work has the potential to tease these apart to understand the role of sign language specific and general language components when it comes to parallelism contrasts on coordination.

5 Conclusions

We end this chapter turning our focus on the big picture questions: what can we learn about sign languages from looking at logical operators like negation, conjunction, and disjunction, what can learn about these operators by looking at sign languages, and what kind of conclusions can we draw about language more broadly? On the last point, it can be instructive to consider the model that we introduced in Chapter 1, in which language meaning contains both **propositional** representations while at the same time constructing representations of **particular events**. Clearly, logical operators contribute to propositional representations: that is one of their most obvious roles. In fact, logical operators are a large motivation for that

kind of meaning: we can derive entailments through logical processes like the interaction between disjunction and negation (e.g. disjunctive syllogism: if a disjunction $p \vee q$ holds and a negation of one disjunct $\neg q$ holds, then we can infer the other disjunct p is true). So if there ever was a clear contributor to propositional meaning, logical operators are it. But do they bear on questions about multiple types of linguistic representations for meaning?

One way to think about this question when it comes to negation, conjunction and disjunction is to consider models of each event as independent, at least at first. So, in the case of “it’s not going to rain today”, there may be a positive representation of a particularly rainy day (we can reason about it through experience/simulation) at the same time as the proposition that rules out all of the possibilities in which it does rain today (the propositional content). This has advantages over purely propositional approaches that cannot explain why we nevertheless seem to conjure up a mental image of a rainy day even when the assertion expressed rules them out. It also can explain why sign languages may be more flexible when it comes to constraints like those on parallel information structure in coordination that we discussed in the last section, if space is going to also be used for depiction (which doesn’t have the same constraint). It also has advantages over purely cognitive linguistic models of events which struggle to model the contribution of logical connectives like negation, conjunction, and disjunction. Clearly, these present intriguing areas to think about the intersection of multiple types of linguistic meaning.

4

Anaphora: a spatial discourse

So far we've focused on whole sentences and how they convey information in a discourse via propositions and the propositional operators that connect them. This chapter will focus on smaller pieces of language, namely, how we refer to, describe, and track the people, places, and things that we are talking about. Innovative work in semantics of spoken languages in the early 1980s by Heim (1982) and Kamp (1983) argued that we used basically the same semantic representations for tracking things within a single sentence and for tracking them across sentences in a discourse. It is consequently one of the most striking aspects of the structure of sign languages from the perspective of formal semantics and pragmatics that sign languages naturally incorporate the signer's 3-dimensional signing space to keep track of things across both a sentence and a discourse (Lillo-Martin and Klima, 1990; Schlenker, 2011), and the way that this spatial nature of discourse is integrated with the use of space to depict these characters, objects and events (Liddell, 2003; Taub, 2001; Cormier et al., 2013; Schlenker et al., 2013; Fenlon et al., 2018). In this chapter we will first focus on a couple of clear examples where locations in space ("loci") are used for both discourse tracking purposes ("anaphora") and for depiction, observing that the two systems are closely tied together. We'll then investigate the use of a pointing indexical sign to these loci/areas of signing space and its comparison to (personal and demonstrative) pronouns and other ways to refer to things. From there, we'll move to such uses in verbs, tying together the pronominal and verbal uses. In the final section we'll compare different formal approaches to the problem of loci, put forth a positive proposal, and set out suggestions for future work in this domain.

1 Space as depictive and arbitrary

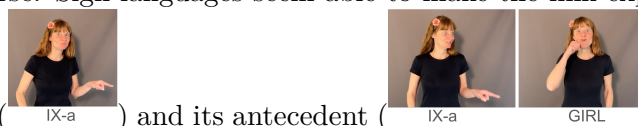
To begin, let's feature an example of signing space used at the same time for both depiction and for tracking discourse referents. In (83), we see part of a narrative in which the main character (a girl) saw a rainbow. The girl is associated to the signer's left side, and the rainbow to the signer's right side. Throughout the story, including in any subsequent sentences, each of these spaces (left signing space and right signing space) can be used to refer back to the girl and the rainbow. At the same time, aspects of the girl and rainbow can potentially be depicted in these spaces, such as the high pointing toward the right side, since the rainbow was up in the sky.

(83)



‘There is a girl. She saw the rainbow (up there).’

In sign language linguistics research, especially in formal semantics, much effort has been spent analyzing this use of space, and for good reason. On the one hand, it has long been a puzzle within formal semantic approaches how to think about the way that we connect pronouns to their antecedents in a discourse. Sign languages seem able to make the link explicit by tying



a pronoun (IX-a) and its antecedent (IX-a GIRL) to the same location in space. This is the motivation behind a significant body of work that emphasizes the overwhelming similarities between pronouns in signed and spoken languages, which we will focus on in the next section, in line with decades of findings that signed and spoken languages are more similar than they are different. Given all of this, we might want to use sign language structure here to also better understand the process in spoken language.

On the other hand, if we over analogize, that is, if we emphasize the similarities too much, we risk missing important aspects of the use of space in sign languages that are simply not available or are less available in spoken language or (especially) in written language. For example, if we think about

the use of space as entirely about linking anaphoric expressions with their antecedents, we risk losing sight of the way that this same use of space is used for depiction (Liddell, 2003; Cogill-Koez, 2000b; Schlenker et al., 2013). For example, it won't explain why particular uses of space are used or not, such as the high pointing to the rainbow in (83) or the way that pragmatics plays a role in determining whether to use overt space at all versus using (covert) strategies more common in spoken languages (Ahn et al., 2019).

At issue in the end is whether and how to emphasize the arbitrary vs. the non-arbitrary nature of space in sign languages, since both come into play directly in the meaningful use of space in sign languages. On the one hand, it seems like space can be used somewhat arbitrarily, and when it is used arbitrarily it seems to serve a function of linking together discourse referents in the way that other systems have been shown to do in spoken and written language. We will investigate these in Section 2 when we discuss the way that pointing behaves pronominally in sign languages, and how the places one points to (we follow the literature in calling these spatial locations “loci”) share commonalities with restrictions on pronominal reference of the sorts seen in written and spoken language. Again, the emphasis in this line of work is on the striking commonalities between the use of space in sign languages, and the way that pronouns and their antecedents are associated with each other in other language modalities like speech and writing.

A focus on the arbitrary nature of loci contrasts with the observation that space can be used in sign languages in a way that is not arbitrary at all: signers can make use of space to depict a relationship between objects and to depict events (Fenlon et al., 2018; Liddell, 2003). This use of space exists in both spoken and signed languages, a way to show who does what to whom (Schlenker and Chemla, 2018), how objects are arranged (Davidson, 2014) and how things move through space (Kita and Özyürek, 2003). Within the formal semantics/pragmatics literature, it is usually said that this use of space is interpreted *iconically*, i.e. not through (potentially arbitrary) symbolic means; Ferrara and Hodge (2018) discuss such uses of space as both depictive and/or indexical.

This chapter will focus on these two uses of space and their interactions in sign language discourse. We will start in Section 2 by discussing the preponderance of evidence of similarities between pronominal structures in sign languages and spoken languages. Section 3 will continue this discussion but with a focus on the verbal domain: how does the discourse information conveyed in pronouns reflect in the verbal domain, i.e. through agreement or clitics. Section 4 will then discuss the hypothesis that the (arbitrary) use of space in sign languages is a visible manifestation of pronominal indices that have been hypothesized in dynamic semantic accounts of spoken languages. Section 5 will explore the comparison between this same use of space in sign languages and gender/noun class features in spoken languages, and compare to the index account. In section 6 we will move on to studies that highlight

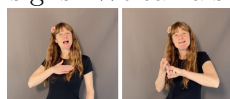
the depictive/iconic nature of loci. Finally, in section 7 we will present a view that attempts to take all three into consideration by taking space to be a kind of “locative coreference constraint”, and conclude in section 8 with future questions and direction.

2 Pronouns: Evidence for shared structure

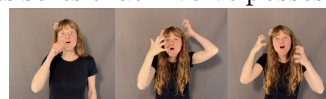
All languages have ways to refer to people, places, and things, and so it is an important part of one’s competence with a language, how one keeps track of which things you’re describing at any given moment. When we describe people, for example, we can use proper names, expressed in ASL either using



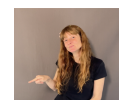
fingerspelling () and/or uniquely associated name signs. We can also use descriptions of various sorts that involve possession



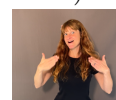
sion () and/or other modifiers () ‘the girl with curly hair’). We can also use shorter forms when we’re more



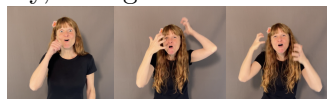
familiar with who we are talking about, such as pointing () or



even leave out a name or sign altogether ((Talking about Gina:) ‘She is happy’). Given this variation in possible ways to refer to exactly the same person, it is a deeply interesting question how we decide which terms to use to refer to Gina at different points in a discourse. For one thing, we know that economy constraints come into play, such as the fact that we typically use a longer expression for something less familiar/less expected, and shorter forms for something more familiar or more expected. This can’t be the whole story, though: each of these expressions convey



different information, e.g. () entails that the referent is both a girl and has curly hair, while a combination expression



() might imply that the girl with curly hair is already familiar to the signer (Barberà, 2012) or to both the signer and the interlocutor (MacLaughlin, 1997). Moreover, there are linguistic



constraints regarding how these kinds of expressions can appear in relation to each other, as in the complementary distribution between personal pronouns and reflective pronouns described in the binding theory (Chomsky, 1981).

One area that has been the source of much discussion in formal linguistics comes from one of the smallest of these expressions, the meaning of pronouns. For example, we might at first blush want to equate a pronoun like the English expression *her* with the name of its referent, e.g. *Gina*. But notice that they cannot simply be exchanged in order. The full name has to precede the pronoun: we can easily imagine that *she* is *Gia* in (84a) but it's much harder to have the same two expressions connected to the same meaning when used in the reverse order, in (84b).

- (84) a. Gia is happy. She likes tea.
 b. She likes tea. Gia is happy. (\rightarrow She \neq Gia)

Note, sometimes we want to notate that coreference is available or unavailable by using subscripts, so for example we can write that (85a) is a well-formed discourse, but (85b) is not, and yet (85c) is.

- (85) a. Gia_i is happy. She_i likes bread.
 b. * She_i likes bread. Gia_i is happy.
 c. She_i likes bread. Gia_j is happy.

Perhaps not surprisingly, the picture that emerges from (85) is found in



sign languages, too. A pointing sign (IX-a) to a location in space (*a*) has a similar pattern to the picture presented in English. That is, the pronoun can't pick out the person whose name is used later, while if they are flipped in order, this is the most natural interpretation.

- (86) a.



‘Gia is happy. She (Gia) likes tea.’

- b. * IX-a LIKE TEA. GIA HAPPY. ‘Gia is happy. She (Gia) likes tea.’

Preferring the whole noun phrase antecedent precede a pronoun might seem like an obvious choice for a language to make for functional reasons, but it is just one of many ways that human languages seem to organize the relationship between pronouns and their antecedents, some of which (like the linear order) seem easy to provide functional explanations for, and others less so. For example, it’s possible to have a pronoun temporally precede a noun with the same reference, as long as they are in certain syntactic/semantic configurations, such as *Because she_i brought her teabag this morning, Gia_i was able to make some tea.* Chomsky (1981) famously outlined several principles in his theory of pronominal binding, which included the observation that a reflexive anaphor (like English *herself* in (87a)) needs to be “bound” (i.e. have a co-indexed structurally higher local antecedent), that a pronoun (like English *her* in (87b)) needs to be “free” (i.e. not have a co-indexed structurally higher local antecedent) and that a referring expression (like English *Alex* in (87c)) needs to be free (i.e. not have a co-indexed structurally higher antecedent). These principles arising from these observations are lettered as in (88).

- (87) a. Alex_i emailed herself_i. (Alex = herself, thanks to Principle A)
 b. Alex_i emailed her_j. (Alex ≠ her, thanks to Principle B)
 c. She_i emailed Alex_j. (She ≠ Alex, thanks to Principle C)

Those who are interested in learning more about Binding Theory and subsequent/related theoretical terminology, especially about the notions of locality (meaning roughly in the same clause, verbal domain, sharing a subject, etc.), binding (being not just co-indexed but also syntactically connected), C-command (a particular definition of “structurally higher”), etc., are encouraged to learn more in a syntax course; basic notions are also introduced in the context of sign language syntax in Sandler and Lillo-Martin (2006).

For our purposes here, it is worth noting that many languages that are unrelated to English show the kind of pattern exemplified in (87) for expressions that seem similar to *herself*, *her*, and *Gia*. Sometimes exceptions arise, and when they do, it becomes especially important to more clearly define what “counts” as being similar to something like the reflexive *herself* or not. In these cases, one is faced with the challenge of either adapting the theory or categorizing it as a different case; so it goes, when developing any linguistic theory, with many factors influencing one’s decision. A natural question for sign linguistics is whether these same patterns hold that are found in so many spoken languages of the world, and in any cases that

they do not, what this says about the similarities and differences between pronouns in spoken and signed languages, and how to draw generalizations across all languages.

Consider, first, some basic sentences in American Sign Language. Some have claimed that they seem to show the same pattern as in English (Sandler and Lillo-Martin, 2006; Schlenker and Mathur, 2012); others have suggested that what are quite strong preferences in English (which originally motivated the binding theory) are weaker preferences in ASL (Kuhn, 2015).

(88) a.



‘Gia emailed herself’ (Gia = SELF, thanks to Principle A)

b. fs(Gia)-a_i a-EMAIL-b IX-b_j. (Gia ≠ IX, thanks to Principle B)

c. IX-b_i b-EMAIL-a fs(Gia)-a_j. (IX ≠ Gia, thanks to Principle C)

To the extent that these preferences resemble English ones but are weaker, or even differ completely, a few possible explanations come to mind. First, all languages have their own set of ways to reduce ambiguities. Consider gender in English pronouns in the two sentence dialogue in (89a). The two people introduced by the first sentence have names which are stereotypically associated with two different genders, and so gendered pronouns can be used to distinguish them in the following sentence. But in a case where the stereotypical gender associated to two names is the same, as in (89b), the story is more clearly ambiguous in written English between the artist as the helper or the helped one. Spoken English can be ambiguous too, but speech can also make use of prosody, for example an extra stress on *she* can signal a topic shift to signal that object of the previous sentence (Ann) is the subject of the new sentence, i.e. the artist.

(89) a. Mary_i helps John_j. She_i/He_j is a wonderful artist.

b. Mary_i helps Ann_j. She_{i/j} is a wonderful artist.

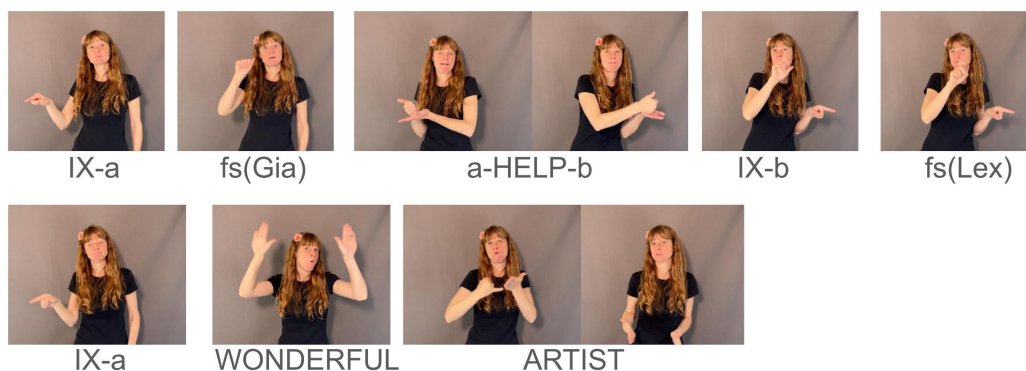
c. Mary_i helps Ann_j. She_{*i/j} is a wonderful artist.
(with disambiguating prosody)

Certainly many spoken languages do not necessarily make use of a gender system for resolving pronouns: for example, spoken Mandarin makes no distinction between male and female third person pronouns (although written Mandarin can, flipping the modality bias yet again), while German has

three genders that can be expressed on pronouns (male, female, neuter) and languages with more extensive noun classes can make many more distinctions including human, classes of other living things and objects, etc. These features can interact with other factors of languages to correctly resolve pronouns, including organizing by topic/comment structure, information on verbs, and many other factors.

Given all of this, it is then not at all surprising that in sign languages, there are also many similar strategies for resolving anaphora. These include topic/comment ordering, the use of different handshapes for different classes of nouns, and associating different referents in a discourse to different areas of space. We will focus on the last of these for the time being: the association of discourse referents to different areas of space, known in the literature as spatial “loci” (Lillo-Martin and Klima, 1990). Consider (90): the association of Gia to the signer’s right-hand signing space and Lex to the left signing space unambiguously picks out Gia as the referent of the pointing sign when it is made to the left signing space.

(90)



‘Gia_i helps Lex_j. She_i (Gia) is a wonderful artist.’

A question that arises again and again in formal approaches to sign language semantics is how to think about this use of space, and how it compares and contrasts to other ways to disambiguate reference in spoken and written language. Attempts toward answering this question will comprise the remainder of this section.

One much-discussed difference between the use of loci in sign languages and systems like gender and noun classes in spoken languages is that there seems to be **no finite limit** to the use of space in terms of the number of distinctions it can support. Lillo-Martin and Klima (1990) note that between any two areas of space associated to individuals in a discourse, the area in between them could be associated to a third referent. This seems true in terms of theoretical possibilities/competence although “performance” in terms of memory demands and/or perceptual distinctions lead to some natural limits; given this, it seems that sign languages can make infinite distinctions.

However, something that has been much less discussed in formal approaches is that it's not at all obvious that spoken languages are restricted to a finite set of gender classes, either. Perhaps traditionally we have thought about pronouns as having limits to gender distinctions (e.g. *he/she/it* for English third person singular reference) but neopronouns (e.g. *xe*) are increasingly used and perfectly illustrate the principle that there is no principled limit to the number of pronoun distinctions for a language (Conrod, 2019). The fact that sign languages can make in principle infinite distinctions was once used as an argument that they are not like gender/noun class features in spoken languages, but given the creativity available in neopronouns this should probably be set aside as a difference between spoken and sign language pronoun/feature classes.

Beyond the sheer number of distinctions, it has also been a point of much discussion how **arbitrary** (or, nonarbitrary) are the use of loci. We saw above one example, where the pronoun pointed high in the sky for a rainbow, in contrast to lower for the girl watching the rainbow (83). Schlenker et al. (2013) for example provide the following dialogue about a short basketball player and a tall basketball player. This height difference will most naturally be reflected in the choices of areas of space to associate to them: the loci associated to the tall basketball player is tall but the one associated to the shorter player is lower in signing space (91).

- (91) (ASL, from Schlenker et al. 2013)
 POSS-1 YOUNG BROTHER WANT IX-1 REST.
 IX-1 UNDERSTAND IX-a-high.
 'My younger brother wants me to rest. I understand him.'
Interlocutor infers: the speaker's younger brother is tall.

Another source of iconicity comes from physical presence: if someone or something being discussed is physically present, a pronoun to pick them out can use their actual location. In the same dialogue about Lex and Gia, for example, if Lex is over in a corner of the room sitting down and playing a board game, she is best referred to by pointing to her directly (92).

- (92)



‘Lex_i helps Gina. She_j is a wonderful artist.’
 (where Gina is present in the corner of the room)

Although the height (on non-present loci) and direct pointing (for present loci) are typically considered as two different kinds of constraints on sign language pronouns, we can consider them unified in the sense that they can each motivate the choice of locus (to the physical presence, features, or even more abstract notions like honorifics, etc.), following Liddell (2003). Both show that the location associated to the referent can be motivated in different ways. Note that some combination of motivation/arbitrariness is present in every feature class in the world’s languages: “gender” is precisely something with some motivation in the natural world but it is extended in many cases in an arbitrary way so that, for example, *bridge* is masculine in some languages (e.g. French *le pont*) but feminine in others (e.g. German *die Brücke*). We will discuss some further notable cases in section 6 of this chapter in which space is used in a motivated way for purposes of scene depiction. The overall takeaway at this point is that the combination of arbitrariness and motivated choice of locus in pronouns in sign languages reflects a mix of arbitrariness and motivated choice found in pronoun systems in spoken languages as well.

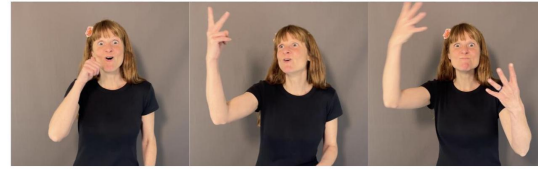
Another important similarity between the pronoun systems of spoken and signed languages is that they are **part of a larger system of referential expressions** that are used in different syntactic and pragmatic contexts. For example, depending on the pragmatic context/salience of the reference in the context, reference in ASL can be made via bare nouns (93a), a pronoun of the sort we have been discussing (93b), or implicitly by argu-



ment omission (93c), or a combination of IX-a and noun phrases (93d-e). It has been argued that IX can sometimes be used as a definite article when it is prenominal as in (93d) like *the* in ASL (MacLaughlin, 1997) or the “strong definite” in German (Irani, 2016). Others have argued that ASL is an “NP language” as in the typology argued for by Bošković (2005), concluding that all noun phrases in ASL are bare noun phrases, and such uses of IX are

modifiers of some sort (Koulidobrova, 2012), especially postnominally (93e) or demonstratives (Koulidobrova and Lillo-Martin, 2016; Ahn, 2019a).

(93) a.



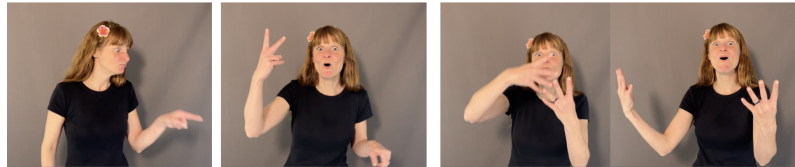
GIRL

SEE

RAINBOW

‘The girl saw the rainbow’

b.



IX-a

SEE

RAINBOW

‘She saw the rainbow’

c.



IX-a

SEE

‘She saw (it)’

d.



IX-a

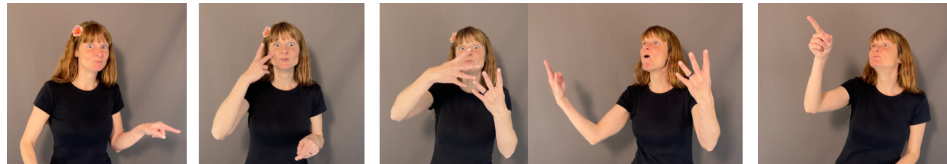
GIRL

SEE

RAINBOW

‘The girl saw the rainbow’

e.



IX-a

SAW

RAINBOW

IX-b

‘She saw the rainbow’

Barberà (2012, 2015) makes a compelling case that the prenominal IX in examples like (93d) marks specificity, not definiteness, at least in analogous

examples in Catalan Sign Language when used in the lower plane of the signing space. Davidson and Gagne (2022) extend this observation to the use of IX in the lower plane to express specificity in ASL, and furthermore they argue that the source of this is a more general use of planes to express domain size (where the smallest/lowest is a domain with a single element, i.e. specific, in agreement with Schwarzschild (2002)’s view of specificity as an extreme domain restriction to just one element in the domain). This raises a point emphasized also in Koulidobrova and Lillo-Martin (2016), that the **presence** of IX and the **locus** it associates with are independent aspects to analyze when trying to understand sentences like (93b-e) and others.

Finally, recall in Chapter 2 that we emphasized the ways in which information structure influences the expression of sentences in sign languages. One example of this kind of influence is the topicalization of a full noun phrase, with a pronoun anaphoric to the noun phrase expressed in argument position later on in the same sentence, or in the same discourse. Example (94) illustrates this in ASL: canonical word order is subject-verb-object, but instead of appearing in its canonical position, the subject FRIENDS has been topicalized, and the pronominal IX-arc_a appears in its argument position immediately preceding the predicate (REAL SMART).

(94) (Davidson and Gagne, 2022)



‘(My) friends, they (are) really smart.’

In examples like (94) we can easily see the link between FRIEND (the topic) and IX (the subject of the sentence), but ASL also permits a subject to be implicit, i.e, unpronounced in a circumscribed set of linguistic contexts (Lillo-Martin, 1986; Koulidobrova, 2012). Moreover, between completely overt pronouns like IX and completely covert pronouns, there are intermediate options for providing anaphoric information, most notably the use of verbs to indicate their arguments via incorporating the same locus system as IX, which will be the focus of the next section.

3 Verbs: Agreement versus cliticization

Many languages in the world, including both spoken and signed languages, change the form of their verbs to reflect different arguments. For example, the Latin verb in (95a) has a “first person” ending because the subject is

the speaker, while the verb in (95b) has a “third person” ending since the subject is someone else not currently participating in the discourse.

- (95) a. *amo* ‘I love’
 b. *amant* ‘They love’



a-EMAIL-b

Similarly, the ASL verb moves from locus *a* to *b* in (96a) to indicate that the person associated to *a* (Gina) was the subject, while it makes the opposite movement (from *b* to *a*) to indicate a third person was the emailer (to Gina).

- (96) a.



IX-a

fs(Gina)

a-EMAIL-b

‘They (Gina) emailed them (singular)’

- b.



IX-b

b-EMAIL-a

IX-a

‘They emailed them (both singular)’

The pattern in (95) is often analyzed as agreement in formal sign linguistics analogous to the Latin type, and many analyses of the ASL pattern in (96) also use the term “agreement” to highlight this similarity, and in some cases to argue that the underlying cause is the same (Pfau et al., 2018). Sometimes, however, what superficially appears to be agreement of the sort famous from Romance languages and other languages with high amounts of inflectional morphology, may in fact have different analyses under the hood. Consider, for example, the case of French clitics *l’/le* (97) which in terms of pronunciation do not stand alone: they must immediately precede a verb and are pronounced as one prosodic unit with the verb, two reasons we might think they are more like the Latin verbal endings/agreement. However, in at least in some cases they behave quite differently from agreement but rather behave semantically like full pronouns in filling in argument slots. We can see this by observing that pronouncing the object clitic along with

the full object as in (97e) is unacceptable, which would be surprising if the clitic were simply agreement. Is there any reason to think that the use of directionality in sign languages should be analyzed along these lines?

- (97) a. Marie voit Jean. 'Marie sees Jean.'
 b. Marie aime Jean 'Marie loves Jean'
 c. Marie l'aime 'Marie loves him'
 d. Marie le voit. 'Marie sees him.'
 e. *Marie le voit Jean. 'Marie sees Jean.'

On the surface, a major difference between French clitics and ASL loci on verbs is that a loci marked verb does not preclude full noun phrases, in contrast to the unacceptability for clitics in (97). However, there is a well known phenomenon of clitic doubling (repeating the argument both as a clitic and in argument position) in general across the world's languages (Anagnostopoulou, 2006), so the locus and full noun phrase co-occurrence do not rule out a clitic analysis. Moreover, when we look more closely at directionality on sign language verbs, we see more deep similarities between clitics and directionality in sign language verbs. There are, for example, many ways in which loci show odd properties from the perspective of analyzing loci as agreement; Nevins (2011) notes that the following are all odd or unexpected properties of ASL agreement:

1. Subject agreement is optional, not required (Meier, 1982)
2. The plural cannot be marked on both subject and object at the same time (Sandler and Lillo-Martin, 2006)
3. Number agreement is realized as through marking dissociated and isolable from that of person (Mathur, 2000)
4. Agreement occurs in non-finite/infinitival clauses (Padden, 1988)
5. There is a preference for marking the indirect object over the direct object (Janis, 1995)
6. Loci occur on prepositions in some sign languages (Meir, 2002)
7. Some directional marking seems to express spatial locations, not identify arguments (Padden, 1988)

What is noteworthy is that so many of these properties are seen in clitics across the world. Nevins (2011) provides the following examples of languages with clitics that show these properties:

1. Subject person marking on verbs is optional: Gruyere clitics
2. Plural cannot be marked on both subject and object at the same time: Georgian omnivorous number triggered by clitics
3. Number agreement realized as a dissociated gesture: Georgian
4. Clitics occur in non-finite/infinitival clauses: Italian
5. Preference of the indirect object over the direct object: French clitics
6. Clitics found on prepositions: Polish
7. Existence of locative clitics: Italian, French

Highlighting similarities between clitics in spoken languages (prosodically dependent pronominal-like elements that fill argument positions) and directional verbs in sign languages in some ways raises more questions than answers. For example, it is known that clitics can be an intermediate path in language change between full pronouns and agreement, and perhaps French in its current state exemplifies this (Culbertson, 2010). Is something like this the way to think about the ASL case too, as not entirely one or the other within the ASL community but rather in a state of ongoing change?

Second, whether or not the use of directionality marked on verbs in sign languages is most closely compared to clitics, agreement, or something in between in spoken languages, the better question is how it works on its own: what are the possibilities and what are the constraints? And how is this best accounted for in a theory of the minds of sign language users? For example, agreement and clitics have historically been viewed entirely differently in theoretical linguistics literature: agreement is typically viewed as a formal link between something that has some features (say, plural/singular grammatical number features, noun class, and/or gender on noun phrases) and other places in the language that take on these features, such as verbs, adjectives, determiners, etc., which “agree” with the noun phrase. Agreement on a verb phrase doesn’t provide the arguments for any verbs (i.e. it doesn’t provide any missing information directly), it is simply a reflection of something elsewhere that has provided that argument, and thus it isn’t in complementary distribution with full noun phrases. In contrast, (prosodically stand alone) pronouns and (phonologically dependent) clitics tend to be viewed as making reference directly and filling argument positions, as we saw in (97). They can introduce things into a discourse on their own, and to the extent that they have a link to another noun phrase it is via co-indexation of the sort that can hold between any two noun phrases. However, even given consensus that certain expressions might be clitics in a spoken language, linguists may disagree on the relationship between full noun phrases and clitics - in some cases there might be reason to posit a

syntactic dependency between a full noun phrase and a clitics. Arguments for treating spoken language clitics as pronouns typically comes from semantics, as in the ability of a clitic to vary with a quantifier (Baker and Kramer, 2018), and we will see more examples of this discussed in Chapter 6.

Kocab et al. (2019) provide further pragmatic arguments in favor of a clitic analysis and against agreement via the optionality (also noted above) of directionality marking on sign language verbs. They show that the use of directionality on verbs depends on several pragmatic factors involving disambiguation: two animate referents in a story are more acceptable disambiguated via verb directionality, whereas a story with a single animate referent is more acceptable without directionally marked verbs or the use of locus and pronominal IX; similarly, stories with unambiguous continuations were acceptable without directionality, whereas stories with ambiguous continuations were much more acceptable with directionally marked verbs. This dependence on discourse pragmatics is expected if we are dealing with clitics and/or pronouns, but not (typically obligatory) syntactic agreement.

The conclusion in this section is that there are important semantic/pragmatic similarities between the use of directionality in sign language verbs and the use of pronouns in the semantic sense, including clitics. Whether or not one also wants to highlight additional similarities to agreement (Lillo-Martin and Meier, 2011; Pfau et al., 2018) or to pointing construed more broadly (Fenlon et al., 2019), the use of loci on verbs is in many ways similar to clitics, which notably have semantic/pragmatic properties of pronouns (even if they are phonologically not separate words). Given this, and the similarities to pronouns shown in the previous section, the natural next question is how to think about the semantics of loci in light of what we know about pronouns. Entire subfields of formal semantics and both the syntax/semantics interface and semantics/pragmatics interface are dedicated to questions about how pronouns are linked to their antecedents. They ask questions like: how does one interpretation for a pronoun become preferred over another? How do we account for pronouns that seem to express quantification instead of refer to an individual (e.g. *Every girl hugged her mother*)? What mechanisms do we need in a theory of anaphora-antecedent relationships to cover the full array of cases that we see in natural language? Sign language loci have played interesting roles in all of these discussions. In the next section, we'll see how loci compare to indices used in "Dynamic Semantic" approaches to anaphora; in the following section we'll discuss the comparison between loci and gender/noun class features. We'll then propose an analysis which takes insights from both accounts in section 6.

4 Loci vs dynamic indices

One view of sign language loci which has gained significant interest in the literature is that of loci as the indices that keep track of discourse referents. Such indices are the core feature around which dynamic semantic systems revolve. In so-called “dynamic semantic” approaches, the level of semantic analysis is an entire discourse, not just as sentence (this contrasts with non-dynamic approaches). Two variants are roughly the representational structures of Kamp and Reyle (1993) or the file cards of Heim (1982) on the one hand, or the context change potentials of Heim (1982) and dynamic predicate logic of Groenendijk and Stokhof (1991) on the other hand; see also Chierchia (1995). In dynamic semantic systems, the idea is roughly that every noun phrase comes with an index (imagine these coming from the natural numbers, which count up our discourse referents), and the index tells you which discourse referent the noun phrase is associated with. For example, the English noun phrase *a happy artist* is indefinite (contrast with the definite *the happy artist*) so the function of *a happy artist* is to introduce an index, which in this case might be 2. This index is never pronounced, but nevertheless is tracked as part of the comprehender’s knowledge of the grammar. Then later, perhaps in the same sentence or in another sentence in the discourse, a pronoun *her* or *she* might be assigned an (unpronounced) index 2, which ensures that *her*, *she* and *a happy artist* are all directed to the same file card, e.g. roughly have the same reference. We can notate the dependency between these interpretations as in (98); the idea of dynamic semantics is that these indices are symbols in the semantics able to be operated on by other symbols (e.g. quantifiers, boolean operators, etc.), and the effort is in understanding the ways that different operators introduce and act on such indices and restrictions on their co-occurrence.

(98) [A happy artist]₂ emailed her₂ friend. She₂ wanted to meet for coffee.

There are many empirical phenomena which are accounted for straightforwardly in dynamic systems, but the trade off is that the logic required to correctly capture the relations between indices depending on where they are in sentences/clauses is quite complex, though at this point also quite well thought through. (Along with references above, a gentle introduction to dynamic approaches can be found in Coppock and Champollion 2022.) Among many key data points are so-called “donkey sentences” (99), which have the notable property that there seems to be no syntactic relation/scopal dependency between the indefinite noun phrase in the antecedent clause (*a donkey*) and the pronoun in the consequent clause *it*, even though they are interpreted as co-varying (e.g. any donkey owned by a farmer is going to end up fed, not just a single particular donkey, so it is not referential, i.e. *it* doesn’t pick out a particular donkey).

(99) If a farmer owns [a donkey]₁, he feeds it₁.

Dynamic theories update information about discourse referents (e.g. *a donkey*) as they go, allowing for dependencies between these two syntactically disconnected clauses. Much of the details of dynamics is involved in understanding the logical configurations which support the kind of dependencies seen in (99) (e.g. antecedent and consequent of a conditional as we see above, or conjunction) and those that don't (e.g. disjunction).

If indices that keep track of the relationship between the meanings of different noun phrases are indeed part of the linguistic structure/semantic computations - and not a peripheral one, but essentially the most core notion in dynamic semantics! - then it might be considered a mystery why such indices would fail to be pronounced in any spoken language. One way to think about this is that the indices do not have a syntactic realization, but rather are a shorthand for a cognitive representational system for different files. With rare exceptions, such as the argument that the spoken language Washo shows evidence for syntactic reality of indices (Arregi and Hanink, 2021; Hanink, 2018), there have been few to no suggestions from spoken languages for indices to be reflected in linguistic forms. An intriguing insight by Lillo-Martin and Klima (1990) then, was that spatial locations, i.e. loci, in American Sign Language might be a good candidate for a language making dynamic indices overt. Their arguments are strong ones: they point out that loci are both infinite and unambiguous, two properties of indices in dynamic semantics. Their argument that loci are infinite is that any two loci can have another between them. They are unambiguous because they constrain coreference just like an index: if two noun phrases have the same index they corefer, and if two noun phrases have the same loci they corefer. (Lillo-Martin and Klima also note the shifting reference involved with loci; this comes up more in Chapter 5.)

The idea that sign language loci are examples of overt variable indices was further pursued by Quer (2005), Schlenker (2011), Steinbach and Onea (2015), and others. Schlenker (2011) and Steinbach and Onea (2015) build on the observations from Lillo-Martin and Klima (1990) in providing sentences from three sign languages (ASL, LSF, and DGS) that compare to donkey sentences. In these cases, the referents for noun phrases introduced in the antecedent of a conditional or in the restrictor argument of a universal quantifier can co-vary with others that seem to be in a syntactically inaccessible clause. Note that the example in (100) does not have stand-alone pronouns in the consequent clause like the English sentence, but rather convey the loci via the directional verb BEAT.

(100) (NGT, Steinbach and Onea 2015)
 COND FARMER_{BS:3a} OWN_{3a} DONKEY - IX_{3a} 3a BEAT_{3b}.
 'If a farmer owns a donkey, he beats it.'

Schlenker argues that sign language loci are in fact an argument *for* dynamic models of semantics over non-dynamic semantic models given that sign languages provide a “visible” manifestation of loci. To understand why, first we take a short detour, regarding so-called “Bishop sentences”. The structure of these sentences is such that two identical indefinite noun phrases (*a bishop... a bishop*) are introduced in one clause, and co-vary with pronouns or definite descriptions in another syntactically inaccessible clause (*he... him*), as in (101).

(101) If a bishop meets a bishop, he blesses him.

In spoken languages, bishop sentences have been used to argue against thinking about pronouns as having unpronounced structure similar to a noun phrase that disambiguates. Contrast, for example, the possible solution to donkey sentences in (102a) (which on its face might encourage is to think about equating *it* = *the donkey*) with the lack of clarity offered in the bishop case in (102b) - the noun *bishop* hardly distinguishes the subject from the object in this case, especially since the verb *meet* is symmetrical, too.

- (102) a. If a farmer owns a donkey, he feeds it[(the) donkey].
 b. If a bishop meets a bishop, the bishop blesses him[(the) bishop].

The problem for non-dynamic accounts basically is that we get the intuition that the bishops should vary in some kind of regular way (perhaps with a series of events/meeting occasions) and this is communicated clearly in (101), but less so in (102b), and so we might conclude that definite noun phrases like the one in (102) are not the hidden structure behind the scenes. This problem is presented in Schlenker (2011) as a choice in theoretical approaches: we can make the idea of the hidden/covert definite noun phrases more complicated (e.g. *The first bishop*), etc., to salvage the idea that pronouns are always hidden definite structures, or we can simply abandon the approach altogether that the way these sentences work is through some kind of covert noun phrase and instead complicate our logical machinery by allowing that pronouns come with their own dynamic indices, and a logical system that acts on these indices. According to Schlenker (2011), sign languages play a major role in deciding between these two accounts because they illustrate an overt version of indices in precisely these places, via loci.

Let’s examine what these sentences look like in sign languages to better understand this claim. As expected if loci are a way to show dynamic indices, both donkey and bishop sentences can make use of loci to distinguish one of the noun phrases from the other. The sentence in (103) has the structure of bishop sentences in some ways: it includes two noun phrases in the first clause (IX-a *a*STUDENT ‘a student’) and (IX-b *b*STUDENT ‘a student’) and the symmetrical verb MEET, except that unlike in English the noun phrases

are not entirely identical: the first is associated to locus *a* and the second to locus *b*.

- (103) (LSF, Schlenker 2011)
 EACH-TIME IX-a _aSTUDENT a-MEET-b IX-b _bSTUDENT, a-GIVE-b CIGARETTE.
 ‘Each time a student meets a student, he [= the former] gives him
 [= the latter] a cigarette.’

Under an account in which the two loci *a* and *b* are ways of overtly marking two different dynamic indices, this is exactly what we expect: “identical” noun phrases except for the indices, which then are used again in the consequent clause on the directional verb a-GIVE-b to provide a co-varying interpretation. This is taken as evidence from sign languages for overt indices Schlenker (2011); Zucchi (2012); Lillo-Martin and Gajewski (2014); Schlenker (2018). However, there are at least two reasons we might be hesitant in jumping to this conclusion.

The most obvious objection to the argument that loci are overt indices is that it’s not clear why the loci *can’t* just be considered as more descriptive material, of the sort seen in definite noun phrases like *the former*, *the latter*, *the one in this locus*, *the one in that locus*, etc. This is roughly the tact taken in response to this data by Ahn (2019a,b). She notes that if the locus is descriptive material then we might expect it to be elided in unambiguous cases where the potential for mistaken pronoun resolution is very low, and in fact this is exactly what we find in studies of the pragmatics of loci, both for indexical pointing Ahn et al. (2019) and loci in directional verbs Kocab et al. (2019). The (potentially descriptive) contribution of the locus usually has to be interpreted as non-restrictive/non-at-issue: we definitely want universal sentences like the one in (103) to range over all possible versions of students who meet (and thus give each other cigarettes), not just the ones who are in a particular location! But this is precisely what material like *former/latter* etc. is able to do, so there’s no reason the spatial locus cannot do this as well (restrict via space and not time, in contrast to *former*, *latter*, etc.)

Schlenker (2011) anticipates this point in arguing that one can add unpronounced descriptive material to the pronouns in donkey sentences of basically exactly this sort we have in mind for loci (*former*, *latter*, etc.), and points out that if we let this unpronounced material become fine-grained enough (e.g. have infinite options for disambiguation) this becomes basically the dynamic analysis. This seems entirely right! But, then the takeaway for formal semantics more broadly is *not* that sign language loci provide a unique kind of evidence in favor of dynamic semantic accounts, only that they follow exactly what we would expect of any language given what we already know about pronouns in these kinds of contexts: we are able to use descriptive content to make increasingly fine grained distinctions, and we seem to be able to do so overtly or covertly. In other words: a conclusion

is *not* that sign languages show unequivocal evidence for dynamic accounts, but rather that they show evidence on exactly the point where dynamic and non-dynamic accounts seem to entirely agree: that languages seem to be able to need some kind of restriction in the meaning of pronouns that is fine-grained enough to account for an unlimited number of distinctions between discourse referents, and while spoken languages can use all kinds of not-at-issue descriptive content, sign languages can also use space.

The second concern for taking sign language indices to be an example of dynamic variable indices is that in most dynamic semantic systems, indices are used on variables both in coreferential contexts and in contexts where the relationship between the two noun phrases seems to be more syntactic, such as quantifier raising, wh-movement, etc. (but see Reinhart 1983, Büring 2005, and Chierchia 2020 for discussion of keeping them separate). It can often be difficult to disentangle examples of the sort that encode discourse dependencies (tracking two discourse referents from sentence to sentence) from those that entirely encode syntactic dependencies, but probably the most reliable way to do it is with negative quantifiers: we can see in (104a) that *Alex* and *he* can be coreferential due to discourse/context factors, and in (104b) we might be able to imagine the *he* in the second sentence as some generic student we have in mind, but it's generally unacceptable to do this in (104c) with a negative quantifier. This contrasts with the cases in (104d-e), where we can get coreference between the negative quantifier phrase or question phrase and a pronoun, thanks to a syntactic/semantic dependency within a sentence.

- (104) a. Alex_{*i*} likes this book. He_{*i*} knows it is good. (discourse)
 b. Every student_{*i*} likes this book. He_{*i*} knows it is good. (discourse?)
 c. # No student_{*i*} likes this book. He_{*i*} knows it isn't good.
 d. No student_{*i*} wants to read his_{*i*} book. (syntactic)
 e. Who_{*i*} wants to read his_{*i*} book? (syntactic)

Intriguingly, the contrast arises in sign language loci as well: Graf and Abner (2012) and Abner and Graf (2012) note that sign language loci that are optional but acceptable to establish coreference between a pronoun and a universal quantifier (105) seem to be unacceptable precisely in cases that necessitate real “syntactic binding”, that is, places when there can't be coreference linking the pronoun and its antecedent because there is no reference in the case of negative quantifiers (106).

(105)

(ASL, Abner and Wilbur (2017); Abner and Graf (2012))

- a. ALL POLITICIAN PERSON-a TELL-STORY IX-a WANT WIN
- b. ALL POLITICIAN PERSON-a TELL-STORY WANT WIN
'Every politician said that he wanted to win.'

(106)

(ASL, Abner and Wilbur (2017); Abner and Graf (2012))

- a. * NO POLITICIAN PERSON-a TELL-STORY IX-a WANT WIN
- b. NO POLITICIAN PERSON-a TELL-STORY WANT WIN
'No politician said that he wanted to win.'

On this point, Kuhn (2020) argues that the use of a locus in sign languages involves a kind of iconicity, basically a claim of existence, and this seems roughly right, and is compatible with the account offered later in this chapter. Before we get there, though, let's consider our conclusions on dynamic indices and loci. One can be highly sympathetic to a dynamic semantic approach that models the introduction and binding of indices of discourse referents in ways that more accurately reflect the dynamics of discourse (for example, binding across sentences, an asymmetric semantics for conjunction, etc.), while still retaining skepticism that sign language loci *are* indices - and that is precisely our take here. Sign language loci provide (descriptive) information about the discourse referent which can be used for disambiguation, just like other descriptive information. Indices can be assigned to any discourse referent, loci or not, and in fact, most discourse referents are not assigned overt loci (Frederiksen and Mayberry, 2016), and their use appears to be constrained by pragmatic information/quantity considerations similar to other descriptive material (Ahn et al., 2019; Ahn, 2019b)

Let's take this idea of loci as (typically not-at-issue) descriptive material, and apply the perspective to one final sentence type often used to probe for dynamic indices: verb phrase ellipsis. Example (107) is from Lillo-Martin and Klima (1990) for ASL, and the claim is that such examples can have two different logical structures, which are reflected in two different interpretations of the "elided" (silent) material in the second sentence. Similarly, the LIS example in (108) shows two different interpretations, depending on whether the elided noun phrase in a "strict" way or a "sloppy" way.

(107)

(ASL, from Lillo-Martin and Klima 1990)

MARY_a, ALICE_b. IX_a THINK IX_a HAVE MUMPS. IX_b SAME

- a. Mary thinks she has mumps. Alice thinks Mary has mumps, too.
- b. Mary thinks she has mumps. Alice thinks Alice has mumps, too.

(108) (LIS, from Cecchetto et al. 2015)

GIANNI_a SECRETARY POSS_a VALUE. PIERO SAME.

- a. Strict reading: “Gianni (who is at a) values the secretary who belongs to the unique individual who is at a and is equal to Gianni. Piero also values the secretary who belongs to the unique individual who is at a and is equal to Gianni.”
- b. Sloppy reading: “Gianni (who is at a) values his own secretary. Piero does too.”

Note, however, that these examples merely show that there are two different ways to recover the content of this verb phrase: the main thing is that the content that is elided needs to be something that is ignored in this reconstruction. Indices presumably have this property, but other information found in descriptive noun phrases does too: in particular, this is true for gender features, which are also ignored for purposes of ellipsis: in example (109) there is no disambiguation of the two readings of verb phrase ellipsis even though the two pronouns that would be pronounced differ in gender (*Mary values her secretary, too* vs. *Mary values his secretary, too*).

(109) *John values his secretary and Mary does too.*

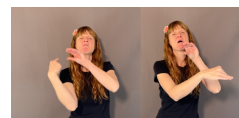
Strict reading: Mary values John’s secretary too.

Slopping reading: Mary values Mary’s secretary.

At this point, we might wonder whether the kind of content that the locus contributes is similar to features like noun class or gender, and in fact this is precisely the second major approach taken in formal semantics/syntax regarding sign language loci, which we turn to in the next section. The takeaway at this point from ellipsis is that if loci do involve descriptive-like material, then it cannot be of the sort that is at issue, i.e. it has to be something like gender features that is not considered in the semantics/logical form upon which focus alternatives are constructed.

5 Loci vs. gender/noun class features

For anyone familiar with languages that have gender and/or noun class marking, the similarities between these kinds of features and the use of loci in sign languages might be striking. Probably the most notable common-



ality is that the markings occur both on verbs, as in *a-EMAIL-b*, and on the noun phrases that provide the arguments for those verbs, as in



. This shares much in common with person, number, and gender features in a language like French, where a verb *aimer* ‘to love’ changes its form depending on different person, number, and gender features of its subject, as the second person singular *aimes* in (110a) and the third person singular in *aime* in (110b), and noun phrases contain gender information in determiners (*la/le*) as well as subsequent pronouns (*elle/il*)(111).

(110) (French)

- a. *Tu aimes la fille.*
‘You love the girl.’
- b. *La fille aime le livre*
‘The girl loves the book.’

(111) (French)

- a. *la fille... elle...*
‘The girl... she...’
- b. *le garçon... il...*
‘The boy... he...’

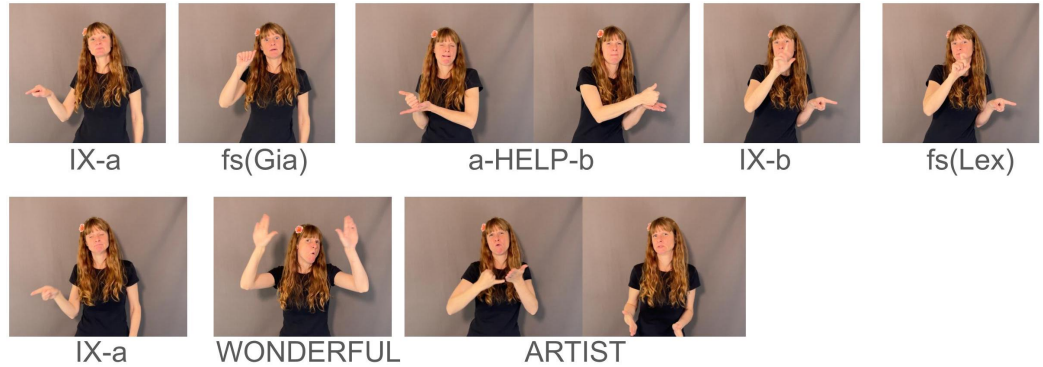
The comparison between (person, number, gender, etc.) features and sign language loci has been around for some time, and has been discussed in particular depth especially with regards to syntax by Neidle (2000) and with regards to semantics by Kuhn (2016), Barberà (2015), and Steinbach and Onea (2015), among many others. The main idea is simple: we see many spoken languages making use of feature classifications like gender, noun class, etc. to help track discourse referents. In terms of semantics, this is often implemented via presupposition: the feature is not part of the asserted content but rather backgrounded in a way that if it fails to hold (say, the wrong gender or number is used) then the utterance fails to be contextually appropriate and/or fails to have a truth value in that context, depending on the theory of presuppositions and truth values. Let’s walk through an example: consider a context in which the name *Kate* refers to someone to whom, roughly approximating the phrasing in Conrod (2019), it is “appropriate to use female gender features in this context”. If I say *Yesterday I ran into Kate while she was taking a walk*, the pronoun *she* can co-refer with *Kate* because it is appropriate to use the (singular, third person, feminine) features of that pronoun to refer to *Kate*. This contrasts with a minimally different sentence like *Yesterday I ran into Kate while he was taking a walk*; the idea is that this sentence fails to have a truth value

if the intended reference for *he* is supposed to be Kate, because there are no salient individuals in that context to whom it is appropriate to use male gender features. A conventional formal approach to this sentence would be in (112) (Heim and Kratzer, 1998).

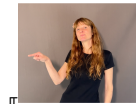
- (112) *Yesterday I₁ ran into Kate₂ while she₂ was taking a walk*
 $\llbracket she_2 \rrbracket^g = ix : fem(x).g(2) = x$
 ‘The extension of *she* (with index 2) under the assignment function *g* is the unique individual in the domain that is referenced by 2 in the assignment function; it is only defined if the individual is appropriately referred to using ‘she’ series pronouns’

We could consider the use of sign language loci in a similar way. Imagine that we take definedness/ability to take a semantic value of the pronoun in ASL to depend on the appropriate use of spatial location (e.g. *a*), along the lines in (113).

- (113)



‘Gia helped Lex. She (Gia) is a wonderful artist.’



$\llbracket \text{IX-a}_2 \rrbracket^g = ix : depicted-at-a(x).g(2) = x$

‘The extension of IX-a with a dynamic index 2 under the assignment function *g* is the unique individual in the domain that is referenced by 2 in the assignment function; only defined if the individual is appropriately referred to using the area of signing space *a*’

How does this account for the patterns of loci that we have been discussing? The property of being associated to a locus will help disambiguate sentences, like the one in (113) above, because only one of the individuals in the first sentence was associated to that locus *a*. This works roughly like gender in the process of disambiguation in English, where co-indexed noun phrases need to not be incompatible with respect to the presuppositional requirement (gender, or spatial location, or perhaps noun class, etc.).

In addition, Kuhn (2016) has highlighted other similarities between gender features and loci, such as the way that both gender and loci are disregarded when creating propositional alternatives. Consider that in the ASL case in (114) and the English case in (115), the possessive expression (POSS-*a*/*his*) shares a feature in common with the subject (locus *a* in ASL and masculine in English), yet this information is disregarded in the consideration of the focus alternatives, which otherwise follow the structure of the sentence without the focus operator ONLY-ONE): the other referents in (114a) need not be associated to locus *a* and the other referents in (115a) need not be masculine. In both cases the “strict” reading of the possessive is available (in the *a* sentences) as well as the so-called “sloppy” reading (in the *b* sentences).

(114) (ASL, Kuhn 2016)

IX-a JOHN_{*a*} ONLY-ONE SEE POSS-a MOTHER.

- a. Alternatives: {Billy saw John’s mother, Andy saw John’s mother, Jessica saw John’s mother, ...}
‘No other kid saw John’s mother.’
- b. Alternatives: {Billy saw Billy’s mother, Andy saw Andy’s mother, Jessica saw Jessica’s mother, ...}
‘No other kid saw their own mother.’

(115) (English)

John is the only one who saw his mother.

- a. Alternatives: {Billy saw John’s mother, Andy saw John’s mother, Jessica saw John’s mother, ...}
‘No other kid saw John’s mother.’
- b. Alternatives: {Billy saw Billy’s mother, Andy saw Andy’s mother, Jessica saw Jessica’s mother, ...}
‘No other kid saw their own mother.’

Along with the verb phrase ellipsis data we saw above in (107)-(108), we can conclude from this that the disregarding of both loci and gender features in focus alternatives puts them in a class together, and apart from other descriptive content: contrast with the object MOTHER/*mother*, which has to be present in each focus alternative.

One objection to thinking about sign language loci as features comes from the apparent difference between their fluidity and that of gender features: typically gender features are considered to be stable features across different discourses (e.g. female gender pronouns are appropriate for *Kate* across all kinds of contexts), whereas appropriate loci change from discourse to discourse: Alex might be placed on the signer’s right hand side in one discourse and on the signer’s left hand side in another. Except that this isn’t

a strong objection to comparing the two at all, if we consider how speakers really use gender in many languages: indeed, gender can vary when it is convenient, including the lack of gender marking. Consider, for example the contrast in (116).

- (116) a. My friend sent me their recommendations for movies.
 b. My friend sent me her recommendations for movies.

There is one interpretation of the sentence in (116a) which is that it is appropriate to refer to the friend using *they/them* series pronouns (as their pronouns of choice); we're ignoring that reading here, to focus on another interpretation, that in fact the friend may use gendered pronouns (let's imagine the friend is actually Kate, for whom it is appropriate to use *she/her* pronouns) but the speaker finds no particular reason to include gender information since it's not relevant to the discussion. This latter reading is widely available among most (although not all) speakers of English in the United States (Ahn and Conrod, 2022), and makes an important point with regard to sign language loci: something might rightfully be analyzed as a "feature" restricting pronominal coreference, and yet still have some optionality for expression and/or fluidity from one context to another.

One important difference between noun classes/gender and sign language loci is that, as far as I know, gender isn't allowed to be assigned differently between two referents just because it would be convenient for disambiguation. For example, without any background context the sentence in (117a) is potentially ambiguous since the friend might be the referent for *his*, whereas (117b) is most likely discussing a ranking of the friend's favorite movies, since *my brother* isn't typically coreferent to feminine pronouns. In ASL, though, the signer can make the choice to assign the two noun phrases to two separate loci in order to ensure that the continuation is unambiguous, as in the artist examples we have seen.

- (117) a. My older brother and my friend discussed all of his favorite movies.
 b. My older brother and my friend discussed all of her favorite movies.

That said, it is also the case that truly arbitrary uses of sign language loci are few and far between, as shown by corpus analyses (Cormier et al., 2015a), so we might wonder, what causes loci to be used at all? There are two separate but possibly related answers that come to mind. For one thing, Ahn et al. (2019) discuss the unacceptability of loci when there is no ambiguity, especially in the case of two noun phrases that differ in animacy, or a context in which plausibility provides clear disambiguation. This highlights the strong disambiguating purpose of sign language features, seeming

to take them one step further than, say the difference we see in (116) in English. It's possible that a language like English may be moving in this direction, though, using semantic gender only when useful for purposes of disambiguation as the singular pronoun *they* becomes more commonly used to intentionally not provide gender information. The second point is that sign language loci are frequently used to *depict* while also *disambiguating*, a dual nature that has long been noticed and subject to theorizing, and which we focus on in the next section.

6 Loci as depictive

So far we have discussed several formal analyses of sign language loci, which included considering them as the visible manifestation of indices in dynamic semantics, or as semantic/syntactic features, but another view of sign language loci emphasizes their iconic/depictive nature (in contrast to the arbitrariness inherently emphasized in both formal accounts). There is some empirical motivation for highlighting the non-arbitrary nature of loci: corpus studies of natural production data show that the use of loci on verbs and/or (pro/)/nominals is highly motivated (Cormier et al., 2015a), and that loci will be established for discourse referents especially in cases when verbs can show as well as tell something about the events in which they are involved, or if they are used to depict further aspects of the referents.

Within the formal literature, this has been sometimes described as iconicity in sign language loci/features (Schlenker, 2014; Schlenker et al., 2013; Schlenker, 2018; Lillo-Martin and Gajewski, 2014), while much foundational work on the theorizing behind the iconic uses of sign language loci has occurred in cognitive linguistics frameworks (Liddell, 2003; Taub, 2001; Cormier et al., 2013). An example of an iconic reflexion in the choice of sign language loci can be seen in the difference between the loci *a* associated to the girl, which is at a lower place near the signer's waist level, and the locus *b* assigned to the rainbow, which is much higher, presumably motivated by the idea that the rainbow is up in the sky (118).

(118)



‘She saw the rainbow up there.’

A similar example is discussed in Schlenker et al. (2013), who investigate this depictive use of loci under various linguistic contexts, finding that

like gender and noun class features, this iconic information is not at issue, i.e. cannot be targeted by negation, among other things. We can see this in (119), where the pronoun IX-a^{high} appears under the scope of negation in the second sentence (IX-1 NOT UNDERSTAND IX-a^{high}), and yet still the presupposition projects/inference goes through through that the speaker's younger brother is tall (i.e. the tallness is not negated).

- (119) (ASL, Schlenker et al. 2013)
 POSS-1 YOUNG BROTHER WANT IX-1 REST. IX-1 NOT UNDERSTAND
 IX-a^{high}.
 'My younger brother wants me to rest. I don't understand him.'
Inference: the speaker's younger brother is tall.

A person's height, or the height of a rainbow in the sky, is an obvious kind of motivated use of space, but it is by no means the only one discussed in sign language linguistics: many others are featured in the sign linguistics literature including Liddell (2003) and Schlenker et al. (2013), Taub (2001), and others. These include the subset/superset relationship of two plural loci: a subset should be assigned to a locus in a way that the spatial arrangement reflects the set/superset relationship of their referents (Schlenker et al., 2013). Liddell (2003) also emphasizes the use of depiction within a single locus, as when an area of the referents body (e.g. head, torso, etc.) can be targeted in an iconic way. The key takeaway from these tends to be that the iconic components found in sign language loci are also mirrored outside of sign languages, for example in co-speech gesture (Schlenker, 2014; Liddell, 2003), suggesting that they may be picking up on extra-linguistic (i.e. perhaps depictive) conventions and not language specific structures.

Compositionally, iconic meaning in loci shares with other presuppositional information in language their inability to be targeted by operators like negation, their local accomodation, etc, both in sign languages and in gesture (Schlenker et al., 2013; Tieu et al., 2019). Schlenker (2021) takes this pattern as a motivation for an analysis in which iconic information is encoded as a presupposition that requires a correct mapping between the world and the form. Under this view, just like there are words that stipulate presuppositions into their meaning (for example, *the* encodes a requirement for something like familiarity or uniqueness, *again* encodes the requirement that something have happened before) in order to provide a truth value, iconic loci stipulate the requirement that there is a mapping between the form and some arrangement in the world.

One might ask *why* it is that iconic loci should be presuppositional, and here we are left with the same kind of stipulative answer we have for symbolic/lexical presuppositions, except no way to stipulate them since there are infinitely many; this is raised as a further mystery when it comes to the presupposition-like behavior of co-speech gestural content (Tieu et al.,

2019). For answers, we probably want to look beyond anaphora, to semantic approaches to iconic language that we have seen in other areas of this book. Recall, for example, the inability of depictions to be targeted by negation in ASL (and Japanese ideophones, and English...) that we discussed in Chapter 2. There too, iconic content is ignored with respect to negation. So, ideally we don't want to stipulate this as a fact about the depictive nature of loci, but rather to understand why depictions and negation interact in this way. For now, though, the takeaway will be that loci serve (at least) two purposes: they can be used to depict, and they can be used for disambiguation. Moreover, compositionally they pattern with the larger class of not-at-issue content (one example of which is semantic gender/noun class features), so any formal analysis of them should take care to predict these uses. In the next section we will propose an analysis that is motivated by their dual depicting/disambiguating nature and that has these properties.

7 Spatial restriction

The takeaway so far from looking at the formal semantic emphasis on the disambiguating role of loci, and the emphasis from cognitive linguistics on the depictive role of loci, brings us to the goal of trying to unify these two uses. Here, we will make a proposal inspired by previous hybrid accounts which include both depictive and descriptive components (e.g. Schlenker et al. 2013) along with definite approaches to pronouns, with some consequences to the analysis of semantic features generally. We begin with a basic pronoun, in both English and ASL, which in the absence of any other restrictions will simply pick out a referent based on some assignment function g . One approach from, say, the classic text Heim and Kratzer (1998) is to simply say that every (pro)nominal includes an index (e.g. 2 in (120) and the interpretation of the pronoun simply involves looking into one's list of discourse referents and looking up the reference based on this index, e.g. $g(2)$. In short, the reference comes from the (value of the) index, as we see for English (120a) and ASL (120b). On top of that, English has an additional restriction that the reference be appropriately referred to using that feature (e.g. female, for *she/her* pronouns in this case)(120a). One big question is, what role should the locus a play (120b)?

- (120) a. $\llbracket she_2 \rrbracket^g = g(2)$ (only defined if $g(2)$ is appropriately referred to using the fem series pronouns, undefined otherwise)



- b. $\llbracket \text{IX-a} \quad 2 \rrbracket^g = g(2) + ??$

In the classic proposal put forth by Lillo-Martin and Klima (1990), the index is a visible version of the variable, so that instead of the complicated (120b) above, we can simplify to (121). Here, instead of the arbitrary index 2 assigned to the discourse referent, the index is made visible by the use of locus a , so roughly we need only track one thing, this index-as-locus.

(121)



$\llbracket \text{IX-}a \rrbracket^g = g(a)$
 ‘The referent assigned to this index a ’

Alternatively, we can also accept something like a “locus as variable index” yet implemented in a non-dynamic approach to pronouns, in which case the locus/index contributes a restriction, as in (122a), potentially with other restrictions in the noun phrase, such as that provided by a noun, e.g.



STUDENT (122b). Esipova (2019b) and Ahn (2019b) both provide discussion and arguments regarding why an index-like restriction (e.g. $x = g(a)$) would be not-at-issue while the nominal restriction (e.g. x is a student) remains at issue.

(122) a.



$\llbracket \text{IX-}a \rrbracket^g = \iota x[x = g(a)]$
 ‘The unique individual which is equal to the referent assigned to this index a ’

b.



$\llbracket \text{IX-}a \text{ STUDENT} \rrbracket^g$
 $= \iota x[x = g(a) \wedge x \text{ is a student}]$
 ‘The unique individual which is a student and is equal to the referent assigned to this index a ’

There are many questions of interest to formal semanticists in this area. One of these relates to whether sign language pronouns are a convincing data point in favor of analyses that one needs to have an index, as suggested in (Schlenker, 2011). It has been debated for quite some time whether one really needs assignment functions as part of the linguistic machinery; arguments in favor come from complex structures accounted for through dynamic semantics, many of which are very elegant (Heim, 1982; Kamp and Reyle, 1993; Chierchia, 1995; Mandelkern and Rothschild, 2020); arguments against come in significant part from parsimony, i.e. if it is possible to account for data without introducing this kind of mechanism, then don't introduce it. These broadly argue that the same phenomena can be accounted for without introducing variables into the system (Jacobson, 2007, 2016; Barker and Jacobson, 2007; Elbourne, 2002). A pronoun can instead get its value in the same way that a definite description like *the student* does, that is, by a contextual restriction to the right kind of situations (123).

- (123) a. $\llbracket \textit{the student} \rrbracket^s = \iota x.x$ is a student and x is in the situation s
 'the unique student in the relevant situation'
- b. $\llbracket \textit{she} \rrbracket^s = \iota x.x$ is referred to using female pronouns and x is in the situation s
 'the unique individual in the relevant situation, who is appropriately referred to with female pronouns'

With respect to sign language loci, we can give a non-dynamic formulation along the lines of the proposals in (122) above as in (124) below, where we leave out an assignment function and instead restrict the definite description via some relation R to the locus.

- (124) a.



- $\llbracket \text{IX-a} \rrbracket^s = \iota x.x$ is in the situation s and $R(x, a)$
 'the unique individual in the situation, related via R to locus a '

- b.



- $\llbracket \text{IX-a} \quad \text{STUDENT} \rrbracket^s$
 $= \iota x.x$ is a student and x is in the situation s and $R(x, a)$.
 'the unique student in the situation related via R to locus a '

The big question under this view is: what meaning comes with “related via R to locus a ”? As mentioned above, “semantic” gender marking in a language like English is often contrasted with what seems like a more arbitrary use of loci in a language like ASL since choice of locus for a particular referent changes across different contexts. However, we’ve also seen that this distinction is not a hard and fast one, given the context dependence of features in English as well, illustrated in (116). Ahn (2019a,b) argues that the locus contributes a locational restriction, something like “having the property of being assigned to the location a ”. The proposal put forward here is something very much along these lines, with extra inspiration from Conrod (2019)’s approach to gendered pronouns, which argues that the meaning of gender features on pronouns is essentially a use condition, i.e. that it is appropriate in the context to refer to someone with female pronouns. In ASL, we can say that for $R(x, a)$ to hold, it simply requires it to be appropriate (sometimes for depictive reasons, sometimes for the pure pragmatic purpose of contrast) to refer to someone with that locus (125a); the dynamic version is provided for comparison in (125b).

(125) a.



$\llbracket \text{IX-a} \rrbracket^s = \iota x.x$ is in the situation s and $R(x, a)$
(where $R(x, y)$ iff it is pragmatically appropriate to use location y for x)

b.



$\llbracket \text{IX-a} \rrbracket^g = \iota x[x = g(a)]$
‘The unique individual which is equal to the referent assigned to this index a ’

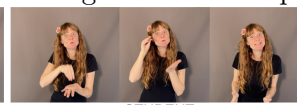
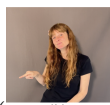
It is interesting that from the perspective of semantics, there is a minimal difference between the role that the locus plays in the “locus as variable” theory and the “locus as restriction/feature” approach: in one, we simply require that $x = g(a)$ (x is what the assignment function assigned to locus a) (125b); in the other, we simply require that there be a recoverable relation $R(x, a)$ that holds between the locus and its referent. The implications for the theory of sign linguistics is that we are hitting on something right about these approaches: a relation (e.g. g/R) relates the locus directly to the

referent in a way that is recoverable by the conversational participants. The implications for our theory of semantics more broadly is that sign language loci do not distinguish so clearly between any two particular approaches to this problem in formal semantics (contra Schlenker 2011, but in the spirit of Schlenker 2016). How could we distinguish between them? To the extent that multiple discourse referents can be assigned to the very same loci (e.g. $R(x, a)$ and $R(y, a)$ as argued in Kuhn 2016), a feature-like account seems to give us better empirical coverage, since assignment functions like g by definition assign only one discourse referent per index. In other words, if both a person and their partner, or both a person and the city that they live in, can be associated to the same locus, then this suggests that some method of association $R(x, a)$ is the right way to think about this anaphoric restriction, instead of directly linking a locus to a particular person, place, or thing that is being tracked in a discourse, but then the implications are pretty minimal from the perspective of arbitrating between possible theories in general.

Another clear advantages of approaching indexical pointing in sign languages through the definite lens (i.e not directly using the indexing function g but rather the ι operator, also seen in the semantics of English definite article *the*) is that from the semantic perspective it naturally extends to locative and demonstrative readings (Koulidobrova and Lillo-Martin, 2016; Ahn,



2019b), all of which are expressed via IX-a in many sign languages, including American Sign Language. Under this system, something can be associated with a particular locus for motivated/depictive reasons (known in the sign language linguistics literature as “topographical space”, Liddell 2003) or for discourse anaphoric reasons, and that difference need not be encoded in the meaning contributed by the indexical sign. It also collapses pronomi-



nal (IX-a) and adnominal (IX-a STUDENT) uses of the pointing sign, common in many languages including English demonstratives (*that*, *that student*).

The broad insight is that the kind of semantic features we see in some spoken language pronominal systems are actually not all that unlike the use of loci in sign languages. For example, traditionally gender class features were considered a limited category but recent linguistic innovations by language communities to reflect a wider variety of gender expressions show that they are only limited by the categories we choose to make of them. Sign language pronouns can capitalize on multiple locations in the same way. Moreover, in the same way that pronoun gender choices can be more or less arbitrary, so can loci: these can be chosen to reflect iconic relationships like

height of tall people, honorifics, etc., but may also be arbitrary and merely contribute pragmatic contrast/distinction for disambiguation, just like spoken language gender, which reflects classes that we perceive in the biological and social world but can be deployed for language in ways that are sensitive to pragmatic context. Finally, we note that encoding the locus either as an index for an assignment function or as a restriction in a definite noun phrase in a given situation ends up being nearly equivalent given some assumptions about the structure of definite noun phrases, an ultimately reassuring way of viewing a longstanding debate between “variable” and “definite”/e-type approaches to anaphora and the contribution to this debate from sign languages.

8 Conclusions

The use of space in sign language discourses is one of the most well-studied areas in sign language semantics/pragmatics, in part because it so beautifully integrates descriptive and depictive elements of language in a discourse. For years, formal approaches to sign languages have been interested in modeling the use of space, famously analogizing it to dynamic indices (Lillo-Martin and Klima, 1990) or to semantic features like gender (Neidle, 2000; Kuhn, 2016). One conclusion of the formal discussion here is that under an approach to pronouns in which they share significant morphosyntactic structure with other definite noun phrases like demonstratives (*that*) and definite phrases (*the student*), these distinctions are hardly significant: both involve semantic restrictions on reference. Furthermore, the “limited categories” of gender features has become an increasingly outdated idea, as we see the proliferation of pronoun features to reflect an increasingly nuanced view of gender in spoken languages like English (and many others), requiring a flexible semantics (Conrod, 2019). This semantics can be minimally adjusted to reflect many depictive uses of space in sign languages while retaining a descriptive function (restriction in a definite noun phrase), as exemplified in the sketch put forward in Section 7.

Many important questions remain. First, we have only touched in very limited ways in the difference between loci on noun phrases and on verbs. In some syntactic theories, such as Minimalism (Chomsky, 2014) these are quite asymmetric and more work should be to understand whether and how sign languages exhibit agreement in the classic sense, discussed in depth in (Lillo-Martin and Meier, 2011) and (Pfau et al., 2018). More should also be said about when loci are covert and non-covert, and how to compare with clitics; in this area, more careful studies of language change and processes in which pronouns change into clitics which change into agreement forms are clearly going to be useful, as they have been in spoken languages (Culbertson, 2010).

Finally, this chapter argued for a hybrid way of thinking about the de-

pictive and descriptive elements of sign language loci, but like other hybrid accounts (e.g. Schlenker et al. 2013; Schlenker 2014) it does not directly provide an account for how the depictive aspect (including but not limited to topographical space) works. This is mostly because depiction is processed through a different stream: not through conventionalized linguistic structures but through cognitive processes involved in picture/image processing, and thus linguists will have limited expertise to lend to this question except to make references to how we convey meaning through depiction (Greenberg, 2013; Camp, 2018; Fodor, 2007). That doesn't mean it isn't deeply important though, and cognitive linguists in particular have more to say about the integration of language and depiction that one hopes can be integrated more fully into the formal account of the descriptive properties as given in this chapter. In the next chapter we turn to perhaps an even clearer way that depiction integrates with description.

5

Classifiers, role shift, and demonstrations

In several previous chapters, we have touched on ways that symbolic vs. depictive elements of sign languages contribute meaning in separate ways. Symbols can be involved in semantic computations based on hierarchical syntactic structures and support the creation of propositional alternatives. In contrast, depiction in languages involves the same processes involved in picture interpretation within and outside of language (Clark, 2016; Dingemanse, 2015; Ferrara and Hodge, 2018; Kita, 1997), and as we have seen, contributes to our representations for events but is unable to directly be involved in the generation of propositional alternatives. Description and depiction are abundant in both signed and spoken languages when people are co-present, yet they are often ignored in the linguistics of spoken languages since there are limited ways to represent depiction in text, and as we’ve seen, depictions are limited in the ways that they interact with symbolic structures. However, in this chapter we will focus specifically on two well-studied ways that depictive meaning seems to interact directly with symbolic aspects of sign languages: depictive classifier predicates, and role shift/constructed action. Although these topics have often been studied separately within the larger sign language linguistics literature, the argument here is that we should ultimately think of them as arising through the same process involving **demonstrations**, and so we discuss them both in this chapter, beginning with depictive classifiers, then moving onto role shift, and finally ending with some examples that have properties of both.

1 Depictive classifiers

We will be using the phrase "depictive classifiers" to refer to a wide class of signed expressions found in nearly all of the world’s sign languages (Zwitserslood, 2012; Emmorey, 2003) which are sometimes also called “depicting

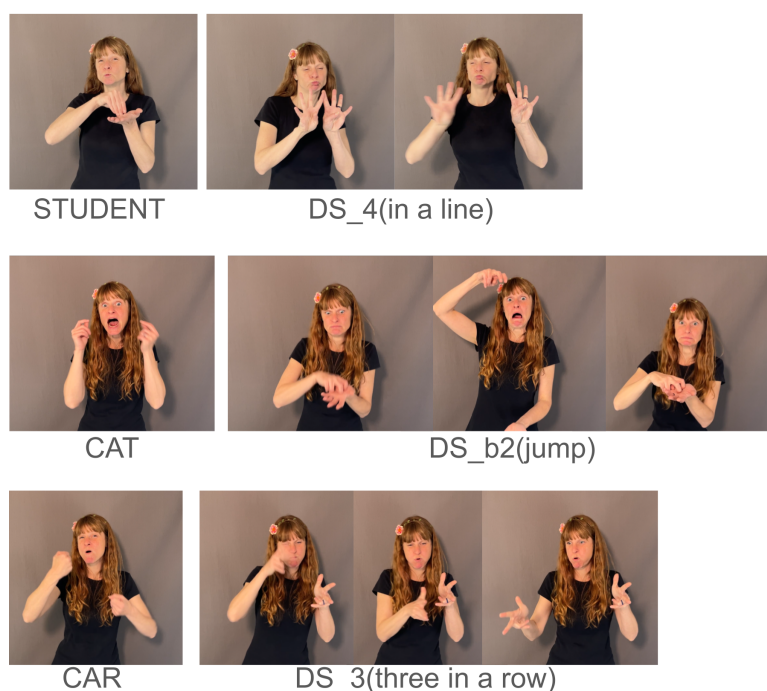







Figure 5.1: Depictive classifiers

verbs”, “classifiers”, “classifier predicates”, or other related phrases depending on the features being highlighted. These expressions take their handshapes from a conventionalized inventory that varies from sign language to sign language, with each handshape corresponding to a semantic class. Since the use of meaningful forms for semantic classes of objects is similar to noun classes in spoken language classifiers, the name “classifier” has frequently been used in formal sign linguistics literature. Comparisons can be made to nominal classifiers/noun classes in many East Asian languages like Mandarin Chinese and even more directly to verbal classifiers in languages of North America such as Navajo. For example, in American Sign Language, the handshape  is used for the semantic class of vehicles (cars, trucks, etc.), while the handshape  is used for the semantic class of humans, or long thin objects like pencils, etc. Handshapes can then combine with movements and locations that are interpreted as depictive, that is, they are used with movements and locations that iconically illustrate movements and locations of the objects classified by the handshapes. We can see three examples in Figure 5.1, each of which shows a handshape for an object class (/4 for lines of people, /b2 for small animals, /3 for vehicles) being used to depict the spatial arrangement (e.g. of students or cars lined up) or movements (e.g. of a cat jumping).

The semantics of these expressions has been of interest since some of the earliest scientific attention to sign languages: Klima and Bellugi (1979) note that the handshake acts as a type of “pronoun”, analogizing the gender classification available for pronouns in languages like English and French to the classes of handshapes available in classifier predicates. They also note that these seem to have a depictive element, as in, for example, the movement of a car up a hill which can illustrate a meandering manner of movement, emphasizing the dual symbolic/iconic nature of classifier predicates.


Although the dual symbolic/iconic nature of classifiers has long been underlying discussion of these “depicting classifiers” in sign languages and is the view that we will work from here, there has also been notable push-back to this kind of hybrid symbolic/iconic analyses from both the symbolic and iconic directions. One perspective has emphasized the highly symbolic/linguistic nature of these elements: Supalla (1983) rightfully notes that in principle any apparently gradient/analog form can be broken down into many (increasingly small) discrete morphemes. So, what might look like a wholistic meandering movement can be broken down into many small discrete movements. From the linguistic perspective, doing so makes the representation of these structures much more complex: instead of an iconic arc, one would have to use many morphemes expressing changes in the arc, i.e. upward, then over, then upwards some more, etc. This tradeoff in complexity might be viewed as favorable if one is committed to the notion that language expresses only discrete meaning-form mappings. In other words, one might motivate increasing the number of morphemes present in depictive classifiers by trying to preserve a parallel between spoken English words and sign language manual signs. However, many other researchers have noted that there is no need to do this to preserve unity between the signed and spoken mode, as spoken languages include abundant analog depictions as well (Clark and Gerrig, 1990; Clark, 1996, 2016; Dingemanse, 2012, 2015; Dingemanse and Akita, 2017; Kita, 1997; Davidson, 2015; Maier, 2018). Given the increasing appreciation for the existence of depiction in spoken language, we seem to lose any motivation for keeping the components of depictive classifiers discrete symbols; depictive classifiers can include analog components and still be “language.”


At the other end of the spectrum, some researchers have emphasized the depictive nature of these expressions, as in work by Liddell (2003); Perniss et al. (2010); Taub (2001); Cogill-Koez (2000a,b) and others. In an important way this of course seems exactly right: clearly these are used when there is intent to depict directly/iconically instead of (only) describe symbolically, and it is unfortunate how often the depictive elements of depictive classifiers have been dismissed. However, an extreme version of this hypothesis ends up also dismissing the symbolic nature of some of their components, such as the handshake, and their compositional status as predicates in sign language sentences. This ends up not only wrong in terms of linguistic analysis but

can also, more practically, lead to a lack of appreciation for the complexity of sign languages and the achievements involved in acquiring them.

While it's good scientific practice to make sure that all ends of the ideological spectrum are explored and tested, experimental evidence as well as recent theoretical analyses appears to support a dual symbolic/iconic approach to depictive classifiers. Emmorey and Herzig (2003) used a controlled experimental setting to compare the interpretations of depictive classifiers by deaf signers of ASL (who have familiarity with both conventionalized and nonconventionalized aspects of the language) and hearing non-signers (who presumably lack familiarity with the conventionalized aspects of the language), to determine what aspects of their forms are interpreted as categorical and gradient by each of these groups and to see if the role of language experience affected these judgments. They found that handshape selection, as well as a few modulations of the handshapes (handshape sizes, figure/ground uses, etc.) seem to be interpreted differently between Deaf ASL signers and hearing nonsigners, suggesting that ASL signers' interpretations are influenced by conventionalized categories since they treated some differences as discrete categories, where nonsigners did not. In contrast, other more depictive aspects (dot placement, for example) were interpreted similarly by both groups as not discrete but analog/continuous. They take these results to support a distinction between symbolic and categorical interpretation of handshapes on the one hand, and iconic and gradient interpretation of movements, locations, and modifications to these handshapes on the other hand. On the theoretical side, Zucchi (2018) provides a detailed discussion of the tradeoffs between discrete and analog analyses of classifier predicates in light of larger questions about gesture-like meaning in both spoken and sign languages, arriving at the same conclusion that sign language classifier predicates contain both discrete symbolic components (in the choice of handshapes) and analog depictive components (in the location and movements used).

2 Classifier semantics

Building from the idea that depictive classifiers convey meaning in two ways, in part via conventionalized symbol and in part via iconic depiction, we will adopt a formal semantics in which the handshape is handled just the same way as semantic features like gender and noun classes (as potentially infinite but still discrete and symbolic) and the depictive component is an event demonstration (Zucchi, 2012; Davidson, 2015; Zucchi, 2017). We will walk here through a possible formalization of this intuition. First, classifier handshapes are conventionalized and provide meaning via their symbolic nature. For a classifier in which a 3 () handshape is used, it should require that we are discussing an event that involves a vehicle; in contrast,

if a b2 () handshape is used, it should require that the event involve an animate being that moves (in this case an animal). Importantly, depictive classifiers as a whole are used to describe events/states, i.e. they don't describe something *as* a vehicle or *as* a cat; the descriptions of the objects themselves came in the subjects of the sentences in figure 5.1 (CAT, CAR, etc.). Rather, depicting classifiers are predicate, which are used to depict events in which vehicles, or cats, are participants. So what we actually want our semantics for the handshake Images/animate.jpeg to model is there is an event in which an animal participates. The semantic role that the animals plays in this event is a theme, so we will want to have a function that is true only of events in which the theme is an animal (in this case, inclusive of humans) (126).

- (126) $\llbracket \text{b2} \rrbracket = \lambda e \exists x : [\text{animal}(x)].\text{theme}(v, x)$
lit. a function that takes events and returns TRUE if there is a theme of the event and (as background) that theme is an animal


This restriction encoded in (126) seems to be a presupposition just like gender and other noun classes, so we note it as a presupposition, preceding the period. So far, this is entirely symbolic meaning, something which we could imagine a language encoding in an entirely arbitrary way, exactly as is done is verbal classifiers of the world's spoken languages that have verbs with noun class markers for animals and humans (Zwitserslood, 2012).

Things get even more interesting when we explore the depictive side of classifier predicates. Under a Supalla (1983)-type analysis, we might analyze each small aspect of the depiction as individual morphemes. Under a Liddell (2003)-type analysis, we might not be interested in giving a formal analysis at all, since the depicting verb is just that: a depiction that cannot participate in compositional semantics. Under a mixed analysis, we can use the notion of a *demonstration* from Clark and Gerrig (1990) to capture the depictive aspect and how it integrates with the symbolic component (Davidson, 2015; Zucchi, 2017). In this view, some events are special because they are demonstrating events, which stand in the demonstration relation with other events, just as one individual can stand in a relation with another individual (e.g. a parent p of a child c : if the relationship holds then $\text{parent}(p, c)$ returns TRUE). So, for example, we can have one event of two cats facing each other, and we can also have a second event of a person, say the signer, demonstrating how the cats were sitting. If one event, which we can name e_2 is an accurate demonstration of another event, which we can name e_1 , then we can say that e_2 demonstrates e_1 : $\text{demonstrate}(e_2, e_1)$. We can then give a function for precisely those events which have animals as their theme and are demonstrated by the depicting event e_2 (127). (For now we'll ignore that there are two cats but we revisit plurality in classifiers in Chapter 7.)



Figure 5.2: An event of two cats sitting, and an event of demonstrating it

$$(127) \quad \llbracket \text{DS_b2(facing)} \rrbracket = \lambda x \exists v [\text{animal}(x)]. \text{theme}(x, v) \wedge \text{demonstrate}(\text{img}, v)$$

lit. a predicate which takes individuals (which have to be animals) and returns TRUE if there is an event in which they are the theme and which the event can be demonstrated by 

The most notable feature of this analysis is the fact that there is a picture on the right hand side of the equation, in fact, a picture of the very same expression that we say we are analyzing in terms of meaning. But this isn't circular! Rather, the *demonstrate* predicate requires an event of as one of its arguments, in particular a depicting language event, and we can find one of those in the sentence itself, i.e. from the “form” side of the equation. Technically, any linguistic expression might be a demonstration of something; in fact, that's exactly how we're going to want to analyze quotations! But, for now, it is clear that some linguistic expressions are especially intended to depict something, and depicting verbs are an especially clear example of that. We encode this via the *demonstrate* relation, which takes the event of communicating (which we are representing in the black and white pictures, just as we might use a different font for the quotational use/mention distinction in English) and relates it to the event of cats facing each other.

3 Argument structure of depictive classifiers

The demonstration semantics given so far is quite simple, but depictive classifiers can be quite complex: often there are multiple objects and the arrangement and interaction of those objects is part of what is being conveyed in the depiction. Therefore, we want to understand these more complicated classifiers in terms of their argument structure, and to ask what kind of

variation there might be within depictive classifier types. For example, in the so far very simple analysis we have given for depictive classifiers, handshapes all seem to have the same status: they simply restrict the kinds of arguments that the depictive classifier predicate can take. In addition, the argument has generally been a theme of the depicted event. However, there is intriguing evidence that different classes of handshapes seem to give rise to different argument structures.

An important development in the study of depictive classifiers was the observation that different classes of classifier predicates seem to take different arguments, and a formal analysis that models these differences, by Benedicto and Brentari (2004). Benedicto and Brentari (2004) argue that one type of depictive classifiers, known as *whole entity classifiers*, which are the sort given in Figure (5.1), all seem to simply take one argument, a theme, but one that acts like a syntactic subject, external to the verb phrase. They note that these contrast with another type of classifier, *handling classifiers*, which introduce two arguments: the object being handled, and the handler, which tend to be semantic themes (the objects being handled) and semantic agents (the handlers). Furthermore, Benedicto and Brentari give arguments that the theme argument of the handling classifiers is different than the theme argument of whole entity classifiers, by investigating the scope of other operators like distributivity and negation. An example is (128): the negation expressed with NOTHING scopes over the theme argument but not the agent in the case of the handling classifier in (128b), whereas it fails to scope over the theme argument in the entity classifier in (128a). Since both are themes, this is evidence in favor of a syntactic/hierarchical distinction between the theme arguments of these kinds of classifiers.

- (128) (ASL, Benedicto and Brentari 2004)
- a. BOOK B+MOVE NOTHING
'None of the books fell down (on its side)'
 - b. Ø BOOK C+MOVE NOTHING
'They (singular) didn't put any book down (on its side).'
* Nobody put the book down (on its side)

These are not even the only classifier types: Benedicto and Brentari (2004) also discuss *body part/limb* classifiers, which they argue using similar tests of negation, distributivity, etc. introduce a single internal argument; this can likely be extended as well to whole "body classifiers" discussed later in the section on Role Shift. Clearly there are many possibilities for cross-linguistic research on this topic in sign languages between classes of handshapes and the possible arguments that they can introduce. Another issue that clearly deserves more study is the syntactic status of the (non-linguistic) depictions introduced by the *demonstrate* relation. In one effort,

Quadros et al. (2020) provide two suggestions for syntax/semantics of depictive classifiers that also introduce demonstration arguments and roughly follow syntactic structure suggested by Benedicto and Brentari (2004), but basic questions remain: is this demonstration an argument or an adjunct? Is it obligatory or optional? Furthermore, how much this will hold in the incorporation of different sign languages as more data are gathered remains to be seen; examples include Sevgi (2022), who provides examples from Turkish sign language (TİD) that illustrate interactions of different classes simultaneously.

4 Classifier pragmatics

Depictive classifiers are a beautiful example from the perspective of semantics and semiotics of both symbolic language and iconic language composing in regular compositional ways: handshapes express symbolic restrictions while movements and locations can iconically depict. Given the discussion in Chapter 2 about the ways that depictions resist participating in question-answer structures, we may ask how depictive classifiers participate in *pragmatic* calculations of various sorts. As one example, expressions related to each other in terms of logical strength, such as *some/all*, are well known to lead to pragmatic inferences known as scalar implicatures: if we use a positive statement with the weaker form, e.g. SOME/some, this tends to lead to the inference that the statement with the stronger term would be false (129).

- (129) a. Some of the cookies broke. (English)
 b. COOKIE, SOME BREAK (ASL)
 Both implicate:
 c. Not all of the cookies broke.

Implicatures are defeasible inferences: note that you can say in English *I ate some of the cookies, in fact, I ate them all*, and in some contexts the weak term doesn't negate the strong one, as in *If you've eaten some of the cookies, you know how good they are*, both of which are used to argue that the scalar implicature comes about through reasoning about alternatives, rather than being encoded in the conventionalized semantics of *some* (this is true whether or not the theory takes that reasoning over alternatives as extralinguistic or as grammatically encoded, see Chierchia 2017).

As a result, conversational participants clearly keep track of semantic/pragmatic alternatives in given scenarios, and reason about them. In fact, inferences similar to scalar implicatures follow from any ordering, even one created *ad hoc* instead of on a conventionalized scale like *some/all*: consider, if asked to describe what is on a table, then a response HAVE

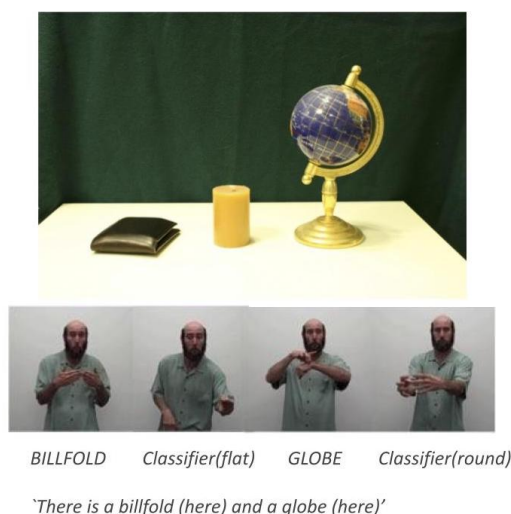


Figure 5.3: Stimuli from study on ad hoc implicatures using depictive classifiers in American Sign Language (Davidson, 2014)

BILLFOLD, GLOBE ‘There is a wallet and a globe’ is typically interpreted as saying that there is *only* a wallet and a globe. Generally, if there were more things there, the speaker should have said so! This kind of inference is known as an *ad hoc* implicature, and in fact young children succeed on this kind of a task even when they show non-adult like behavior with classic scalar implicatures like those arising from the *some/all* contrast (Stiller et al., 2015). With respect to sign language linguistics, Davidson (2014) investigated scalar implicatures in American Sign Language and in English, including in both languages classic scalar implicatures with SOME/ALL and *ad hoc* implicatures. In this study, sentences in ASL used to prompt ad hoc implicatures were in addition based on sentences that used depictive classifiers, conveying not just which objects were included but also their positions on a table (see Figure 5.3), with the goal to understand how depiction enters into pragmatic calculations. The result was that scalar implicatures were stronger in ASL with depictive classifiers than the comparison in English ad hoc scales without depiction, even when the classic scalar implicatures (based on *some/all*) were the same in both languages. Thus, something about adding a depiction led to a stronger “exhaustive” interpretation, i.e. that the description must be a complete one and no relevant alternatives went unmentioned.

We might have thought that the effect of depiction on the pragmatics of an utterance is that it is simply unrelated: as we have been saying throughout this book, depiction seems to be resistant to the construction of propositional alternatives. It would have been a natural conclusion, perhaps, that pragmatic mechanisms in natural language deal only with these

propositional alternatives and the logical strength of utterances within that domain. On the other hand, this finding suggests that the depictive component does seem affect pragmatics, such that an incomplete depiction seems to be less acceptable. We might look toward the underlying QUDs as an explanation: depictions may be addressing a question about what things looked like, while non-depictive lists might address a different question more focused on quantity that prioritizes exhaustive answers. In any case, it seems that the relationship between depiction and description within pragmatics is just getting started, and ideally can shed light on areas of spoken languages as well where the pragmatics of descriptive and depictive content seem to interact, as in ideophones (Kita, 1997) and co-speech gesture (Esipova, 2019a; Zlogar and Davidson, 2018; Alsop et al., 2018). In fact, this issues arises in any domain in language in which we see depiction affecting aspects of the at-issue assertion; the same will be the case with the linguistic structures that we turn to next.

5 Role shift

Another well studied area in sign language linguistics in which we see depiction clearly interact with description is in the reporting of others' thoughts, words, and even others' actions. An example from Padden (1986) is presented in Figure (130), in which the signer "shifts" eyegaze, direction, and other nonmanuals while expressing an attitude (REALLY IX-1 NOT MEAN) attributed to another's perspective (HUSBAND), represented in text as in (130). A similar example can be found in (131a), where an attitude (IX_1 BUSY) is expressed from the perspective of someone else, here, Alex. When glossed, the "shift" can be represented as a line marked with *RS* (131b.)

- (130) (ASL, Padden 1986)

$$\text{HUSBAND-a} \overline{\text{REALLY IX}_1 \text{ NOT MEAN}}^{\text{rs-a}}$$
 'The husband goes, "Really, I didn't mean it.''

- (131) a.



'Alex was like, "I'm busy"'

- b.
$$\text{FS(Alex)} \overline{\text{IX}_1 \text{ BUSY}}^{\text{RS}}$$
 'Alex was like, "I'm busy"'

As with depictive classifiers, terminology in this domain in sign linguistics tends to depend on whether the descriptive or depictive aspects are highlighted in the analysis. For example, *constructed action* and *role shift* are terms with slightly different meanings that have significant overlap, both describing the narrative technique of a speaker taking on the perspective and characteristics of another character. Cormier et al. (2015b) provide a detailed discussion of both terminology and naturally produced examples from corpora. Within formal semantics, *role shift* has tended to be the preferred term because so much of the focus has been on the semantic effect of the perspective *shift* that they bring, so we will focus on that here as well, but ultimately we end up with an analysis viewing this as a depiction, sharing much in common with analyses that use the term *constructed action*.

The view that we will take in this chapter is that role shift in sign languages shares the same semantics with structures that involve depiction by demonstration both in spoken language stories and narratives and also sign language depictive classifiers. The parallelism between role shift and similar constructions in spoken languages is shared in early formal work by Padden (1986) and Lillo-Martin (1995) in sign linguistics, and the view of reported speech as demonstration originates from Clark and Gerrig (1990); the view that role shift is a subset of sign language classifiers is also found in Supalla (1983), so all of the perspectives in this chapter are quite old and persistent, though the implementation via formal semantics is more recent.

First, let's note that relative to spoken and signed language, written language is more limited in expressing the depictive nature of constructed action/role shift, but we can see remnants in written quotation: the sentence *Alex was like, "I'm exHAUSTed!"* not only describes an event of which Alex was a participant, but also depicts aspects of Alex's behavior, in particular, the way that he said what he said. We can actually view all classic quotations this way: *Alex said, "I'm happy"* can be viewed as an event of saying in which Alex was a participant, and the quotation "I'm happy" depicts/demonstrates aspects of the event, namely, the way that the words were said. This is precisely the view of quotation given by Clark and Gerrig (1990), who analyze written and spoken language quotations as demonstrations, highlighting their depictive nature. Davidson (2015) formalizes this intuition of quotation as demonstration, and extends it to depictive classifiers (as we already saw above, similar to the analysis by Zucchi 2017) and to sign language role shift, which we focus on in this section. Subsequent work by Maier (2017, 2018) provides further evidence in support of this framework for both signed and spoken language quotation/role shift.

Under the demonstration view of quotation, a quotative sentence such as *Alex said, "I'm happy"* is true in those possibilities in which there is a saying event of which Alex was an agent ($\lambda w \exists v. \text{saying}(v) \wedge \text{agent}(v, \text{Alex})$), which accounts for the *Alex said* part of the quotation. It will, furthermore, require that the quoted speech "I'm happy" is an accurate (in some relevant

way) demonstration of the original event, leading us to (132).

$$(132) \quad \llbracket \text{Alex said, "I'm happy"} \rrbracket = \\ \lambda w \exists v. \text{say}ing(v) \wedge \text{agent}(v, \text{Alex}) \wedge \text{demonstrates}(\text{I'm happy}, v))$$



Note that just like how we had black-and-white version () of depictive classifiers on the right hand side of the equation in (127) because the linguistic form is a demonstrating event, similarly in (132) the language *I'm happy* appears on the right side of the equation, because that use of language is an event which is a demonstration of another (in this case, the Alex saying event).

One of the strongest motivations for formalizing quotation in this way is to highlight its iconic nature and the lack of real boundaries between written quotation and more obvious demonstrations common in spoken language, such as *Alex was like, "I'm exHAUSTed!"*. These depictively iconic demonstrations can be formalized in a completely parallel way, as in (133), returning a proposition in which there was an event in which Alex was an agent, and which is demonstrated accurately by "I'm exHAUSTed".

$$(133) \quad \llbracket \text{Alex was like, "I'm exHAUSTed!"} \rrbracket = \\ \lambda w \exists v. \text{agent}(v, \text{Alex}) \wedge \text{demonstrates}(\text{I'm exHAUSTed}, v))$$

A further advantage is that the same analysis can also naturally apply to classic cases of role shift/constructed action in sign languages, in which the words and other mannerisms of another character are demonstrated, such as in (134), where one's thoughts/words are demonstrated. They can even be extended to the kinds of sentences in (135), where the giving action (not an attitude!) is demonstrated.

(134)



$$= \lambda w \exists v. \text{agent}(v, \text{Alex}) \wedge \text{demonstrates}(\text{Alex was like, "I'm tired"} \\ \text{'Alex was like, "I'm tired"}', v))$$



(135)



$= \lambda w \exists v. agent(v, Alex) \wedge giving(v) \wedge demonstrates(\text{[this]}, v)$
 ‘Alex was giving it away like [this]’

On top of connecting the depictive elements of written quotation, spoken demonstration, and sign language role shift through the notion of a demonstration, this approach also connects sign language role shift with depictive classifiers, which were also analyzed as involving demonstrations, as we saw above. This is somewhat unusual from the perspective of recent sign language linguistics, in which the two topics have been largely disconnected (see, for example, separate overview chapters in edited collections such as Brentari 2010 and Pfau et al. 2012) but is in line with foundational work by Supalla (1983), who discussed “body classifiers” in this category of role shift and constructed action, which maps nicely onto the parallel semantics to depictive classifiers.

The core intuition behind the demonstration view of role shift/constructed actions is that they are ultimately depictive, just like depictive classifiers, and yet interact with descriptive language in regular ways that can be modeled in formal semantics. Importantly, the depictive aspects include the use of expressions in the same way that they were used by a character,



e.g. the use of the first person *because the character used it in that way*, just as expressions that were used by a character are demonstrated by the speaker/signer. Since a lot of attention has been paid to how and why



context-dependent expressions like ‘I/me’ are used in role shift and in constructed action in sign languages, especially within the field of sign language semantics, we will turn to them next in more depth.

6 Interpreting indexical expressions



Indexical expressions (e.g. English *I*, *here*, *tomorrow*, ASL *IX-1*, *TODAY*, etc.) have long captured the attention of philosophers and formal semanticists for having a meaning that depends directly on the context. For example, the meaning of *here* depends on who is speaking and where they are in a way that *London* does not: the former will pick out the location of the person saying *here* (it could be London if the speaker is in London, or Boston if the speaker is in Boston), while *London* will pick out London independently of where the speaker is. The dependence of these indexical expressions on the context has motivated formal analyses to relativize interpretations of all expressions relative to the context of evaluation, so, for example, we have (136), where the interpretation is dependent on a context of evaluation, picking out the speaker of context c as the meaning of the first person pronoun *I* (we are ignoring the difference between statives and events here).

- (136) $\llbracket \text{I am tired} \rrbracket^c =$
 $\lambda w \exists x \exists v (\text{experiencer}(v, x) \wedge \text{being} - \text{tired}(v) \wedge \text{speaker}(c) = x)$
 ‘The speaker in the context is an experiencer of a being tired event’

As argued by Kaplan (1979), indexical expressions like *I* are not equivalent to a definite description like “the speaker” in terms of their compositional properties, which we can see by varying contexts and events. The reference of a definite description can vary across events, as in the example in (137a), but an indexical expression is always connected directly to the original utterance context, as in (137b), which is not equivalent: it refers to the speaker of the context of utterance and not the speaker of various president-speaking-events. The takeaway is that semantic interpretation of indexical expressions really do need to depend on the context of utterance and cannot be paraphrased by descriptive material. This context dependence was indicated through the superscript c in (136).

- (137) a. Whenever the president is speaking, the speaker lives in the White House.
 b. # Whenever the president is speaking, I live in the White House.

Given this, a much discussed claim in this area of linguistics and philosophy is the claim that the context is not something which itself can participate in compositionality, i.e. be affected by any linguistic operators. In other words, conversational participants and their roles, locations, etc. are simply facts of a context and while language can access these details, it

doesn't include any symbols that affect what the context for evaluation is, i.e. nothing overwrites *c*. Kaplan (1979) famously argued that a linguistic operator that changed the context of evaluation would be a “monster”. Despite, or perhaps because of, this claim, interest in its universality has gained an interest in recent years, propelled by work suggesting that some languages actually do have operators that “shift” a context of evaluation, without the use of quotation. Such “shifty” indexical expressions tend to look like the Zazaki example in (138) (from Anand and Nevins (2004), presented as in Sundaresan (2021)), which includes a first person indexical expression within a clause introduced by *va* and in the scope of an attitude verb, in this case *va* ‘say’. Notably, the first person indexical pronoun (ϵz) can be interpreted as the speaker of the context (as in English) or as the holder of the attitude in the main clause, e.g. John (the latter seems to be impossible in English).

- (138) (Zazaki, Anand and Nevins 2004)
 hesen- i_j (mi $_k$ -ra) va [kε $\epsilon z_{j/k}$ dεzletia].
 Hesen-OBL I-OBL.TO said that I rich.be.PRS
 ‘Hesen told me [that I am rich].’ (Unshifted reading)
 ‘Hesen told me [that Hesen is rich].’ (Shifted reading)

The idea is that the context of evaluation for the indexical expression in the embedded clause need not only be the main clause speech event, but could also be some other context, introduced by the attitude (here, saying). In the literature on reported examples of indexical shift there is some variation between languages, but one stable observation is that across languages verbs of speech are the most likely to allow this kind of shift than are verbs of thought, which are in turn more likely to allow indexical shift in their complement than are verbs of knowledge (Sundaresan, 2013). These “shifty” indexicals are sometimes called “monsters”, in reference to Kaplan’s claim, and it has become an important question for syntax/semantic theory which languages allow such shifts, under what contexts, and involving which indexical expressions (Deal, 2020; Sundaresan, 2021).

7 Role shift as context shift

It may come as no surprise then that in sign languages, it has also become a major question within the study of sign language semantics whether we see evidence among them for “monstrous” shifted indexicals. Quer (2005) suggests that role shift is precisely a case where we do, and moreover, that role shift is a clear case of precisely this shifting of a context. Consider example (139) below: the first person pronoun expressed by the point to self IX_1 is not interpreted as the speaker of the whole sentence, but rather as Alex, just as in the Zazaki example in (138).

(139)



‘Alex said, “I’m tired”’/Alex said that he (Alex) was tired.

The translation given for (139) reflects two possible analyses of the sentence with role shift in American Sign Language. On the one hand, we can think of role shift as something like quotation, in which, again, the use of the first person is because the quotation depicts how something was said in the event being demonstrated, in this case, an event of Alex talking. This would be the demonstration analysis of role shift, and typically is considered to be a separate phenomenon from context shift, since quotations are understood to be noncompositional in other ways. On the other hand, a context shifting analysis of role shift explains the use of the first person indexical not because that is how Alex said it, but because the context of evaluation for the embedded clause is different than the context of evaluation for the whole sentence, thus a case of “monstrous” contextual overwriting.

How could we ever tell these apart? Don’t they both seem to be reflecting something right? The main way this issue has been approached in the theoretical literature has been to test comparisons to written language quotation, since written quotation is clearly depictive (“mentioned” speech, not used) and is not typically seen as integrating compositionally with the rest of the sentence, while in contrast, shifted indexical are by definition integrated with the rest of the sentence compositionally. We can see this effect of compositional integration/non-integration in English through long-distance dependencies like *wh*-questions, where (140a) is acceptable since there is no quotation (*I* is interpreted as the speaker of the whole sentence), and (140a) has a quotation which allows the indexical *I* to refer to Alex, but then fails to allow a dependency between the *wh*-word and the object of *like*. Another example of a long-distance dependency is the licensing of negative polarity items like *ever*, which makes a natural sentence in (141a) since *ever* is in a negative environment but here *I* refers to the speaker not Alex, and in (141b) has a quotation allowing *I* to refer to Alex but no longer supports the use of *ever* given that the negation is outside of the quotation.

- (140) a. Who did Alex said I liked?
 b. *Who did Alex said “I liked”?

- (141) a. Alex didn't think I ever had a chance.
 b. *Alex didn't think "I ever had a chance."

In other words, it might seem like we have “monstrous” indexicals in English too, but they seem to only occur under quotation, in the same places that break other semantic dependencies.

If we truly have a context shifting operator of the monstrous kind, we should expect to have long-distance dependencies like *wh*-movement and NPI licensing at the same time as indexicals that depend on a context that isn't the main context of utterance. This has been reported in many spoken languages across the world, including Zazaki; example (142) comes from Navajo (Speas, 2000), in which the embedded verb *dínílnish* 'you work' has second person marking even though it is interpreted as referring to Mary, the one that Kii is addressing, not the addressee of the entire utterance, and even though the embedded clause seems to be compositionally integrated with the main clause given the *wh*-dependency (the question is about the location of work, not the location of saying).

- (142) (Navajo, Speas 2000)
Háadilá Kii Mary dínílnish yílní
 where.at Kii Mary 2.sgS.work 3sgIO.3sgS.say
 'Where did Kii tell Mary to work?'
lit. 'Where did Kii say to Mary you work'

Returning to sign languages, it seems natural to test for context shift in the same way: asking about the co-occurrence of dependencies and shifted indexicals. One problem is that the data on this point is quite mixed, both because judgments seem less clear than are reported for English and for clear shifting languages, and because the analyses of various possible long distance dependencies is up for debate as well. Consider for example data provided from Schlenker (2017a) for American Sign Language in (143), which has a *wh*-question which has to be interpreted as a dependency with the object of LIVE WITH, shown in (143a) with a third person pronoun. In (143b), we see a first person indexical that is interpreted as a John, not the speaker, and a location indexical that is interpreted also with respect to the context in which the speaker originally was asking the question, not the current utterance context.

- (143) (ASL, Schlenker 2017a)
 a. *Context: The speaker is in NYC; the listener was recently in LA with John.*
 BEFORE IX-a JOHN IN LA, WHO IX-a SAY [IX-A WILL LIVE WITH HERE] WHO?

‘While John was in LA, who did he say he would live with there?’

- b. *Context: The speaker is in NYC; the listener was recently in LA with John.*

BEFORE IX-a JOHN IN LA, WHO IX-a SAY IX₁ WILL LIVE WITH THERE^{RS}
WHO?

‘While John was in LA, who did he say he would live with there?’

These sentences (143a)-(143b) seem to have the same meaning yet different indexicals, with one more obvious difference: the appearance of role shift, notated through the superscript *RS* and line marking the extent of the role shifting. This makes for a somewhat persuasive case of role shift as a kind of visible context shift! But as is often the case, things are more complicated than we see at first blush. In presenting this data, Schlenker (2017a) notes at least four complications of this generalization in favor of clear evidence for context shift. The first is that the very same pattern is found with the use of a quotation introducing sign (“air quotes”) instead of SAY; if air quotes introduce true quotation (which intuitively seems more likely) then that would suggest in ASL quotation really does seem to allow extraction - and then it becomes less clear what this diagnostic is doing in the first place if not ruling out quotation. At least, it certainly blurs the line in both the language and the diagnostic between non-compositional quotation and embedded clauses. A second issue, related to the first, is that perhaps quotation is only partial, since as Maier (2018) and others have noted, it’s always possible to just partially quote others’ speech. Third, a possible NPI in ASL, ANY, behaves just like English *any* in resulting in unacceptability with shifted indexicals even in cases of role shift, suggesting that perhaps the clause under role shift is not compositionally integrated after all, despite the *wh*-test. Finally, Schlenker (2017a) finds that the same *wh*-extraction tests for shifted indexicals fail to hold when applied to role shift in French sign language (LSF), so even if they do hold for the two signers consulted for ASL, they do not necessarily generalize to the way that role shift interacts with compositionality and structure across sign languages or all signers. These all raise doubt on a straightforward analysis of role shift as context shift, or at least makes the case much weaker than some of the clearer cases in some spoken languages. We turn more broadly to cross-linguistic differences in the next section.

8 Cross-linguistic variation, attraction and iconicity

A striking fact about indexical shift across spoken languages is the existence of implicational hierarchies among the predicates that license this

shift, which, for example, privilege verbs of saying over other attitude predicates (Sundaresan, 2013) and among the kinds of indexicals that can be shifted, which, for example, privilege shifting in first person over second person Deal (2020). It should therefore not be shocking to find both regularities and cross-linguistic variation in sign languages, even when we see the same kinds of nonmanual movements supporting the role shift. As just mentioned, Schlenker (2017a) reports that LSF, for example, contrasts with ASL in not allowing wh-question dependencies in the same contexts, as in (144a-b)(more examples are given in the original text with wh-words in various positions and the point holds across them).

(144) (LSF, Schlenker 2017a)

- a. WHO PIERRE SAY IX-a LIKE WHO?
'Who did/does Pierre say he likes?'
- b. * WHO PIERRE SAY $\overline{\text{IX}_1 \text{ LIKE}}^{\text{RS-a}}$ who?
'Who did/does Pierre say he likes?'

On top of the variation in the way that role shift interacts with long-distance dependencies, there are also differences in the kind of indexical expressions which seem to shift across sign languages. Quer (2005) illustrates this with the Catalan sign language (LSC) example in (145). The first person indexical IX_1 refers not to the one who utters the sentence but to Joan, the subject of the sentence, while at the same time another indexical, *HERE* refers to the location in the context of the utterance, Barcelona (where the speaker is, but not where Joan was).

(145) (LSC, Quer 2005)

- $\overline{\text{IX-A}_m \text{ MADRID MOMENT } \overline{\text{JOAN}_i}^{\text{topic}} \text{ THINK } \overline{\text{IX}_1 \text{ STUDY FINISH } \text{HERE}_b}^{\text{RS-i}}}$
'When he was in Madrid, Joan thought he would finish his study here (in Barcelona)'

Such indexical “mixing” of the kind seen in LSC is important from the point of view of semantic analysis. At one point, it was assumed that even in languages that allow indexical expressions to shift, they’d have to shift together in the same clause, known as the “shift together” constraint (Anand and Nevins, 2004). However, subsequent research on spoken languages shifty indexicals broadened to a wider variety of language families, and it became clear that there were not only differences, but a typology of differences such that first person pronouns seem to shift before second person, and second person indexicals before locative indexicals (Deal, 2020). The mixed example in (145) actually fits the spoken language generalization well: the first person indexical “shifts” but the locative is interpreted with respect to the utterance context. In general if sign languages follow the spoken language pattern, we

expect that the reverse, with a shifted locative indexical but unshifted first person indexical, should be unacceptable.

Sign languages also bring another valuable perspective to the discussion of indexical shifting because they highlight the role of iconicity in this domain. Spoken language linguists have a tendency to ignore iconicity, such as taking on a character's emotions/bodily movements or acting in other ways as a character does, since it's not captured in the segmental nature of a language's orthography or the International Phonetic Alphabet. This is a place in which the impoverished options for writing systems for sign languages turn to an advantage, since they don't force attention to only certain easily written aspects. In sign languages, it has been noticed that role shift is most supported in iconic contexts, such as in the use of classifier predicates (Davidson, 2015; Engberg-Pedersen, 2013; Schlenker, 2017b), and this has motivated at least three analyses to explain the iconicity/role shift data. On the one hand, if role shift involves a demonstration, the depictive iconicity is core to the meaning, so it directly motivates both the use of the indexicals and the iconic content (Davidson, 2015); the challenge becomes the mixed cases. Maier (2017) and Maier (2018) provide an intriguing answer to this question, suggesting that combinations of quotation/demonstration and "unquotation" (non-demonstrated speech) is motivated by a principle of indexical *attraction*: if a mentioned person or place is present in a discourse, a signer or speaker will prefer to refer to them directly with an indexical appropriate to that speech act, not the one used in the reported act. So, for example, in the LSC example (145), the physical location of the speech act occurring in Barcelona attracts the participants to use the appropriate indexical *HERE* instead of how it was phrased in the reported utterance (e.g. *THERE* or *BARCELONA*), motivated by pragmatic reasoning.

Iconicity adds yet another dimension of variation and uncertainty, since many indexical expressions involve indexical pointing to a person or place. It's clear that we need to know more about variation in shifting among indexicals, between language communities, among signers, and in iconic/non-iconic contexts. This is especially the case because most of the theoretical research on role shift tends to involve language consultations/elicitations with a very small number of signers (in many cases, a single signer), often by hearing researchers who are not native signers, and so one-off examples run the risk of being taken as representative of a community when it might instead be due to individual variation, or representative of an individual in certain contexts but not others, etc. To counteract the first issue, there is experimental work on role shift that sheds some light on the variation issue, and more generally on role shift in sign languages, which we turn to next.

Hübl et al. (2019) conducted a quantitative experiment on role shift in German sign language (DGS) (see Herrmann and Steinbach 2012 for more on role shift in DGS specifically and quotation in sign languages). In the experiment reported in Hübl et al. (2019) the participants, who were 5 Deaf

signers of DGS, were asked to view 50 video paired videos and judge their acceptability. Each pair consisted of one video (A) and then another video reporting on what happened in that video (B), in order to set up the right context to test for speech reports. Among the goals of the study was to test the attraction hypothesis, that a motivation for shifting indexicals was to use a context-of-speech based indexical for a present discourse participant, as in (146b), in contrast to (146a).

- (146) (DGS, Hübl et al. 2019)
- a. (Verbatim condition)
 Felicia signs: SATURDAY NEXT TIM WITH IX₁ DANCE
 ‘Tim is going dancing with me on Saturday’
 Tim reports: FELICIA₃INFORM₁: SATURDAY NEXT TIM WITH IX₁ DANCE^{rs}
 ‘Felicia told me, “Tim is going dancing with me on Saturday”’
- b. (Attraction condition)
 Felicia signs: SATURDAY NEXT IX₁ WITH IX₁ DANCE
 ‘Tim is going dancing with me on Saturday’
 Tim reports: FELICIA₃INFORM₁: SATURDAY NEXT IX₁ WITH IX₁ DANCE^{rs}
 ‘Felicia_i told me_j, “[I_j am] going dancing with me_i on Saturday”’

Their results were and mixed, finding a preference for the verbatim condition for the first person pronoun and the location indexical *HERE*, and a preference for the attraction condition for the second person pronoun, although as they note, there are many possible explanations. That said, work like this sets an example of how to do careful and controlled “semi-experimental” (Davidson, 2020) work to better understand variation within and across (signed and spoken) languages. With better data, we can understand how sign languages fit into the typology of indexical shift cross-linguistically; until then, most questions are difficult to resolve without better understanding the sources of variation as cross-individual, cross-context, and/or cross-linguistic (arguably, a question arising in spoken language work on this topic just as much as in sign languages).

9 Constructed actions/Action role shift

Finally, we end with an topic that connects depictive classifiers and role shift. In this chapter we have so far discussed demonstrations as a way to view classifiers as depicting events/arrangements (in Section 2), and role shift as depicting reported speech/attitudes (in Section 5), but outside of its use with attitude predicates, role shift can also been seen as introducing a “body classifier” (Supalla, 1983) to depict another’s action, sometimes called “constructed action”. This category includes the signer depicting through

their own bodies the characteristics of characters in a story (movements, facial expressions, etc.), in a sense becoming them, while “reporting” not their speech but their **actions**. As we’ve seen, some conventionalized signs are iconic in ways that quite naturally support depiction (such as for example GIVE in ASL), so that the sign can easily be made to resemble the action. In these cases it’s actually possible to demonstrate the action while also signing the conventionalized word, so that the lines between doing, depicting, and describing become quite porous.

Within the formal semantic discussion of role shift, Schlenker (2017b) has used the term “action role shift” to describe the shifting of person indexicals on more iconic verbs that don’t include reported speech but rather reported action. He notes that just like the example from Navajo above ((142) from Speas 2000), person marking on verbs can be shifted, but that in sign languages, unlike in Navajo and other spoken languages, this seems to be possible without even any speech reports at all, merely with the presence of role shift. An example of this is the utterance in (147), which involves no reported speech or other mental attitude report, but does include role shift as well as a shifted indexical. Here, the purported shifted indexical is the person marking on the verb, which begins at the signer’s body (and so takes the first of first person marking) but which is interpreted as the referring to the agent, Alex, (who is the subject of the sentence) and not the speaker.

(147)



‘Alex gave it to them.’

Schlenker (2017b) takes these “action role shifts” to be the strongest evidence in favor of monstrous context shift in sign languages, given that they clearly cannot be interpreted as quotation (there is nothing to quote, as there is no speech report) and yet involve indexical forms like the first person verbal agreement that are not interpreted with respect to the context of utterance. In response, Davidson (2015) proposes that these are simply demonstrations as adverbial modifiers, and that the first person indexical is not actually one at all, but appears to be that because the first person simply means that it is anchored to the body (Meir et al., 2007), and these are cases of the signer demonstrating an action. This is supported by the observation that these occur only with highly iconic verbs: signing GIVE in a way that appears as if one is giving something supports action role shift, but Schlenker (2017b) shows that using a less iconic sign leads to a less acceptable use of action role shift.

There is clearly an important role to play here in both experimental work as well as corpus studies and careful categorization, as modeled in work by Cormier et al. (2015b) for British Sign Language, who also ultimately support a demonstrative/depictive story of action role shift. Ultimately at stake is the interesting case of the semantic analysis for action role shift, which can be taken as either (a) the strongest evidence for context shift in sign languages, or (b) a particularly natural implementation of the demonstration account of role shift in sign languages, depending on the centrality of depiction to the phenomenon.

Within the same liminal space between depictive classifiers and quotation-like role shifts are examples that may involve an attitude report, but not necessarily a speech report and no overt attitude verb. We started this chapter with just such an example, provided by Padden (1986), repeated in (148), which has no overt attitude verb, just a subject (the husband) and, as she argues and relects in the translation with “goes”, an attitude report in a subordinate clause.

- (148) (ASL, Padden 1986)
- | | |
|---|---------------|
| $\text{HUSBAND-a} \overline{\text{REALLY IX}_1 \text{ NOT MEAN}}$ | RS-a |
|---|---------------|
- ‘The husband goes, “Really, I didn’t mean it”’

Lillo-Martin (1995) further highlights the similarities between these kind of attitude reports and English expressions like *He’s like, I can’t believe you did that!*. Since these aren’t technically speech reports, and certainly not direct quotations, she argues for a Point of View operator with a scope associated to the role shifted component. There’s an important sense that this shares with a demonstration view, namely, that the key is that a perspective is being conveyed by the role shift, and that the right comparison to spoken English are the complements introduced by *goes* and *be like*. There is also an important difference: Lillo-Martin (1995)’s syntax is multi-clausal, in that there is a main verb (the Point of View operator) and an embedded verb (in embedded clause, e.g. MEAN), whereas under a demonstration analysis such as Davidson (2015) there is a main verb with the semantics of “be like”, and the entire content under the Role Shift becomes a demonstration, understood in the same way as quotations (i.e. as a depictive demonstration) and not compositionally integrated.


10 Conclusions

This chapter brought together two types of structures in sign languages that have separately received significant attention in formal semantics and linguistics: depictive classifiers and role shift. The motivation in doing so was to highlight the way that both of these kinds of expressions incorporate depiction along with description, and how because of this, both can be

analyzed within formal semantics in a unified way through the notion of a *demonstration*. As should also be clear, this is not the only analysis on the market, and so hopefully some of the advantages and disadvantages of particular approaches are clear: their syntactic and semantic predictions, their emphasis on indexical interpretations, depictive iconicity, compositional integration, etc.

To see yet another example with a concrete implementation, we can conclude by returning to (part of) the utterance we introduced earlier in Chapter 1 of this text, which contains an example of a classifier predicate (149), which depicts the way that students are arranged around a library desk. Line (a) shows the propositional contribution of the noun STUDENT. The crucial innovation comes in line (b), which shows the contribution of the verb phrase DS₄(students in line, at a): this is a predicate, meaning that it describes some set of individuals, just like HAPPY or JUMP. In this case, it will be true not of happy individuals, or of individuals who were themes of jumping events, but rather true of individuals that are themes of events *v*



depicted by  and (because of the DS₄ handshape) are upright figures, and (because of the locus *a*) must be appropriately depicted in that location (building on discussion in Chapter 4). That is the semantics given in line (b). Line (c) provides the propositional contribution of the quantifier TEN, which takes two sets as arguments and requires that their intersection have at least ten members. In (d) we see how the quantifier combines with the restrictor noun STUDENT to form the generalized quantifier TEN STUDENTS, and in (e) how it combines with the scope set, DS₄(students in line, at a).

(149)



‘Ten students stood in a line [like this, here].’

a.



$\llbracket \text{STUDENT} \rrbracket = \lambda x.x \text{ is a student}$

b.



$$\llbracket \text{DS_4(students in line, at } a) \rrbracket = \lambda x \exists v [\text{demonstrate}(\text{image}, v) \wedge \text{theme}(x, v)] \wedge \text{upright-figure}(x) \wedge R(x, a)$$

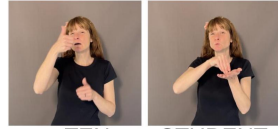


c.



$$\llbracket \text{TEN} \rrbracket = \lambda P \lambda Q. |P \cap Q| \geq 10$$

d.



$$\llbracket \text{TEN} \quad \text{STUDENT} \rrbracket = \lambda Q. |Q \cap \{x.x \text{ is a student}\}| \geq 10$$

e.



$$\llbracket \text{TEN} \quad \text{STUDENT} \quad \text{DS_4(students in line, at } a) \rrbracket$$



$$= \lambda w. | \{x. \exists v [\text{demonstrate}(\text{image}, v) \wedge \text{theme}(x, v) \wedge R(x, a) \wedge \text{upright-figure}(x)] \} \cap \{x.x \text{ is a student}\} | \geq 10 \text{ in } w$$

lit. the proposition defined as the set of worlds in which there are at least ten individuals in the intersection of the set of students and the set of upright figures who were themes of events



depicted by and are related to location a

As we have noted earlier in this chapter, an unusual feature from the perspective of most formal semantic analyses is that two pieces of the “form” appear also on the meaning side of the equations in (149): we have the



demonstration sign referenced in meaning, and the locus a referenced. But this isn’t a mistake, rather, these are two places where meaning is “iconic”, that is, meaning comes from the forms, similar to how we need to reference the forms of language in quotations.

More generally, one hopes that these data show how depictive content in general interacts with descriptive content, in tandem, in sign languages. It is worth emphasizing in these conclusions a point that is easy to lose

sight of when focuses on sign languages in this chapter, that *there is nothing about the way that depiction is integrated into classifiers and role shift that makes sign languages somehow less linguistic than spoken languages*. Quite the opposite is true: all languages, spoken and signed, make abundant use of both description and depiction, including many understudied but common aspects of spoken languages such as quotation and constructed action (Clark, 1996, 2016), depiction in ideophones (Dingemanse et al., 2015; Kita, 1997), and manner demonstrations through co-speech gestures, and there are exciting insights to be gained by emphasizing this point of commonality in the use of multiple semiotic resources within sign languages and across language modalities (Ferrara and Hodge, 2018; Hodge and Ferrara, 2022). Furthermore, not only do we gain insight by pushing these commonalities, but formalizing the way that depiction interacts with symbolic descriptive content can lead to new insights into commonalities both across and within languages, such as the underlying structural similarities between commonly studied areas of quotation and reported attitudes in spoken languages and role shift and classifiers in sign languages.

6

Quantification

One of the most notable aspects of human language is its ability to express generalizations. Many non-human animals, for example, are able to communicate about particular threats (e.g. predator presence) or opportunities (e.g. current location of food), but there seems to be no evidence for their ability to express generalizations like *Food is always available in that area*, *Tigers sometimes come from that direction*, or *No eagles fly that high*. Human languages, on the other hand, are chock full of expressions of exactly these sorts, allowing us to express generalizations in a precise way that supports even further inferences (e.g. if food is always available somewhere, then it is available now). Expressions like this are found in every human language that we know so far (Partee, 1995), including the earliest stages of an emerging sign language like Nicaraguan Sign Language (Kocab et al., 2022), making for one of the most convincing test cases of the unique expressiveness of human language.

We use the term **quantification** to refer to a function that takes two sets and expresses the relation between them build on the “tri-partite” structure given in (150).

(150) [Quantifier (e.g. some/all/no/etc.)][X][Y]

For example, if we say *No hippos fly high*, then we are claiming that the set of things that are hippos ($X = \{x.x \text{ is a hippo}\}$) and the high fliers ($Y = \{x.x \text{ is a thing that flies high}\}$) have no members in their intersection, e.g. nothing that is both a hippo and flies high. Languages can vary quite a lot in how they express quantification: some languages use determiners like *Every*, *No*, *Some*, etc. that form part of a noun phrase, while other languages express quantification through adverbials like *Always*, *never*, *sometimes*, etc., the latter being more common crosslinguistically than the former, but with an overwhelming number of languages, including English, American Sign Language (Abner and Wilbur, 2017) and Russian sign language (Kimmelman, 2017) employing both strategies.

Quantification has also been a primary motivation for postulating an underlying logic for natural language, due to our ability to draw inferences beyond what is said directly, including both entailments and implicatures. Consider, for example, the entailments of a sentence like (151a): it follows logically from the meaning of *always* that on a particular day food will be available in the given area. Similarly, the logical structure of quantifiers prompts (cancellable) pragmatic judgments: since *always* is a strictly stronger quantifier than *sometimes*, use of the weaker one like in (152) will implicate that use of the stronger one is unwarranted.

(151) Context: looking for food today

a. *Food is always available in that area.*

Entails:

b. *Food is available in that area today.*

(152) Context: discussing predators

a. *Tigers sometimes come from that direction*

Implicates:

b. *Tigers don't always come from that direction*

Those interested in the logical structure of language have long noted the relationship between quantificational expressions of the sort we see in (151) and (152), most notably the interaction of quantifiers with negation (Horn, 1989). For example, we see that the use of the existential quantifier *sometimes* in (152) leads to the negation of the universal (*not always*). Similarly, use of the universal *always* entails the negation of the negative (*not none*). Thus, the study of quantifiers builds on our understanding of negation of the sort that we saw in earlier chapters.

In terms of the expression of quantification in natural language, Partee (1995) propose that it is characterized by a tripartite structure: a quantifier, a restrictor, and a scope. So in the case of *All tigers come from that direction*, we might have [Quantifier: *All*][Restrictor: *tigers*][Scope: *come from that direction*]. In terms of its semantics, the quantifier can be thought of as expressing the relationship between the restrictor and the scope, so that in this case, *All* tells us that the restrictor set is a subset of the scope, e.g. the set of tigers is a subset of the things that come from that direction, e.g. there is nothing that is a tiger that doesn't come from that direction. Other quantifiers express different set relationships. For example, [Quantifier: *No*][Restrictor: *tigers*][Scope: *come from that direction*] would be equivalent to claiming that there is nothing in the intersection/overlap between the set of tigers and the things that come from that direction. [Quantifier: *Some*][Restrictor: *tigers*][Scope: *come from that direction*] would be equivalent to claiming that there is something in the intersection/overlap between

the set of tigers and the things that come from that direction, i.e. that the intersection is nonempty.

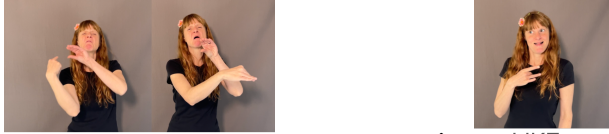

Let us model these relationships formally to illustrate their compositionality. As above, we can say that any quantifier is a function of two sets that expresses the relation between them (e.g. returns TRUE if that relation holds, FALSE if it does not). The general structure for a quantificational expression *Quant* that requires a relation *R* between two sets would be $\llbracket Quant \rrbracket = \lambda P \lambda Q. R(P, Q)$. To be concrete with an example from English, the quantifier *every* is a function that takes two sets, first *P* and then *Q*, and requires *P* to be a subset of *Q*: $\llbracket every \rrbracket = \lambda P \lambda Q. P \subseteq Q$. Taken step by step we arrive at the following semantic derivation in (153).


- (153) a. $\llbracket every \rrbracket = \lambda P \lambda Q. P \subseteq Q$
 ‘the function that takes in two sets, and requires that the first be a subset of the second’
- b. $\llbracket tiger \rrbracket = \lambda x. x \text{ is a tiger}$ (*P*)
 ‘the function which returns TRUE only for those things that are tigers’
- c. $\llbracket comes from that direction \rrbracket = \lambda x. x \text{ comes from that direction}$
 (*Q*)
 ‘the function that returns TRUE only for those things that come from that direction’
- d. $\llbracket every tiger \rrbracket = \lambda Q. x \text{ is a tiger and } x \in Q$
 ‘the function that takes in one set, and requires that everything that is a tiger be a member of that set’
- e. $\llbracket (every tiger) (comes from that direction) \rrbracket$
 $= \lambda w. \forall x [x \text{ is a tiger in } w \rightarrow x \text{ comes from that direction in } w]$
 ‘true in worlds in which everything that is a tiger is also something that comes from that direction’

In this chapter we’ll take a short tour in quantification in sign languages, first starting with an overview of different kinds of quantificational expressions in sign languages: determiners, adverbials, and other kinds of quantificational-like expressions, in Section 1. The focus will be on variation within and across sign languages in these expressions. In Section 2, we’ll focus on the way that space is used to express quantificational domain information in sign languages. In Section 3, we’ll turn to the intersection of discourse referents and quantification, drawing on our discussion of anaphora from Chapter 4, since this has often been a source for understanding both. Finally, in Section 4 we’ll end with psycholinguistic studies on quantification in sign languages, both production studies in an emerging language and scalar implicature studies in an established sign language.

1 Quantification strategies across sign languages

Sign languages have been featured in the formal semantics literature on quantification ever since the first cross-linguistic studies on tripartite quantificational structures were proposed for natural languages. For example, the classic compilation on cross-linguistic quantification by Partee (1995) includes a chapter on American Sign Language and the relationship between bare nominal expressions and quantifiers in ASL (Petronio, 1995). Petronio notes that there are several common sentence types in ASL that involve quantification, and that often quantificational meaning is expressed on verbs. The foundation of this work was analysis by Padden (1988) who showed that verbs in ASL can change their form depending on their argu-

ments as in  , or not, as in  , along with a

third categorization of spatial verbs like  whose form depends on a path instead of the subject or object. Petronio (1995) builds on this distinction by analyzing the interaction of quantity expressions with these different classes of verbs, as in the analysis of the directional verb ASK in (154). She shows that the reduplicative *multiple* marking on the directional verb ASK is compatible with three or more (including MANY) students asking, but not (just) two.

(154) (ASL, Petronio 1995)

- a. $\overline{*TWO\ STUDENT\ IX-1\ ASK_{Multiple}}^t$
'I asked two students'
- b. $\overline{MANY\ STUDENT\ IX-1\ ASK_{Multiple}}^t$
'I asked many students'
- c. $\overline{THREE\ STUDENT\ IX-1\ ASK_{Multiple}}^t$
'I asked three students'

This is included as part of the first discussion of quantifiers in sign languages. Similar kinds of (non-cardinal number) quantity expressions are discussed in both Kimmelman (2017) and Abner and Wilbur (2017) in comparison to similar expressions in spoken languages. One thing that seems to set apart the number marking seen in sign languages such as in (154) is the optionality/obligatoriness of numeracy marking (singular/dual/trial/plural). On

the face of it, the *multiple* marking appears similar to tri-al marking in spoken languages, but just like other “agreement” type phenomena in sign languages like directionality, it is optional, not obligatory: verbs that do not change their form show no multiple marking, and sometimes even verbs like ASK need not show such marking, and can instead be signed in an prototypical/uninflected form. This suggests that the use of multiple marking may be more semantically contentful than the seemingly purely “formal” use in spoken languages like, say, Slovenian which has more formal/grammatical trial marking, and more generally connects to the way that we modeled the optionality of loci use in general in Chapter 4, so that the *multiple* marking can be seen as both a way to disambiguate discourse referents via non-restrictive modification and also to depict/show aspects of an event.

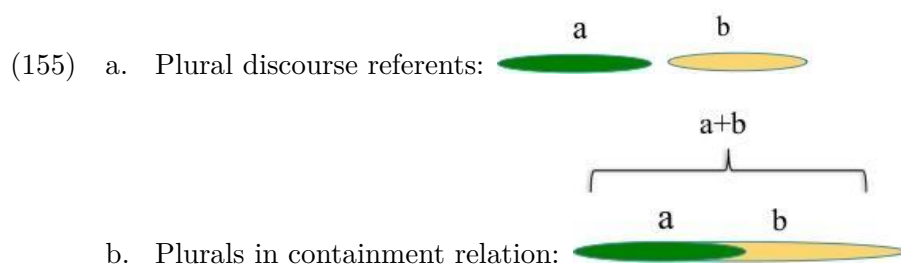
Moving on from this kind of verbal marking/pluractionality (which we will also address more in Chapter 7), Quer (2012b) considers sign languages in light of the tri-partite structure for quantification, bringing together arguments that sign languages exhibit quantification through determiners and adverbials using the same tripartite structure seen cross-linguistically in spoken languages. He builds on an insight from Wilbur (2011) and others that the use of nonmanual markers in ASL is related to the scope position, in particular, that the brow raise nonmanual marking is a marker of a restrictor set in general (in Wilbur’s system, a particular syntactic position). In other words, in sign language sentences with quantification, the restrictor set will often be set off with brow raising nonmanual marking, in contrast to the scope set.

When it comes to cross-linguistic variation, there seem to be many similarities across sign languages and spoken languages in the domain of quantification. A direct comparison between American sign language and Russian sign language is available through Abner and Wilbur (2017) and Kimmelman (2017), which report on the two sign languages and their use of several quantificational strategies, including but not limited to both determiner and adverbial quantification. These are especially useful because they occur in a handbook with direct comparison via the same typological survey to many spoken languages as well, so variation between sign languages can be considered in light of the same variation among spoken languages. Kimmelman and Quer (2021) provide an overview of quantification in sign languages, focusing on lexical differences, the pervasiveness of both determiner and adverbial quantification across sign languages, and some potential modality-specific properties, which we turn to in the next two sections. Beyond simply the use of space that we discuss next, there seems to be iconicity in quantificational forms themselves: for example, Crabtree and Wilbur (2020) propose that the difference between two universal quantificational forms in ASL reflects a boundedness difference, such that the bounded form of ASL reflects a bounded semantics, in contrast to the unbounded form (and corresponding unbounded semantics) of the latter.

2 Quantificational domains

We have focused so far on the tripartite structure of quantification: a quantifier's force (all/some/none/etc.), its restrictor, and its scope. However, it is also the case that not all of these pieces need to be visible: for example, we can leave out much detail of the restrictor when we say *everyone jumps*, which presumably has the structure [Every][one][jumps], yet *one* hardly describes a set on its own. What counts as *one*? We might say it is every individual in some relevant context, and say that whoever they are, they comprise the domain for quantification. This need arises even when there is more overt information in the restrictor than just *one*. For example, *Every cat drank their milk* is presumably telling us something about every cat in a particularly relevant group, not every single cat that has ever existed. We call this context-dependent aspect of quantification its domain restriction, and it has long been a topic of interest formal semantics and pragmatics (Stanley and Szabó, 2000; Stanley, 2002; von Stechow, 1994). As we will see, sign languages are able to integrate their use of space for discourse referents to convey domain restriction information in a unique way, which will be the focus of the rest of this section.

In many sign languages, plural discourse referents can be associated to 2-dimensional areas of signing space (often expressed through an arc-like movement across that area), in order to establish an antecedent for anaphora in later discourse, exactly like non-plural discourse referents (155a). However, there are some properties of plural discourse referents that deserve further discussion when it comes to quantification. One of these is that they must respect a type of iconic geometry, such that a plural discourse referent associated to an area of space that is inside the space associated to another plural discourse referent, as in (155b) should have the same relationship to it as the referents do, e.g. one should properly contain the other in its extension (Schlenker et al., 2013).



Plural discourse referents are important to understanding sign language quantification because quantifiers in sign languages are able to make use of these plural referents as their restrictors, shown among other languages for American Sign Language (Boster, 1996) and Catalan sign language (Barberà, 2015). In these spatial quantified noun phrases, the quantifier is signed

in an area of space, and the interpretation is that the quantifier is restricted to that particular set associate to the area of space. Compare, for example, the quantificational expression in (156), which doesn't make use of any area of space to locate the quantifier, and (157) in which the quantifier is associated to a locus *a*, in this case to support anaphora in the subsequent sentence.

- (156) (Davidson and Gagne, 2022)
 FS(ALL)/NONE/SOMEONE LIKE TEST *QNP without locus*
 'Everyone/No-one/someone likes tests/that test'

- (157) (Davidson and Gagne, 2022)
 Context: A group of my friends recently took the bar exam.
 FS(ALL)-a/NONE-a/ONE-a FAIL. *Spatial QNP*
 'All/none/one of them (of the friends) failed.'
 IX-arc-a MAD.
 'They (my friends) were mad'

There are at least two interesting consequences that this has for quantifier semantics in sign languages. The first is quite simple: Schlenker et al. (2013) note that while spoken languages like English do not have an easy way to refer back to a complement set of a mentioned referent, the use of space supports "complement set anaphora" in sign languages. Consider for example the short two-sentence English discourse in (158a-c). In (158a-c) the most natural interpretation is that *they* refers to all of the students (the some who did their homework and the others who did not). In (158b) the most natural interpretation is that *they* refers to the some of the children who did their homework. Both of these options for interpreting *they* are fine. However, it is strange to try to have *they* refer to the others who did not do their homework, as in (158c), and this is descriptively called the inability to license "complement set anaphora."

- (158) a. Some of the children did their homework. They are a good class.
 b. Some of the children did their homework. They were proud.
 c. Some of the children did their homework. ?They couldn't find it.

In American Sign Language, there is no ambiguity, since three different loci are used for the indexical signs in (158a-c): a large arc in the case of (158a), a subset of this arc for (158b), and the complementary subset for (158c). This has led some to conclude that sign languages have iconic support for complement set anaphora (Schlenker et al., 2013), and indeed, perhaps another way to phrase this would simply be that when space is used to disambiguate, the scenario for complement set anaphora never arises


because the use of space to depict these sets distinguishes each of these groups uniquely.

A second major consequence of spatial quantified noun phrases is that the use of loci supports the expression of domain narrowing and widening through a metaphorical (MORE IS UP) use of space (Davidson and Gagne, 2022). Consider example (159): the signs in both (159a) and (159b) are the same except that the quantifier FS(ALL) is signed at a neutral height in (159a) and at a much higher height in (159b), and this has truth conditional consequences: the first is interpreted as a narrower domain (All of my friends) while the latter is interpreted as a wider domain (All of the people in the world).

(159) (Davidson and Gagne, 2022)

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


a.



FS(ALL)-neutral BECOME VAMPIRE

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

b.



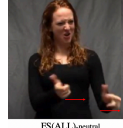
FS(ALL)-high BECOME VAMPIRE

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

Davidson and Gagne (2022) argue that this difference comes from a pronominal restriction in the quantifier, something roughly like fs(ALL) [of ix] ‘All of them’, by illustrating that this same use of height to convey wider

or narrower domains is also present in the basic pronoun system independent from quantification, as well as in directional verbs that incorporate pronouns/have pronominal clitics (for more discussion on directionality and clitics see Chapter 4). They conclude then that while this use of height is particularly productive in cases of quantification when there is a clear use for expressing domain widening/narrowing, that compositionally it should be seen as a restriction on pronouns, similar in spirit to the spatial restrictions we took as analyses for loci in Chapter 4.

Like role shift and classifiers, this is another place in the structure of sign languages where depictions seem to interact directly with compositional structures, in this case with truth conditional consequences about who exactly are being quantified over! As with those, the solution comes in through (demonstrative-like) referential pronoun (160b), and so to compare we will walk through an example step-by-step as well (160). In this case we will use glosses instead of images of signs, since much of what we are focusing on is composition *inside* of a single expression, i.e. different parts



of meaning that contribute to the sign FS(ALL)-neutral . The pieces/ingredients are as follows: the universal quantifier sign fs-ALL (160a), the indexical pointing sign IX-arc-neutral (a point to an arc in space at a neutral signing height) (160b), and a silent semantic “glue” equivalent to English partitive *of* (160c). Note that for the indexical, the plural restriction (expressed by the arc) is instantiated through $\neg\text{atomic}$ and the ‘maximal discourse entity’ through $\forall y(y \leq z \rightarrow y \in C)$, following Davidson and Gagne (2022): the second says that everything that’s part of the plural is part of the given context C .

- (160) a. $\llbracket \text{FS-ALL} \rrbracket = \lambda P \lambda Q (\forall x (P(x) \rightarrow Q(x)))$
 b. $\llbracket \text{IX}_i\text{-arc-neutral} \rrbracket^{g,C} = \iota z : \neg\text{atomic}(z) \wedge \forall y (y \leq z \rightarrow y \in C). (z = g(i))$
 (plural pronoun, the maximal discourse entity (here, the movie watching friends) unless further restricted by descriptive content, locus, etc.).
 c. $\llbracket (\text{of}) \rrbracket = \lambda x \lambda y. y \leq x$
 d. $\llbracket (\text{of}) \text{IX}_i\text{-arc-neutral} \rrbracket^{g,C} = \lambda y. y \leq \iota z \neg\text{atomic}(z) \wedge \forall y (y \leq z \rightarrow y \in C). (z = g(i))$
 $= \lambda y. y \in C_e$
 e. $\llbracket \text{FS-ALL-neutral} \rrbracket^{g,C} = \llbracket \text{FS-ALL}[-\text{of}[\text{IX}_i\text{-arc-neutral}]] \rrbracket^{g,C}$
 $= \lambda Q (\forall x (x \in C_e \rightarrow Q(x)))$
 ‘All of them’ (default domain C_e unless further restricted by descriptive content, locus, etc.)

The higher version, with a widening domain, involves exactly the same composition except that the plural pronoun has a restriction to a context set that is a superset of the default ($C \subset \{y : y \leq z\}$), as in (161).

- (161) a. $\llbracket \text{IX}_i\text{-arc-high} \rrbracket^{g,C} = \iota z : \neg \text{atomic}(z) \wedge (C \subset \{yy \leq z\}). (z = g(i))$
 b. $\llbracket \text{FS-ALL-high} \rrbracket^{g,C} = \llbracket \text{FS-ALL}[-\text{of}[\text{IX}_i\text{-arc-high}]] \rrbracket^{g,C}$
 $= \lambda Q(\forall x(x \in C'_e \rightarrow Q(x)))$
 ‘All of them’ (expanded domain C' , where $C \subset C'$)

In this implementation, the difference between using a high space for a universal quantifier (FS-ALL-high) and a neutral space (FS-ALL-neutral) comes down to hard coding this as a restriction on the pronoun: a plural point to a neutral height will require that everything contained in the plural is part of the default context C , while a point to a higher space requires that everything that makes up the plural be contained in a superset of this, a wider context C' . What’s important for compositional semantics is that this can then be applied to any other quantifiers, e.g. NONE, FEW, etc., essentially with the same semantics as ‘all of them’ where ‘them’ comes from a narrow or wider domain, and it allows for multiple heights and multiple domains as long as they are ordered this way, which there is indeed evidence for in ASL, as shown by (Davidson and Gagne, 2022). But why exactly is space used in this way? It seems to have an origin in a well known metaphor MORE IS UP (Lakoff and Johnson, 1980), but what is notable about this use in sign languages is that it has truth conditional consequences when the intended referent of the pronoun (the domain) restricts the quantifier that it appears with. Thinking more broadly about how metaphorical uses of space can influence semantics/pragmatics in sign languages, we might imagine hard-coding something based on the metaphor PROXIMITY IS SIMILARITY in the use of horizontal loci to explain the use of different areas of space in cases of contrast (as discussed in Chapter 3). These are cases where a noncompositional aspect of meaning (metaphor) influences truth conditions by influencing what kind of meaning gets conventionalized, a different way yet similar in spirit to the method of integrating non-propositional content we saw for the demonstrations in the previous Chapter 5.

3 Quantification and binding

In the previous section we focused on the way that quantified noun phrases are able to use the spatial nature of discourse referents in sign languages to mark domain information. But, there is another way in which discourse referents in sign languages interact with quantifiers: through individual discourse referents not used for a domain but instead for variable binding. Consider, first, the difference between the two universal quantificational

sentences in (162): each expresses something with universal force, that is, something about each and every member of the set of students, and the set of those that were glad they brought their toothbrushes, namely, that the first is a subset of the latter. But, they do so in different ways: the first one (162a) takes the set of students as a whole and their behavior as group behavior, which we can notice in the plural morphology on *students* and *toothbrushes*. In contrast, the second one quantifies individually student by student: notice, for example, the singular morphology on *student* and *toothbrush* in (162b).

- (162) a. All of the students were glad that they brought their toothbrushes.
 b. Every student was glad that they brought their toothbrush.

We saw in the previous section plenty of examples of the first sort, with plural morphology indicated by an arc and the use of higher or lower space to express domain information via the plural restrictor (e.g. *students*). What about the second sort (162b)? This doesn't seem to be a universal in spoken languages by any means (Partee, 1995); nevertheless, it is not uncommon either, so we might ask whether we see this kind of quantification in sign languages. The answer is somewhat complicated: there is some evidence that sign languages do have this kind of quantification, yet other evidence that they do not, or at least not in all the same ways as English.

One kind of evidence in favor comes from sentences that express behavior that seems to vary by individuals. Take (163), which associates the noun phrase BOY with one area of space (locus *a*), and associates another noun phrase GIRL with a second area of space (locus *b*), and then in the clause embedded under THINK, the singular pronouns IX-a and IX-b are intended to be interpreted as ranging over the whole set of boys and whole set of girls, respectively, similar to (162b) above.

- (163) (Kuhn, 2015)
 [ALL BOY]_a WANT [ALL GIRL]_b THINK IX-a LIKE IX-b.
 'All the boys want all the girls to think they like them.'

A similar kind of example can be found in (164) from Schlenker (2011), which uses a universal temporal quantifier EACH-TIME and associates separate locus to two noun phrases (LINGUIST and PSYCHOLOGIST) in the restrictor of that quantifier. In the scope, the pronouns IX-a and IX-b with singular morphology are intended to be interpreted as ranging over all of the possible linguists and psychologists, not just a single one.

- (164) (Schlenker, 2011)
 EACH-TIME LINGUIST_a PSYCHOLOGIST_b THE-THREE-a,b,1 TOGETHER
 WORK, IX-a HAPPY BUT IX-b HAPPY NOT.

‘Whenever I work with a linguist and a psychologist, the linguist is happy but the psychologist is not happy.’

Neither of these examples have the clear combination of a nominal quantifier with a singular morphology on the noun phrase that we found in the English example in (162b), but we might be inclined to overlook this given that bare nouns like the ones in (163) are par for the course in ASL, and temporal quantification like EACH-TIME is also common crosslinguistically and supports binding, as in English *Each time I see a student I ask for their toothbrush*. However, there is one further difference that seems to set the sign language case apart: the inability of negative quantifiers to participate in these same binding structures. Consider for example that in English, a negative quantifier works just as well as a positive one, as in (165).

- (165) a. None of the students were glad that they brought their toothbrushes.
 b. No student was glad that they brought their toothbrush.

In contrast, Abner and Graf (2012) note that switching to negative quantification (from universal quantification) significantly degrades bound quantificational readings in American Sign Language (see also Graf and Abner 2012; Kuhn 2020; Abner and Wilbur 2017). In their example (166), they report that this form is unable to express the bound meaning expressing that nobody in the set of politicians is also in the set of individuals who say that they wanted to win. However, the same example with a universal quantifier is improved, as is the same example without a singular locus (more similar to the negative quantification with plural domain restrictions we saw above).

- (166) (ASL, adapted from Abner and Graf 2012)
- a. POLITICS PERSONa TELL-STORY IX-a WANT WIN.
 ‘A politician said that he wanted to win.’
 - b. NO POLITICS PERSONa TELL-STORY WANT WIN.
 No politician said that he wanted to win.
 - c. *NO POLITICS PERSONa TELL-STORY IX-a WANT WIN.
 Intended: No politician said that he wanted to win.

Graf and Abner (2012) take this difference to be due to the inability to support “syntactic” binding in sign languages. The idea behind this is that the types of quantification over individuals that we saw in the English case *No student... they...* (165) are only available in languages that have a syntactic dependency between the quantificational noun phrase (*No student*) and the anaphoric pronoun (*they*). In ASL, Graf and Abner (2012) argue, there is not the same syntactic dependency between the quantificational

noun phrase (e.g. NO POLITICS PERSON) and the anaphoric pronoun (IX). When we talk about a syntactic dependency, we mean the same sort of dependency that we see in, say, wh-questions between a question word and the position where it is interpreted, the kind of cross-clausal dependencies that we used to probe for compositionally integrated clauses and contrast with quotation in Chapter 5, for example. This can be contrasted with the kind of binding that arises through discourse-based coreference that can cross sentences, like the kind that governs coreference between the politician and the pronoun, as in *I met a student. He brought a toothbrush.*; the latter sort cannot arise in negative quantification since there is nothing there at the discourse level to corefer to (compare the odd: *I met no student. He brought his toothbrush.*).

A related but different explanation for the difference between universal and negative quantificational binding in ASL is that the inability to have bound interpretation of sign language pronoun comes from iconic constraints on the use of space. Kuhn (2020) argues that the use of a locus itself has an iconic requirement, following a similar suggestion by Schlenker (2011) that there is an iconicity presupposition that rules out the use of loci in cases of negative quantification. Kuhn (2020) discusses this iconic restriction on the use of loci in the larger context of two other phenomena in sign languages that involve dependencies: negative concord (see discussion earlier in Chapter 3) and distributivity, which uses space to mark dependencies in an iconic manner. We can see an example in (167), where the locus *a* is expressed on the universal quantifier EACH and uses space to illustrate the dependency between the professors and the students.

- (167) (Kuhn, 2017a)
 EACH-a PROFESSOR NOMINATE ONE-arc-a STUDENT
 Each professor nominated one(-dist) student.

Overall, the notion of the use of space as being ultimately depictive, even if in a quite abstract way, has roots in many approaches to sign languages linguistics, especially cognitive approaches like Liddell (2003) and the hybrid approach of Schlenker et al. (2013), and is also consistent with general views of the use of pointing to space as demonstrative by Ahn (2019a) and Koulidobrova and Lillo-Martin (2016). However these views all differ in their implementations for the interface between the depictive aspects of space and the descriptive/non-iconic aspects of sign languages. The view we will take is as follows: depictions can be used to create and augment the event representations we lead our interlocutors to construct. As Kuhn (2020) suggests, establishing a locus for a negative quantifier is in conflict with any use of that space to depict something (which, given the negative quantifier, cannot exist) so a locus is not used in these cases of negative quantification. Recall the incompatibility between negation and depiction is a theme we have seen

before, as in Chapter 2. However, when it comes to quantification, negative quantifiers can indeed occur with spatial loci in the plural case (e.g. NONE-high from Davidson and Gagne 2022), and a story consistent with the one we are giving is that these are possible because the reference of the demonstrative pronoun that picks out the domain exists (e.g. ‘them’) and we may want to depict its location as part of constructing the relevant event representation; negation plays a role in those cases simply by claiming a lack of overlap between that set and the scope set. In contrast, in the bound singular locus case, there is no individual associated to the locus, instead some syntactic dependency/functional linguistic structure (Reinhart, 1983). Presumably, more detailed data collection in this domain will help establish these patterns more firmly and test how closely these abilities/inabilities to allow binding track across quantifiers beyond the one or two that have been described so far, in order to more fully clarify this picture.

4 Quantification and scope

We have focused so far on single quantificational expressions across sign languages, and ways that they can mark their restriction and scope, including the use of space to track both plural and single discourse referents. Yet another notable feature of quantifiers in natural language is that the presence of two or more quantifiers is known to lead to (in some cases, in some languages) quantifier scope ambiguities: two different interpretations of a sentence depending on which quantifier “scopes” over the other. Consider, for example, the sentence in (168), which could be interpreted with the universal quantificational noun phrase *every student* having wide scope (168a), or with the existential quantificational noun phrase *a book* having wide scope (168b).

- (168) Every student bought a book.
- a. For every student, the student bought a book.
 - b. There is a book such that every student bought it.

Some languages allow the same sentence to have these two separate interpretations, as exemplified in English in (168), while other languages seem to bias interpretation toward the “surface” reading, i.e. to use word order and other organizing properties of information structure to disambiguate. It is a natural question, then, whether quantificational scope ambiguities arise in sign languages. Petronio (1995) reports the narrow (169a) and wide (169b) scope existential readings for the bare noun phrase BOOK to be available in ASL (note, here, that the “wide” scope reading is actually a collective reading in which the students bought the book together, not required by

(168b), as well as a third reading more common for bare noun phrases that is not equivalent to either of the English readings (169c).

- (169) (ASL, Petronio 1995)
- ^{re}
BOOK two student buy.
- a. ‘Two students each bought a book.’
- b. ‘Two students together bought a book.’
- c. ‘Two students bought books.’

In (169) the noun phrase BOOK is topicalized, which has been argued by Wilbur and Patschke (1999) to affect quantifier scope options via a visible marking of topicalization/A’ movement (the eyebrow raising). Others have noted that the use of space, as used to keep track of discourse referents, can disambiguate such readings, especially with the use of the distributive marker (Kuhn, 2020; Quer, 2012b). Quer (2012b) provides the example in (170) which is not understood as ambiguous but rather unambiguously requires STUDENT to take wide scope.

- (170) (LSC, Quer 2012b)
- ^{re}
STUDENT ONE-DIST TEACHER POSS-DIST ASK-DIST
‘Each student asked his/her teacher.’

Lurking in these discussions about availability or unavailability of quantifier scope ambiguities is often a presumption coming from analyses of text from languages like English, taken out of context, in which there is a clear ambiguity. This might be due to the general ability of a sentence with multiple quantifiers in argument positions to permit multiple scoping possibilities. But in context, such sentences are rarely truly ambiguous, and we will never be looking at the context-less equivalent in sign languages given that the visual medium frequently includes more prosodic and gestural marking precisely in order to disambiguate, much as we saw with general coordinators in Chapter 3. Moreover, the use of space and gestural expression provides an easier means for depiction, which can be used in any language to support more clarity on one reading or another, which has itself perhaps motivated the conventionalization of distributivity marking in ASL and LSC.

As a takeaway then, we should consider the question not as whether sign languages “lack” these scope ambiguities but rather what aspects of sign languages support disambiguation and investigate the presence (or absence) of these in spoken languages during investigation of quantifier scope readings. Further, within a language (signed or spoken) we might find differences in availability of scopal readings depending on one’s interest in accompanying description with depiction, a known area of speaker choice/variation.

Finally, we discussed in Chapter 2 the ways that sign languages reflect information structure of the discourse (backgrounded information can be encoded in a question, new information foregrounded in an answer), which can potentially affect scope if, for example, wide scope negation is encoded as a negative answer (Gonzalez et al., 2019). A particularly interesting consequence of this, discussed in Chapter 3, is the possibility that a strategy for expression wide scope is through the use of question-answer clauses and using a quantifier in the answer, which disambiguates scope in sign languages and raises the question of whether this might be an underappreciated strategy in some spoken languages as well.

5 Psycholinguistic studies: Comprehension

Finally, quantification has typically been the domain of formal linguistics, but work at the psycho-semantics interface finds multiple areas of research in which quantification has come to the attention of psycholinguists interested in the processes for language comprehension and production, and sign languages are no exception. One example comes from scalar implicatures and their processing and acquisition. A long line of research on spoken languages lead to the conclusion that existential and universal quantifiers stand in a structural semantic relation such that in a positive environment (i.e. not under negation or similar operators) a universal quantifier is going to entail an existential quantifier (171). This has a pragmatic effect such that the use of the weaker term often implies that the stronger term is not true, i.e. the use of (171a) tends to imply that the speaker could not have truthfully claimed (171b).

- (171) a. Some of the students forgot their toothbrushes.
 b. All of the students forgot their toothbrushes.

Among the profusion of work on scalar implicatures in psycholinguistics, one of the most interesting findings has been the general divergence between children and adults on evaluating underinformative scalar terms. Foundational studies by Noveck (2001), Papafragou and Musolino (2003), and others showed that children tend to accept a description using a weak scalar item (e.g. (171a)) in a situation where the corresponding strong scalar term (e.g. (171b)) is true, where adults will reject the weak term in such a scenario. The classic description is that adults are computing a scalar/quantity implicature (additional pragmatic inference) that one should use the most informative term one can truthfully say, and in the absence of using the strongest term, the stronger term is taken to be untrue. This series of reasoning is assumed to be difficult for children for various reasons, hence their “inability” to draw implicatures, or their having more “logical”

interpretations as opposed to the “pragmatically enriched” interpretation given by adults. Much subsequent literature has differed in where to place this difference between children and adults: it could be due to differences in knowing what scalar terms are alternatives to each other (Barner et al., 2011), differences in how adults and children react to pragmatic infelicity (Katsos and Bishop, 2011), differences in children and adults’ ability to compare alternatives (Guasti et al., 2005), or other reasons. Always, an interesting question presented itself: what would happen if one’s competence in a language were dissociated from their cognitive development (Siegal and Surian, 2004)?

A natural way to investigate this question is to look at adults who are learning a second language later in life, since their decades of cognitive development would seem to be in contrast to their newer experience with that language. However, this topic proves hard to study in that context because many well-studied scales like existential/universal quantifiers (*some/all*) occur in similar patterns in one’s first and later learned languages, so it is difficult to account for language transfer effects from one’s first language to the new language. Davidson and Mayberry (2015) investigate scalar implicature interpretations among deaf adults with varying ages of first language exposure (from birth, as compared to much later acquisition of a sign language as first language), and compared implicature calculation in ASL across three scales: quantifiers, logical operators expression conjunction and disjunction, and a number task. All of the participants had many years of experience with ASL and all considered it their dominant language, but some adults learned ASL early in life, while others learned it later. Interestingly, all had similar reactions to classic quantifier scalar implicatures, rejecting underinformative descriptions exactly as adults generally are reported to do in other languages. The only difference found between signers based on their age of first language acquisition was, interestingly, in the coordination scale, which as we discussed in Chapter 3 has other differences that seem to be ASL specific. From the perspective of understanding quantifier comprehension, these results find similar patterns in ASL as for English in terms of their pragmatic landscape, suggesting that despite different language experiences, adults approach the task in a different way than children. Moreover, while many tasks find differences in sign language processing between late and early first language learners, scalar implicatures broadly are less affected, although the more narrow task of learning a particular scale might be affected.

6 Psycholinguistic studies: Production

Scalar implicatures involve comprehension and pragmatic reasoning about the meaning of quantifiers one encounters; on the other side of the commu-

nicative equation is message formation and language production. In this domain, there is little work on quantifier production in sign languages, but one area where this has been investigated in some detail and proven fruitful is in the investigation of the emergence of quantification in a new language. Kocab et al. (2022) study the production of quantifiers by signers of Nicaraguan Sign Language, a relatively newly conventionalized national sign language established in Managua, Nicaragua only since the 1970s. The goal of that study was to investigate the presence of expressions for quantification in different generations of signers of the language, and to understand how their meanings might or might not change in the first decades of this language.

Kocab et al. (2022) elicited quantifier production by showing signers pictures illustrating a scene with a quantity of animals/characters too high to easily count and use cardinal numbers, for example 20 or so birds in a tree, of which some proportion (all, some, none) leave and fly out of the tree. Signers were prompted to describe a target picture showing a particular proportion. One of the most surprising results is that quantificational expressions that distinguished universal ('all'), existential ('some'/'a few'), and negative ('no'/'none') quantification were used even in the earliest generations, a finding underscored by analyses of videos from earlier decades in which the same quantificational expressions were used (which both indicate that these quantifiers were present early in the language's development and that they have these meanings). A striking conclusion of this work is that despite the complexity that quantifiers introduce into language through their potential for scopal interactions, tripartite structure, and domain restriction, they emerge very quickly in the time scale of a languages' development even in the absence of external input, which seems to only further underscore the core role of quantification in human languages, both signed and spoken.

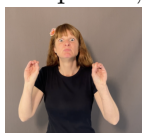
7 Conclusions

Quantification is known as one of the places where human language makes use of a combination of complexity and precision that we do not yet have evidence for among non-human animals. There are several places where sign language specific properties make studying quantification especially interesting. One of these is at the intersection of quantification and the association of space with discourse referents, both for domains and for potential binding; another is in the interaction of quantifiers and other operators with respect to scope, such as distributivity and other quantifiers. There are also psycholinguistic studies that focus on quantifiers, both on pragmatics in ASL and on the production of quantifiers in NSL, although possibilities remain wide open in this area for future work.

There is especially a need for more crosslinguistic work on quantifiers in sign languages. The notable exceptions, as we have seen, are chapters on

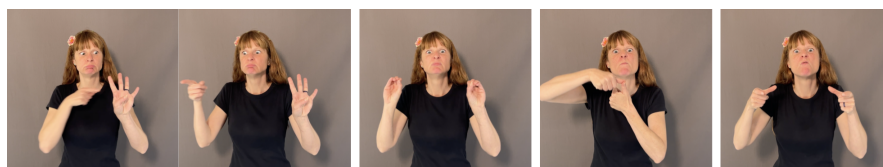
Russian sign language (Kimmelman, 2017) and on ASL (Abner and Wilbur, 2017) in a volume on quantification cross-linguistically, which provide a sense of the syntactic distribution of quantifiers across these languages, and on LSC (Quer, 2012b). Further works should also take care to consider semantic/pragmatic interface questions like the nature of the scales in each language (not necessarily equivalent), and the use of space, especially since we have seen evidence from both Catalan SL (Barberà, 2015, 2014) and Japanese and Nicaraguan SLs (Davidson and Gagne, 2022) that it plays an important role in domain restriction across several unrelated sign languages.

We'll end this chapter with a concrete example that follows the semantics we have introduced and show how it integrates with other notions we have covered in earlier chapters such as loci and depictions. In terms of quantification, we will want to model the quantificational **force**, the **restriction** and the **scope/domain**, the three parts of quantificational tri-partite structures. For this we can actually turn to one of our original examples from Chapter 1, part of which can be seen in (172), which includes a quantifier,



NONEsym . The semantic force of this quantifier is negative existential (172a), requiring the intersection of the restriction set (P) and the domain set (Q) to be the empty set \emptyset (i.e. there is nothing in the intersection). The domain is restricted to the set of individuals that comprise the plural IX-arc, given in (172b) as proposed in Chapter 4. This is an individual, not a set that we usually think of as a restrictor for a quantifier, but we borrow from Davidson and Gagne 2022 an implementation for moving from the individual to the restrictor set using semantics essentially equivalent to the partitive structure in *none of them* in English. In (172c) we see the full subject of the sentence IX-arc NONE, which has the semantic form of a generalized quantifier (roughly, 'none of them'); this takes the predicate REMEMBER CARD (172d) as an argument, resulting in the proposition in (172e).

(172)



IXArc(students, at a)

NONEsym

REMEMBER

CARD

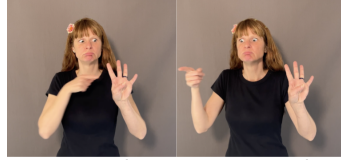
'None of them remembered a card.'

a.



$$\llbracket \text{NONEsym} \rrbracket = \lambda P \lambda Q. P \cap Q = \emptyset$$

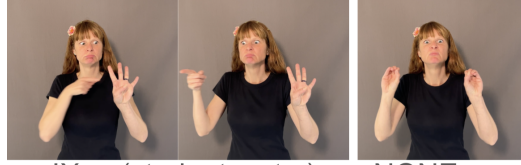
b.



$$\llbracket \text{IXarc}(\text{students, at } a) \rrbracket = \iota x. \neg \text{atomic} \wedge R(x, a)$$

‘The unique plural (i.e. non-atomic) individual that is related by R to location a ’

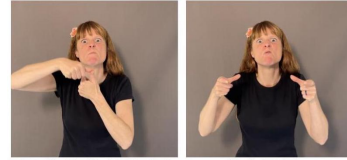
c.



$$\llbracket \text{IXarc}(\text{students, at } a) \quad \text{NONEsym} \rrbracket = \lambda Q. \{x.x \leq \iota x. \neg \text{atomic} \wedge R(x, a)\} \cap Q = \emptyset$$

‘None of them (the ones associated to a)’

d.



$$\llbracket \text{REMEMBER} \quad \text{CARD} \rrbracket^w = \lambda x. x \text{ remembers (a relevant) card in } w$$

e.



$$\llbracket \text{IXarc}(\text{students, at } a) \quad \text{NONEsym} \quad \text{REMEMBER} \quad \text{CARD} \rrbracket = \lambda w. \{x.x \leq \iota x. \neg \text{atomic} \wedge R(x, a)\} \cap \{x.x \text{ remembered card}\} = \emptyset$$

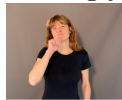
‘The proposition consisting of the worlds in which there is no individual that both remembered a card and that is a subpart of the plural individual related to the locus a (the lined up students)’

Of course, this is just one example; sometimes quantifier domains aren't so overt, just like in spoken languages. Note, for example, that the pronoun IXarc(students, a) is really in a topic position here, and structurally is optional: the sentence NONESym REMEMBER CARD 'None remembered their card' is also well formed and acceptable. Quantifiers can also take many different forces, e.g. NONE, ALL, SOME, FEW, etc. As we have seen, one reason to emphasize the quantificational properties of sign languages is that they are simply not present outside of human language in the same way, and because they support inferences that are difficult to model as representations of particular events (what does 'No one remembered their card' exactly look like?) but quite easy to model in terms of reasoning about propositional alternatives, and these in turn support the inferences that participants make when quantifiers are used.

7

Countability

Many areas of formal semantics focus on the functional words in language, the sort of forms that we can think of as the kind of “glue” that holds language together: the words like ALL, NOT, NONE, WHAT, etc. Mostly as a reflection of this bias in formal semantics, these have also been the focus of much of this book so far. In large part, the emphasis on these function words is because understanding their contributions helps us understand propositions and propositional alternatives better: these functional vocabulary items strongly affect entailments, so that for example the presence or



absence of NOT will drastically change entailments. As we pointed out in Chapter 1, understanding how we can infer so much about what has not directly been said helps us understand the infinite communicative potential of human language. However, some extremely interesting entailment patterns also pop up when we investigate many categories of “content” words more closely. One area like this that has been well studied in spoken languages and that has also received significant study in sign languages comes from understanding the internal structure of noun and verb phrases based on their **countability**, e.g. how we count their internal pieces and how different languages reflect these distinctions.

For example, English uses some nouns to talk about stuff as individual units (*cat*, *shoe*, *house*), while other nouns seem to talk about the substance and not the way it is partitioned into units (*milk*, *rice*, *water*). Moreover, these differences are reflected with how these classes of nouns interact with other elements like quantifiers. For example, the class of **count nouns** can occur as a restrictor of count quantifiers like *many* but not mass quantifiers like *much* (173a), while others known as **mass nouns** show the reverse pattern (173b).

- (173) a. I don't see {many/*much} cats/shoes/houses. (**count**)
 b. I don't see {*many/much} milk/rice/water. (**mass**)

Moreover, the same nouns that occur with count quantifiers can combine directly with numerals (174a), whereas those that occur with mass quantifiers cannot combine directly with numerals (174b), and instead need to be measured (via bottles, puddles, pounds etc.) before combining with numerals (174c).

- (174) a. I see two cats/shoes/houses. (**count**)
 b. # I see two milk/rice/water. (**mass**)
 c. I see two {bottles of/puddles of/pounds of} milk/rice/water. (**mass**)

It has been an area of significant investigation by linguists as well as psychologists and philosophers and those working at the intersections of these disciplines how different languages count, and how different words come to be categorized as mass or count in a given language (with respect to the kinds of properties like those shown in (173)-(174)), and whether categories like “mass noun” and “count noun” are meaningful, exhaustive of the possibilities allowed in human language, and/or have different subparts. This is because on the one hand, there is noteworthy consistency across languages. In terms of what concepts get categorized in which ways, if a language makes a distinction like English does in terms of what nouns go with which kinds of quantifiers, then the word for *cat* is very likely to be a count noun and the word for *milk* is likely to be a mass noun. On the other hand, there are also language specific distinctions that seem quite arbitrary: English *hair* is a mass noun while its Italian equivalent *capelli* is a count noun.

To make things even more complicated, other languages don't at face value seem to make the same distinctions that we see in terms of what nouns can occur with what quantifiers, or they make this distinction in different ways. For example, a great deal has been written about the topic of countability in Mandarin, a language in which a count **classifier** (e.g. *zhī*, *shuāng*) is required to appear between a numeral and the noun, as in (175a-b); direct composition between the numeral and the noun is unacceptable (175c), in striking contrast to English.

- (175) (Mandarin)
- a. *Liǎng zhī māo*
 two CL cat
- b. *Liǎng shuāng xié*
 two CL shoe

- c. # *Liǎng māo/xié*
two cats/shoes

The two classifiers *zhī* and *shuāng* reflect various semantic/sortal properties of the nouns, in a very similar way to sign language classifier handshapes discussed in Chapter 5, hence, the use of the term “classifier” for the handshapes of depicting classifier signs in sign languages.

Chierchia (1998) observes that the required use of classifiers to combine with numbers/counting in languages like Mandarin tracks with another distinction crosslinguistically: the ability of a language to use bare nouns as arguments for verbs, as in the contrast between (176a) in Mandarin and (176b) in English.

- (176) a. *māo tiàole*
cat jump
‘The/a cat jumped’
b. **Cat jumped.*
The/a cat jumped.

Chierchia accounts for this difference between the English and the Mandarin cases by supposing that all nouns in some basic sense start out as a kind of undifferentiated/uncountable stuff (a **kind**, in the terms of Carlson 1977), and then some languages like Mandarin are able to allow these kinds to participate directly as arguments to a verb like jump. In this case, they would need another function to turn them into something countable, which is what we see being done through their classifier morphemes. In contrast, a language like English has nouns that are - speaking roughly- already closer to something that is needed to be counted. In these languages, the already countable noun can take number marking (e.g. singular and plural), and they have the ability to combine directly with numerals like *two cats*. These languages then require an extra (covert, in English) function when we want to talk about them as kinds, such as in *the cat [kind] is common* (Chierchia, 1998, 2015).

A third class of languages seems to permit their nouns to occur directly in noun phrases with numerals (like English, unlike Mandarin), and directly as arguments (like Mandarin, unlike English). In these languages, even very mass-like things can appear without an overt classifier. Compare the English cases we saw above with the example in (177) from Nez Perce, which has no need for the intervening *bottle*, *puddle*, *pound*, etc. between the numeral and the noun (177a) and where English might use measure words Nez Perce can use plural marking instead (177b) (Deal, 2017).

(177)

(Deal, 2017)

- a. *kuyc heecu*
 nine wood
 ‘nine pieces of wood’
- b. *yi-yos-yi-yos mayx*
 PL-blue sand
 ‘[individuated/apportioned] quantities of blue sand’

In such a language we might wonder if there are really mass or count categories since they don’t seem to be distinguished by syntactic distributions (the combination with numerals, classifiers, and/or the presence of grammatical number). Interestingly, it seems that even in these cases there may be evidence for a mass/count distinction if we look to other areas of the grammar like plural marking on adjectives in Nez Perce (Deal, 2017). (As we will see, a similar unexpected distinction, in this case in topicalization and conjunction, shows up for ASL as well.)

In addition to the nominal domain, we can ask about countability distinctions in the verbal domain. For example, verbs can express events in a way that is countable (English *She jumped three times!*) or not (English *She is playing outside!*). Just like the nominal mass/count distinction, there are formal/syntactic as well as semantic distinctions that often but do not always align. Consider, for example, the verb phrase *fold the towel*. This seems countable in some sense: we can say that we did it once, or twice, or twenty times. We can even count instances in an amount of time, as in (178a). In contrast, a verb phrase like *fold laundry* feels much stranger to count and instead we mark volumes/durations (178b).

- (178) a. She folded the towel twenty times {in an hour/# for an hour}.
 (telic: *fold the towel*)
- b. She folded laundry {# in an hour/for an hour}.
 (atelic: *fold laundry*)

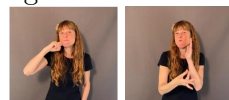
There are many distinctions to make in this domain that we won’t have time to explore in depth here, given the potential complexity of verb phrases crosslinguistically. However, one important distinction raised in sign language research is the distinction between **telic** and **atelic** predicates. The intuition behind telicity is that sometimes we can refer to events in a way that makes reference to their end points, i.e. their telos. For example *I folded the towel* tends to imply one particular event that finished when the towel was completely folded, which is the end point/culmination/goal of that event. In contrast, *I folded laundry* may be talking about the same part of one’s evening, but it is a way of looking at this event which is less marked by boundary points. This is reflected in, among other things, the ability to combine with different categories of temporal modifiers that we saw in (178),

and can be viewed (e.g. Bach 1986) as a the verbal countability distinction in contrast to the mass/count distinction in the nominal domain.

In this chapter, we will discuss work on countability distinctions in nouns in sign languages in the first section (Mass/Count) and countability distinctions in verbs in the second section (Telicity). We will focus both on the kinds of inferences that these distinctions help us understand in languages generally, and on different approaches to analyzing mass/count distinctions and telicity in sign languages.

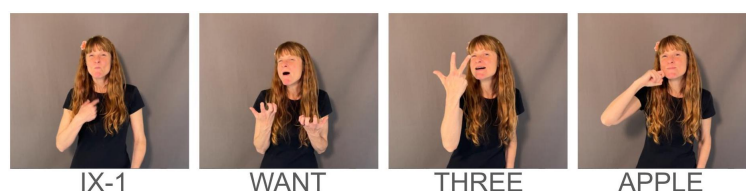
1 The mass/count distinction

When it comes to sign languages, we'll begin our study of countability in the nominal domain. Koulidobrova (2021) considers the question of how American Sign Language patterns in the typology of mass/count languages. She points out that unlike English-type languages or Mandarin-type languages,



bare nouns in American Sign Language (APPLE, OIL) do not require any grammatical number marking or classifier to combine with numerals for a counted interpretation (179a-b), or to combine with quantifiers that seem to count, like MANY or FEW (179c-d).

(179) a.



'I want three apples'

b.



'I want three oils'

(can be piles, containers, puddles of oil)

c.



‘I want many apples’

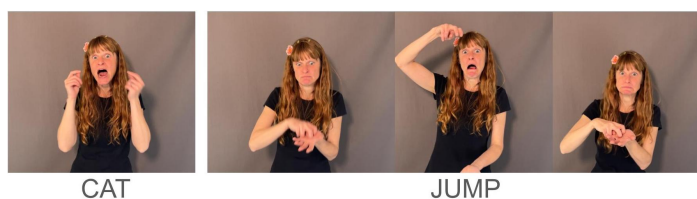
d.



‘I want many amounts of oil’

As expected given the availability of the bare noun in counting contexts (Chierchia, 1998), bare nouns in ASL can also appear in argument position (180).

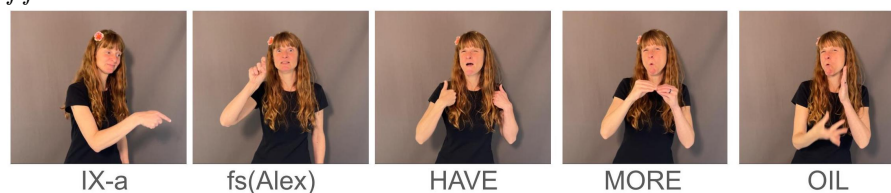
(180)



‘The/a cat jumped’

Finally, in ASL the bare noun forms can also be interpreted as measured either by quantity or volume in a comparison expression (181).

(181) *Context: Mary’s oil bottle contains more oil (by volume) than Alex’s fifteen smaller bottles*



‘Alex has more oil’ (acceptable in this context)

By these diagnostics and others that she lays out (see Koulidobrova 2021 for full set), Koulidobrova concludes that ASL is most like the third category of languages we discussed above, like Nez Perce (Deal, 2017) and Yudja (Lima, 2014). Moreover, she shows that just like in Nez Perce (Deal,

2017), the distinction between two classes (mass vs. count) does emerge in at least one area in the language, when it comes to topicalization, as she provides in the contrast in example (182): the mass noun BLOOD can't be separated from the quantificational expressions THREE and FEW, whereas the count noun APPLE can.

(182) (ASL, Koulidobrova 2021)

- a. *BLOOD, I WANT {THREE/FEW}
'I want three/a few bloods'
(lit. of blood, I want three/a few)
- b. APPLE, I WANT {THREE/FEW}
'I want three/a few apples'
(lit. of apples, I want three/a few)

Another place that the mass/count distinction appears in the grammar according to Koulidobrova (2021) is in conjunction: she reports that whereas count nouns can be conjoined with each other (183a) and mass nouns can be conjoined with each other (183b), mass and count nouns cannot be conjoined together (183c) except if the mass nouns are "countified" via a count quantifier (183d).

(183) (ASL, Koulidobrova 2021)







- a. GIVE-1 BOOK shift PEN
'Give me a book and a pen.'
- b. GIVE-1 MUD shift BLOOD
'Give me some mud and some blood.'
- c. *GIVE-1 BLOOD shift GUN
'Give me [some] blood and a gun.'
- d. GIVE-1 BOOK shift FEW/THREE BLOOD
'Give me a book and a few/three blood.'

A takeaway is, then, that for American Sign Language there is some distinction in how mass and count is treated in the grammar, although it largely patterns with a Yudja or Nez Perce-type language in allowing bare nouns to combine directly with verbs (seeming to directly allow kinds to serve as arguments, like Mandarin according to Chierchia 1998) and also not requiring overt classifiers in count environments like numerals and count quantifiers, although perhaps the work is done through a covert version of this same function.

On its face this summary seems entirely straightforward, but Koulidobrova (2021) rightfully points out two possible counterarguments to this broad generalization. One is that ASL might instead have classifiers like

Mandarin: we already saw in Chapter 5 some discussion of classifiers in sign languages. Another counterpoint could be an argument that ASL does have plural marking. We examine each point in turn, as each have been topics of study in their own right in some sign languages, although we conclude (in agreement with Koulidobrova 2021) that neither of these counterarguments ultimately holds weight, but gaining some better understanding of both classifiers and number marking in sign languages along the way.

2 Classifiers and countability

First, there is a class of expressions sometimes called “classifiers” in sign languages, so understanding their semantic contribution is important to understanding countability more broadly in sign languages. We explored some aspects of the semantic contribution of depictive classifiers in Chapter 5, focusing on the depictive side, but here we focus on the second aspect: what is their role, if any, in countability? As we noted above, one similarity between Mandarin-type classifiers and ASL-type classifiers is the way that they sort: classifier handshapes in sign languages like ASL sort by animacy, size, shape, etc. just like Mandarin-type classifier morphemes. For example, both ASL and Mandarin have a dedicated classifier for flat objects like paper (ASL ) that differs from the classifier for long skinny objects like pencils (ASL ) that differs yet again for the classifier for vehicles (ASL ) . So, there is something deeply right about referring to (aspects of) depictive classifiers and classifiers. Moreover, it’s also true that there may be some traces of quantizing in sign language classifiers: Koulidobrova (2021) points to example (184) from Petronio (1995), which contrasts two classifiers ( vs. ) and results in what is translated as a singular vs. plural meaning difference. We saw the “plural” version of this classifier handshape  in the depiction of students around a library desk, excerpted in (185).

(184)

(Petronio, 1995)

- a. $a-\overline{\text{STORE}}^t$, MAN CL:/1/-GO-a
‘The man went to a store.’
- b. $a-\overline{\text{STORE}}^t$, MAN CL:/44/-GO-a
‘The men went to a store.’

(185)



DS_4(students in line, at a)

Similarities notwithstanding, we might note that even here, classifying handshapes of depicting signs are quite unlike classifiers even in languages like Mandarin, which do not encode number themselves but rather turn the noun into something which can be counted. For example, the difference between one and two cats is not reflected in form of the classifier in Mandarin (the classifier remains the same no matter how many cats there are) but rather in the form of the numeral; this contrasts with the ASL example, which seems to be expressing the difference between one and more than one individual going to the store on the classifier handshape. If we tried to analogize the two, we could force the similarity by saying that the ASL handshape was portioning the human-kind into portions made of one individual (in the 1/👉 classifier) versus into portions of multiple individuals (in the 44/👋 classifier), but it's a stretch, and further evidence suggests differences, not similarities.

As a second example of the differences between Mandarin-type classifiers and sign language classifiers, Pfau and Steinbach (2006) and Koulidobrova (2021) both note that for numeral classifier languages the classifier and the numeral have to appear adjacent to each other (Greenberg, 1972), in contrast to sign languages where this seems to not be required: the numeral (e.g. THREE) can be separated from the combination of noun (CAR) and depicting classifier in both ASL (186a) and DGS (186b).

(186) a.



‘Three yellow cars are standing like this’

b.

(DGS, Pfau and Steinbach 2006)

THREE CAR CL_{vehicle}(rep)

Three cars are standing next to each other.

The separation of the numeral from the classifier in (186) and the quantity being expressed on the classifier and not via a numeral/quantifier in (184) both lead to the conclusion that the classifier handshapes in ASL are

not performing the same function we see in Mandarin. We might contrast them in the following way: Mandarin classifiers can be seen as an overt realization of the process of taking the “kind” of a noun (the shoe kind, the cat kind, the oil kind, etc.) and turning it into countable units so that we can talk about, e.g. two pairs of shoes, two individuals of cats, two bottles of oil, etc. As we saw, Mandarin seems to require this classifier to be overt when numerals are present. ASL, however, patterns instead with languages like Nez Perce in having numerals which can combine directly with the noun (187a), where the process of turning the cat kind into something countable is done implicitly, without need for overt classifier morphemes to overtly instantiate this function. There is no evidence for a role of depicting classifiers in the process of making countable units from kinds in ASL.

Classifiers in ASL, instead, seem to be part of a system that deals with events in the verbal domain: note that the addition of a classifier even turns a nominal phrase (187a) into a full clause, as in (187b).

(187) Context: Someone asks what just happened.

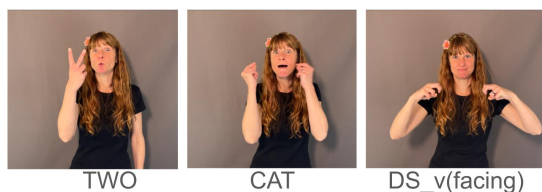
a.



‘two cats’

(Unacceptable response; it is a well-formed expression but not an acceptable answer in this context since it’s not a full clause)

b.



‘Two cats were like this (in location a and b)’
(Acceptable response)

Zwitserlood (2012) lays out additional arguments that sign language classifiers seem most similar to verbal classifiers/noun classes found, for example, in many languages of North America such as Navajo. In terms of their semantics, then, we probably want to think about them functioning more like agreement/inflectional systems and not nominal classifiers for quantizing/apportioning. Theoretical analyses by Benedicto and Brentari (2004) and Abner (2017), among others, take this same view and are consistent with the semantic story we provided in Chapter 5 using event semantics.

That is not to say that classifiers cannot be used within a nominal structure, but rather that they do not play the quantizing role that Mandarin classifiers do, and instead even in nominal instances are derived from a verbal form at some level (Abner, 2017).

3 Grammatical number

We've seen how despite having depicting classifiers, ASL differs significantly from languages like Mandarin in how it uses (or, in the case of ASL, doesn't use) classifiers to apportion quantities for counting, e.g. number noun phrases. We have not yet in depth explored the other possibility, though: that it actually uses grammatical number in a similar way to English-type languages. On the face of it, there is a straightforward case for separating ASL from number marking languages, as ASL clearly permits bare nouns in argument position (188a) and does not have any plural marking on the noun in a numeral noun phrase (188b): note that the form of the noun is



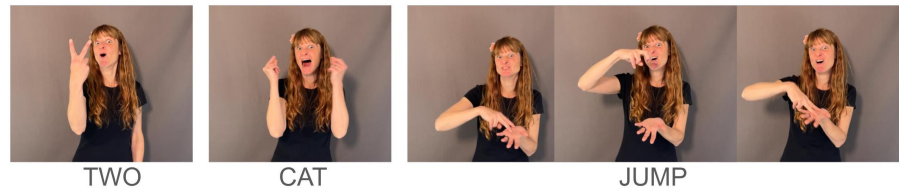
the same in both sentences (CAT). If anything, there can be an (optional) marking on the verb, seen in the two options in (188b) and (188c).

(188) a.



'The/a cat jumped'

b.



'Two cats jumped.'

c.



'Two cats jumped.'

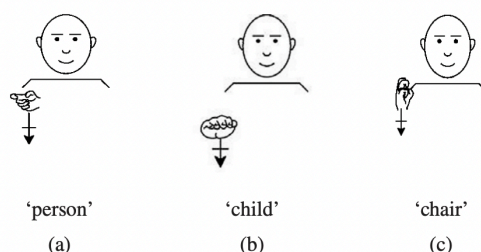


Figure 7.1: Lateral plural marking in DGS (Pfau and Steinbach, 2006)

However, it has been argued that some languages that initially appear to have bare nouns in argument position (of the Mandarin variety), actually appear more like English under a microscope, in the sense that their noun phrases seem to be marked for grammatical number in other ways. Deal (2017) shows that Nez Perce does precisely this through number marking on adjectives, although this distinction is only visible precisely in noun phrases that include these adjectives. Could ASL be a language with some kind of covert number marking on simply noun phrases that shows evidence of a grammatical number system in other ways?

A particularly detailed discussion of this hypothesis can be found in Pfau and Steinbach (2006), who argue in favor of such a view for German sign language (DGS). As they point out, grammatical number can sometimes appear to be unmarked, as in some lexical items in English like *sheep* which clearly has a grammatical number distinction as reflected on the verbal morphology, despite the same form (*sheep*) being used for the singular and plural noun (189).

- (189) a. The sheep are sleeping.
 b. The sheep is sleeping.

Pfau and Steinbach (2006) propose that this “zero-marking” of plural is basically what is happening in DGS, except with a much wider array of nouns. As evidence, they argue that there are some nouns that do mark plural, in a couple of different ways. An example is the lateral movement used to plural one set of nouns that includes PERSON, CHILD and CHAIR, illustrated in Fig 7.1. Roughly, they propose that there are many possible forms of the plural marking, with the idea that there are several different forms that depend on the shape and meaning of each noun, each of which can mark plural (or, it can be marked with no change in form); for details for DGS, see Pfau and Steinbach (2006) as well as Herbert (2018). It’s clear that these tell us something about quantities, but are they really marking grammatical number of the sort we see in English plural?

For ASL in particular, early work by Petronio (1995) made clear that number is only conveyed, at least in ASL, outside of the noun phrase, in the verbal domain or contextually inferred. Arguments from ellided noun phrases in Koulidobrova (2021) argue in favor of this as well. Curiously, Pfau and Steinbach (2006) also note that number seems to be not marked internal to the noun phrase, so in a sense there is agreement about this in signed languages: number marking in sign languages is syntactically unlike grammatical number of the more common sort in that it is not part of the noun phrase. In another sense, this raises deep questions because it is then not clear what exactly is meant by plural marking that occurs outside of an NP, as something outside of the noun phrase would be handled in a different way by current syntax/semantics theories of number, which take number to originate within the nominal domain.

For the purposes of the current text and our focus on semantics, we will highlight one important argument that seems to clearly show that ASL does not have number marking in any sense recognized as such in spoken language semantics, based on its negation. Consider the sentence *Alex doesn't have any sheep/children/cats*, which is false even if he just has one (sheep/child/cat): it doesn't negate the plurality, but rather the plurality here seems to be the unmarked form, used here to express the complete lack (Sauerland, 2003). Similarly, the dialogue in (190) uses the plural form and it is clear it should be understood as any number, including one. This contrasts with the ASL version of the same demonstrated in (191) and in (192) from Koulidobrova (2021).

- (190) a. Does Alex have any sheep/children/cats?
 b. Yes, he has one.
 c. # No, he (only) has one.

- (191) a.



‘Hey, do you have three basketballs [like this]?’

- b.



‘No, only one [like this].’

(192)

(ASL, Koulidobrova 2021)

- y/n*
- a. $\frac{\text{HAVE TREE(Rep)}/\text{BALL(Rep)}/\text{CHILD(Rep)}}{\text{HERE?}}$
 ‘Do you have trees/balls/children?’
- b. # YES, HAVE ONE PINE/BASKETBALL/DAUGHTER
 ‘Yes, we have one pine/basketball/daughter’
- c. NO, ONLY ONE PINE/BASKETBALL/DAUGHTER
 ‘No, only one pine/basketball/daughter’

This suggests a different meaning for the quantity morpheme expressed in ASL via movement over space and the plural in English. We can easily imagine some possibilities for the right analogy to ASL: consider an existential/indefinite expression like the English *a plurality* in (193). Here we find a similar patterning to the ASL repetition, not the English grammatical number marking. The point isn’t that the repetition is exactly the same as the indefinite expression in English, only that we can come up with expressions that require existence and plurality, as in *a plurality of* that nevertheless does not make the same semantic contribution as number features in English.

- (193) a. Does Alex have a plurality of sheep/children/cats?
 b. # Yes, he has one.
 c. No, he (only) has one.

Finally, number has been connected via this existential type use to the expression of explicitly **spatial** information. Pfau and Steinbach (2006) discuss how the use of classifiers seems to require the expression of a spatial localization in a way that the lateral movement does not. Schlenker and Lamberton (2019) focus on the spatial information in these kinds of repetitions of the sort we saw in the basketball example in (191) as well as the related example in (194).

(194)



‘There was a basketball like this, this, and this.’

Schlenker and Lamberton (2019) provide a semantics for these kinds of quantity expressions in American Sign Language that focuses on its depictive use in showing the arrangement of several objects and their spatial arrangement. They explicitly resist an indefinite/existential analysis of spatial repetition based on examples where the numeral is not an exact match to the number of depicted points, in particular, where the numeral is greater, such as (195).

(195)

(ASL, Schlenker and Lamberton 2019)

10 [TROPHY TROPHY TROPHY]horizontal-arc.

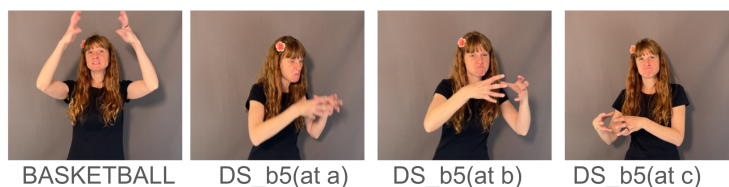
‘The museum has 10 trophies (spread out).’

In their own words: “The heart of the matter is that an expression such as 10 [TROPHY TROPHY TROPHY]horizontal-arc is acceptable (and makes reference to ten trophies), which makes little sense if we are dealing with a conjunction of three singular indefinites.” They are right that the numeral (e.g. 10) and the number of repetitions do not have to match, so in that sense the plurality is not actually coordinating separately noun phrases that each have existential meaning. In other words, we would not want this to be equivalent to *There is a trophy (here) and there is a trophy (here) and there is a trophy (here)*. But, as we have seen, these expressions seem to be existential nonetheless, something similar perhaps to the English expression *a plurality* with a given arrangement, although they cannot simply be grammatical plural (in the sense of english *-s*) due to their interaction with negation, as we saw above. In addition, Schlenker and Lamberton (2019) rightfully point out that the way that space is used to show arrangements that need not correspond exactly numerically is seen in many gestural systems, including homesign (Spaepen et al., 2011) and gesturers that they elicit from non-signers (Schlenker and Lamberton, 2019). Ideally, then, we can incorporate depiction into the semantics of these expressions while also getting the quantificational aspect right.

Let’s consider in particular the example in (196), with BASKETBALL followed by a depictive classifier (DS: Depicting Sign) indicating the arrangement of the balls, DS_b5(three in a row). This is acceptable in the situation in which there are three basketballs on a table, and unacceptable to describe a situation in which there are three buttons or soccer balls on the table, or in a situation in which there are (only) two basketballs on the table (196).

There also seems to be the interpretation that has come up in discussion of plurality marking in ASL and DGS in which the movements are less punctuated, in which case the sentence is acceptable if there are more than three basketballs as long as they are arranged in the shape shown (196d).

(196)



‘There are three basketballs (like this).’

Acceptability across contexts:

- a. Three basketballs are arranged on a table (acceptable)
- b. Three buttons sit on a table (unacceptable)
- c. Two basketballs sit on a table (unacceptable)
- d. Nine basketballs sit on a table in a triangle arrangement (acceptable, a long as movements are less punctuated)


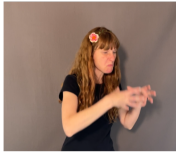


The first three judgments can be accounted for through the same classifier semantics we used in Chapter 5, along the lines of (197).

(197)

$$\begin{aligned}
 & \ll \text{BASKETBALL} \quad \text{DS_b5(at a)} \quad \text{DS_b5(at b)} \quad \text{DS_b5(at c)} \gg \\
 & = \lambda w \exists e \exists x, y, z : \text{bulky_item}(x, y, z) \cdot [\text{theme}(e, (x, y, z)) \wedge R(a, x) \\
 & \quad \wedge R(b, y) \wedge R(c, z) \wedge \text{demonstration}(e, \text{[three frames of the gesture]}) \text{in } w] \\
 & \text{‘The proposition true in worlds in which there is an event that has} \\
 & \text{three individuals who comprise the theme of the event and the event} \\
 & \text{is demonstrated by [three frames of the gesture], these individuals have relations} \\
 & \text{to the areas of space } a, b \text{ and } c, \text{ and it fails to hold if the themes aren’t} \\
 & \text{bulky items.’}
 \end{aligned}$$




On the other hand, to capture the last (plurality-like) judgement, we’re going to want to ensure that there is a plurality with at least three (but perhaps more) atomic subparts, all of which have to be basketballs, as in


(198). Here the same triangle arrangement can be used to demonstrate an event with more than three parts, as is known to be a depicting strategy used by homesigners (Spaepen et al., 2011) and non-signing gesturers (Schlenker and Lamberton, 2022).









(198) \llbracket BASKETBALL DS_b5(at a) DS_b5(at b) DS_b5(at c) \rrbracket

$$= \lambda w \exists e \exists x_1, x, y, z : bulky_item(x, y, z). [theme(e, x_1) \wedge (x \neq y \neq z) \wedge basketball(x, y, z) \wedge x, y, z \leq x_1$$

$\wedge demonstration(e,$  $)$ in w

‘The proposition which returns TRUE for worlds in which there is an event that has a theme, and that theme argument has at least three individual sub-parts, all of which are basketballs, and the event is demonstrated by   , it fails to hold if they are aren’t bulky items.’

More broadly, the observation in this section has been that ASL (and, it seems DGS as well) does not have grammatical number marking/plural in the English/German way in terms of its syntax and its semantics. It does clearly, however, express the concept of plurality through conventionalized morphemes and the depicting classifier system, although the classifier system itself is tied closely to the verbal system, not to the nominal system. What can we say more generally about countability in the verbal domain? We turn to this topic in the next section.

4 Telicity and aspect

There is generally consensus that grammatical categories like nouns and verbs exist as distinct categories in sign languages (Abner et al. 2019). So far in our focus on countability we have focused on nouns: whether sign languages seem to make a distinction between mass and count nouns (indeed, they seem to be differently sensitive to ellipsis and topicalization) and how they fit into the typology of languages in terms of classifiers or number marking (grammatical number marking does not seem to be widespread, at least in ASL, and there are no overt nominal classifiers of the Mandarin type). In this section we will shift our focus to verbs, and a productive line of research that has investigated the role that the form of a verb in sign

languages has on its meaning, following similar questions: do sign languages seem to differentiate different semantic/conceptual categories? And how do sign languages fit into a typology of languages more generally with regard to relating forms to these categories?

Linguists working on the structure of sign languages have long noticed that there are some verbs in sign languages that can take many forms involving repetition, and that these forms seem to correspond to just as many different meanings. For example, Klima and Bellugi (1979) discuss at some



length how for one verb LOOK, the same handshape and roughly the same location can be combined with many different internal movements, each of which seems to convey aspectual-like information. (Hou 2022 provides a more modern analysis of the broad flexibility of this same sign.) Names given to these different categories of meaning include “protractive, incessant, durational, habitual, continuative,” and “iterative”. Klima and Bellugi (1979) find similarly complex categories, with sometimes even more distinctions, for other predicates, e.g. (be)SICK. These kinds of categories are all meanings that are morphemic in some spoken languages as well, although more rarely are they morphemic all in the same language. Moreover, the timing/rate of repetitions and holds often seems transparent to non-signers, in the sense that they seem to be able to guess some (but certainly not all) of the meanings of this verbal inflection without much experience with ASL. This naturally raises the question about the nature of this change in meaning: are the different movements morphemic or depictively iconic? Or, is this a case of a motivated form which is interpreted as symbolic? For ex-



READ



READ

ample, could the difference between READ and READ be closer to the change in form of verbs from English, such as *run* → *ran*. Should we think about this difference in meaning as description or depiction, as morphology or iconicity, or both?

Even if we’re focused entirely on a symbolic analysis, we will want to understand the different contributing roles of aspectual marking that is contributing by additional morphemes, and the inherent semantic properties of a predicate. This is in many ways similar to the mass/count distinction in which different nouns may on their own contribute mass or count meanings, and yet these can be adjusted by additional morphology, e.g. *water* is mass but *bottle of water* is countable. Moreover, the categories of telic predicates vs. extra morphemes expressing other categories like aspect often track together, so are more difficult to disentangle. For example, in English it is most common to use an imperfective aspect for atelic predicates, as in (199a) and perfective aspect with telic predicates as in (199b), although we

can also dissociate the two, as in (199c-d).

- (199) a. Alex was playing in the laundry. (imperfective aspect, atelic predicate)
 b. Alex has folded a towel. (perfective aspect, telic predicate)
 c. Alex has played in the laundry. (perfective aspect, atelic predicate)
 d. Alex was folding a towel. (imperfective aspect, telic predicate)

Conceptually, we can think about grammatical aspect (perfective/imperfective) marking the perspective we take on the event that we are reporting: imperfective aspect puts us in some sense inside the event (during the playing or folding of the laundry), while perfective talks about this event from some distance. In contrast telicity, a kind of countability, tells us whether the event is bounded: telic predicates like *fold a towel* come with natural boundaries that allow us to count them, similar to count nouns like *cat*; atelic predicates like *play in the laundry* are more similar to nouns like *water* in not being naturally bounded or countable (see Bach 1986 for more on the analogy between the notions of telicity and mass/count). Also similar to countability in the nominal domain with mass/count, there is reasonable debate to be had about how much of the telic/atelic distinction comes from the inherent lexical meanings or is built on them compositionality, and evidence that both play a role. Note for example that both the verb and its arguments play a role in the telicity of a predicate: in English, *eat applesauce* seems to be atelic but *eat an apple* is telic, so it does not seem that we want to say that the meaning of the verb *eat* determines telicity on its own, but rather the combination of verb and its arguments. Similarly, *play in the laundry* seems to be atelic but *play a game of Monopoly* seems to be telic, bounded by the end of the game. We keep this in mind as we turn in the next section to theories about telicity in sign languages.

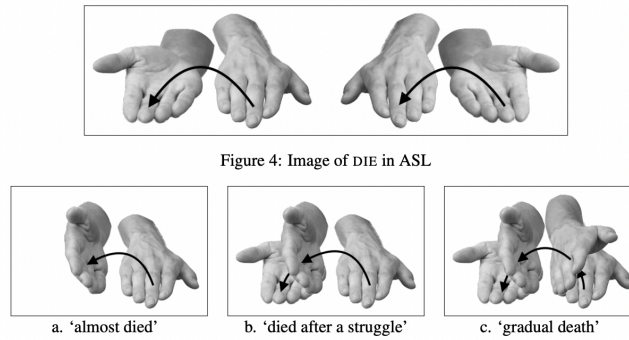
5 Event visibility

Telicity has become an increasingly well studied topic in sign language research in recent years due to an extremely interesting proposal by Wilbur (2008) that the boundedness in the meaning of verb phrases is mirrored in the structure of verb phrases in sign languages, and that this is done in an iconic way (see also Malaia and Wilbur 2012). This *Event Visibility Hypothesis* (EVH) begins with the observation that verbs expressing bounded events, like STEAL, tend to be expressed with a form that is bounded as well. This contrasts with verbs that express unbounded events, like PLAY, which do not end in an abrupt stop in the same way.

As proposed in Malaia and Wilbur (2012) and Wilbur (2008), the theoretical claim of the EVH is that the boundary point in the form of signs like STEAL is an overt manifestation of the resultative morpheme proposed in Ramchand (2008). As a consequence of this “visibility” of the resultative morpheme, verb forms with an overt boundary point necessarily express telic predicates, while those without typically express atelic predicates. That is to say: the idea that telic predicates contain a piece of meaning that specifically encodes telicity has been proposed independently of the sign language data (Ramchand 2008), but Malaia and Wilbur (2012) and Wilbur (2008) draw a fascinating parallel to sign languages when they suggest that sign language encode this boundary morpheme overtly, by the existence of an abrupt stop.

The EVH captures a strong intuition, which is that often something in the verbal form in sign languages feels natural given their meaning, and moreover, that it crops up regularly in unrelated sign languages of the world. It would seem quite wrong to reverse the signs for PLAY and STEAL even though neither is especially iconic or transparent in its meaning. Strickland et al. (2015) confirm this intuition experimentally, showing that non-signers categorize signs with overt boundary points as expressing telic meanings more often than those without boundary points. Given this intuition, a kind of semantic analysis that posits a universal due to iconicity available in the visual modality might be well motivated. On the other hand, the morphological claim is quite surprising from the crosslinguistic perspective: no spoken languages seem to encode telicity directly in their morphology. In a skeptical view of the overtness of telicity in sign languages, Davidson et al. (2019) note that telicity is like mass/count in many ways (Bach, 1986), one of which is that it is usually seen as an emergent property depending on lexical semantics and semantic properties of its arguments; while many things interact differently with mass and count nouns, no overt morphology marks that distinction as such directly on the nouns themselves in the way that the EVH proposes for telicity in sign languages. Building on Wilbur’s work, different theoretical takes have been proposed to cover the intuition behind the EVH. For example, Kuhn (2017b) speculates on an especially iconic implementation of the EVH, proposing that signs might encode not just the presence or absence of the boundary point, but that the completion of the event is mirrored in the form of the sign, mapping the production of the sign directly onto the event structure. He gives the example of the type in (200), where producing the sign DIE in a way that ends before the citation endpoint is interpreted as ‘almost die’, and where internal modulations of the timing of the sign are interpreted as reflecting the timing of the event, e.g. ‘after a struggle’ or ‘gradual’.

(200)





Different iconic modulations of the verb DIE from Kuhn (2017b)

Under this view, the EVH is both stronger and yet even simpler than proposed by Wilbur (2008); it simply restricts though a manner adverbial that the event progressed in the manner shown, imposed by an iconic function (**Icon_φ**). Note that this builds the depiction into the propositional meaning.

Another way to think about the relationship between iconicity and the grammar is to map even (perhaps, especially) the form of verbs that encode atelic predicates to small portions of an event taking place, as suggested by Wright (2014). Wright notes that the sign for SEW in ASL is frequently atelic and lacks a boundary point, having a repetitive movement without a boundary, in line with the EVH, but that the internal movements of the sign SEW in ASL can be thought of as corresponding to individual stitches, and so iconicity comes into play in the semantics through the repetition and not the boundary. One could think about PLAY like this as well, with each small internal repetition mapping to some interval of playing. The fact that telic predicates are frequently expressed with verbs that have an abrupt boundary point is in this sense epiphenomenal, in that they do not continue indefinitely.

The original formulation of the EVH (Wilbur, 2008; Malaia and Wilbur, 2012) as well as other takes by Kuhn (2017b) and Wright (2014) take an iconic mapping between the telicity of the predicates and their (bounded or unbounded) verb forms to be a given. As noted above, a source of empirical support for this is often taken to be the fact that people who do not have any previous experience with a sign language guess at above change levels at whether a verb has a (typically) telic or atelic interpretation, as shown in experimental work by Strickland et al. (2015). However, Davidson et al. (2019) discuss several reasons to be skeptical of a strong version of the EVH. On the one hand, they highlight the existence of alternating predicates in ASL like READ, WRITE, DRIVE, and SKI, which take one bounded form

in telic predicates (e.g. ) and another unbounded form in

atelic predicates (e.g. ) , providing evidence in favor of the EVH. On the other hand, they also provide several counterexamples to the correspondance in both directions from verbs that don't change forms. There are atelic predicates which have a clear boundary point, and while many of these exceptions are statives like KNOW, some are eventives like DRINK (coffee)). There are also several telic predicates which do not have a clear boundary point, such as PAINT (a picture). So, clearly, there is a nontrivial linking between these forms and meanings in the direction of the EVH, but it is also straightforward to find counterexamples to the claim that telicity is encoded directly as necessarily expressing endstate via a bounded verbal form.

We can also view the behavior of nonsigners in Strickland et al. (2015) through the lens of depiction vs. description. Their results report some above chance level of use of verb form used by nonsigners to decide between meanings in a way that corresponds to something like telicity. However, this may well be a “last resort” kind of mechanism used if there are no other cues at all; there may be some transparency in these forms that we can call iconic, and in fact this is supported by further experimental results showing that the same analogy (for abrupt stopping in verb forms for event boundaries) is found in spoken language (Kuhn et al., 2021). However, that doesn't mean this iconicity is interpreted in way that bears on propositional meaning: iconic motivations for conventionalized forms need not be taken to affect interpretation. The form of the verb VOTE in ASL is clearly iconically motivated by how one stuffs a physical ballot box, but it can be used to describe all kinds of voting that is electronic, etc. (see Hodge and Ferrara 2022 and Ferrara and Hodge 2018 for detailed discussion of these kinds of iconicity). Similarly, the English onomatopoeia *knock* ends in a stop consonant and supports iconic depiction, even though its denotation is symbolic, i.e. it simply restricts us to certain knocking events. Thus, instead of sign languages making the event structure “visible” in the form in a way that should be reflected in the semantics, sign languages may be simply using motivated forms to express meanings in the same way that all languages are known to take advantage of when possible. In addition, these forms may additionally support depictive meanings just like *knock*; perhaps the iconicity discussed in, e.g. (almost) DIE by Kuhn (2017b) is emblematic of this use of descriptive iconicity to support depiction.

6 Pluractionality

Finally, recall that we discussed grammatical number (e.g. singular/plural marking) in the nominal domain. Many languages also mark number in the verbal domain, through **pluractionality**. Kuhn and Aristodemo (2017) describe and analyze two ways that French SL (LSF) marks pluralities of events, through two different forms of repetition. One distributes over time (they call this *rep*, since the form of the verb is repeated); another distributes over participants (they call this *alt*, since the form of the verb involves alternating). One is exemplified in (201a): repeating the verb FORGET with the same hand is interpreted as a particular type of event, involving the same participants (in this case, Jean as the agent and a particular word as the theme), occurring multiple times; note that it contrasts with the phrase EVERY-DAY which permits the words to vary from occasion to occasion.

(201) (LSF, Kuhn and Aristodemo 2017)

- a. JEAN ONE WORD FORGET-*rep*
‘Jean forgot one word repeatedly’
(can’t be different words)
- b. EVERY-DAY JEAN ONE WORD FORGET
‘Every day Jean forgot one word.’
(can be many words, or one word)

The other pluractionality marker in LSF is exemplified in (202a), where the form of the verb involves alternating between the dominant and non-dominant hands; with it comes a change in interpretation which requires variation between the participants only. In this case, it is variation between the students but specifically not variation in the words; note this contrasts with the distributive marker EACH which permits variation both for the students and the words.

(202) (LSF, Kuhn and Aristodemo 2017)

- a. STUDENT IX-arc FORGOT-*alt* ONE WORD.
‘The students forgot (the same) one word.’
(can’t be different words)
- b. STUDENT EACH FORGOT ONE WORD
‘Each student forgot one word’
(can be many words or one word)

The proposed semantics by Kuhn and Aristodemo (2017) captures this contrast, following an analysis of two pluractionality expressions in Kaqchikel by Henderson (2014), with the idea that pluractionality is marked in a dependency between a distributivity operator (like EACH (over participants) or

EVERY-DAY (over times)) which interact with filters like *-rep* or *-alt*. Under this approach there is significant similarity with grammatical number marking, which is also a filter in some sense: when we have plural marking on a noun, this is frequently modeled as a function that takes some set of individuals and returns only those which have more than one individual as some part of them. Similarly, Kuhn and Aristodemo (2017) propose semantics for pluractional markers in LIS which takes some set of events and returns those which have more than one sub event as part of them. This was the function of the restriction $\neg atomic$ in the word on quantification in Chapter 6. In the case of *-alt* these have to be events (that are part of the larger event) with different participants ($\theta(e') \neq \theta(e'')$); in the case of *-rep* these have to be events (that are part of the larger event) with different run times ($\tau(e') \neq \tau(e'')$) (203)a-b).

- (203) (Kuhn and Aristodemo, 2017)
- a. $[[\text{-alt}]] = \lambda V \lambda e [V(e) \wedge \exists e', e'' \preceq e [\theta(e') \neq \theta(e'')]]$
 - b. $[[\text{-rep}]] = \lambda V \lambda e [V(e) \wedge \exists e', e'' \preceq e [\tau(e') \neq \tau(e'')]]$

In the case of LSF *-alt*, they analyze it as a function that takes verb types (e.g. FORGET) and returns events of that kind (e.g. the forgetting events) such that they have two different sub events each with a different event participant. In contrast, the LSF morpheme *-rep* is a function that takes verb types (e.g. FORGET) and returns events of that kind (e.g. the forgetting events) such that they have two different sub events each with a different run time.

We end by noting that pluractionality intersects with the other area of countability in the verbal domain we have discussed in this chapter: telicity. Even if a basic verb plus its arguments would typically be telic, the addition of pluractionality can cause a predicate to pass a test for telicity. Consider, for example, the English sentence *My friend gave me one book*. This doesn't pass the "for an hour" test for telicity: you can't say that *My friend gave me one book for a year*. However, if we add repetition, it's fine to say *For a year, my friend repeatedly gave me one book* or *For a year, my friend often forgot one word*. One question then becomes whether we can account for some of the observations made about iconicity and telicity through understanding pluractionality. Most likely, these analyses are right in different ways, for example, that sign languages have conventionalized ways to express different kinds of pluractionality (Kuhn and Aristodemo, 2017), and an endstate/telos seems to be reflected in the bounded forms for many verbs like ASL STEAL, DIE, and FORGET, and that on top of both of these descriptively iconic conventionalizations, they can also support (iconic) depictions, such as the depiction of the progression toward death explored by Kuhn (2017b) or some of the alternations in manner as in LOOK-AT noted by Klima and Bellugi

(1979) and in (bounded vs. ongoing) alternating verbs like READ (Davidson et al., 2019).

To imagine how this might work, let's consider a verbal case involving



the ASL verb ^{READ}, which is an alternator: it regularly expresses telic predicates and in those cases tends to use one single motion seen in (204), and also regularly expresses atelic predicates, and in those cases uses many small internal movements, seen in (205).

(204)



‘The girl has read (it).’

Acceptability across contexts:

- a. We are discussing a famous book, and a girl we both know. The girl recently finished reading the book. (acceptable)
- b. We are discussing a famous book, and a girl we both know. The girl is currently reading the book, but hasn't finished. (unacceptable)

(205)



‘The girl has read (it).’

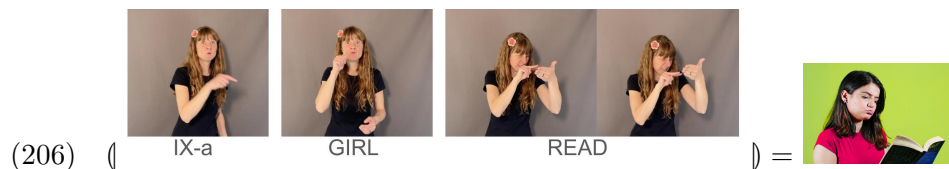
Acceptability across contexts:

- a. We are discussing a famous book, and a girl we both know. The girl recently finished reading the book. (marginal)
- b. We are discussing a famous book, and a girl we both know. The girl is currently reading the book, but hasn't finished. (acceptable)

In the case of the verb that has an end point form, the end point is naturally taken as a point at which one finishes the reading goal, as in the book, in the situation in (204a). Note that the sentence with the bounded

form is not acceptable in the situation where the girl hasn't finished reading the salient book (204b). In contrast, in (205), we see that a form with small internal movements (i.e. without the endstate form) is less acceptable in a context in which the girl finished the book, but acceptable if she is still reading it and hasn't finished.

We'll naturally want to reflect these semantic differences in our semantic analysis, but as things stand, many possibilities remain open for how exactly we might want to do this. One way to model the distinction we see in (204)-(205) is roughly via the EVH, as proposed by Wilbur (2008), in which the endstate form in (204a) reflects the presence of the telos in the semantics. This would correctly account for the judgments in (204), and we can imagine why it would also account for the preference in (205), given pragmatic competition between the two forms. But this isn't the only way to model the pattern seen in (204)-(205): telicity and aspect are collapsed in these cases, so we could also model this particular distinction by taking the endstate form to express perfective aspect (e.g. *has read (the book)*) and/or the small internal movements as a type of progressive form (e.g. *is reading (the book)*). Of course, the ideal goal is to dissociate telicity from aspect in ASL and other sign languages, as we did for English above in (199), but this proves to be complicated for both logistical and form-based reasons, detailed in (Davidson et al., 2019). Certainly, one thing we don't want to do is to encode the difference in the verb itself, since we find the same basic verb form in both sentences (contra Strickland et al. (2015)'s implication that telicity is a property of verbs and not verbs with their arguments). Yet another possibility is to consider the depictive potential of these verb phrases, and consider that some distinctions may be being convey via depiction and not description. We began this chapter with the observation that much of the countability expressed in sign languages seems to be more transparent to nonsigners than other iconic areas of sign language grammar, which would point toward depiction (although, is not an argument for it; we can have symbols with more or less transparent meanings). But consider the kind of event conveyed in (206) where the subject is shown as taking part in effortful reading; we might simply consider this a simultaneous depiction without propositional consequences.



Most likely, there are aspects of truth to each of these observations. Imagine, for example, that we take pluractionality to be expressed through dedicated morphemes along the lines of Kuhn and Aristodemo (2017), and the use of a bounded form to correspond to telic events, along the lines

of Wilbur (2008) and Malaia and Wilbur (2012). In addition, although all of these notions are technically dissociable, reduplication is known to be a form recruited for progressive markings crosslinguistically, while telicity frequently tracks with perfective aspect. Therefore, we might be encountering not just challenges from the perspective of an analysis, but also challenges from the dynamicity of language: a state of flux could make these difficult to disentangle, but in entirely expected ways given our understanding of (spoken) languages and language change/typology more broadly, as noted specifically in this domain of aspect marking by Deo (2015b).

In addition, when it comes to iconicity, conventionalized symbolic morphemes may nevertheless have some amount of iconicity, which can itself support further depictive iconicity. This is exemplified in English in the case of using onomatopoeia (e.g. *knock*, an entirely conventionalized symbol, representable in text, that nonetheless makes for compelling depictions). Evidence for this might be the concentration on the signer's face and the intense hand movements in the utterance in (206), an example of morphemic distinction that also naturally supports further depiction. The symbolic and the depictive seem to especially rely on each other in the verbal domain (we saw this in work on demonstrations in Chapter 5), even in ways that might differ between signers and nonsigners: experiments on nonsigners may be picking up on an underlying tendency in depiction, which might be used to bias certain symbols to meanings (e.g. verb forms) but which are not themselves directly interpreted *as* a visible manifestation of a symbolic endstate morpheme.

7 Conclusions

We perceive the world as comprised of different types of things, such as events, objects, and substances. We also use language to talk about the world in ways that reflects these different categories, but via mappings that are not determined by them: the same event out in the world can be described as *folding laundry* (atelic) or *folding a towel* (telic); the same puddle can be described as *water* (mass) or *a puddle of water* (count). Sign languages have been investigated in both the nominal and verbal domain when it comes to countability, with special attention played to the role of iconicity in the expression of countability. This section emphasized in particular the value in considering the separation of iconically motivated morphemes from further, additional iconic depictions that they might very naturally support. In particular, while some previous work in these domains has assumed because there is some iconicity that it must be reflected directly in the semantics (as in, e.g. the Event Visibility Hypothesis), we argued that this need not be true either in the nominal or verbal domain, but rather came to the conclusion that descriptive iconicity exists in both domains,

as an organizing principle of a system of form-meaning mappings that can simply support depictive iconicity, in the same way we see forms used for depiction in spoken languages (Clark, 2016; Dingemanse, 2015).

8

Intensionality

Human languages, across all modalities, are notable not just for their compositionality and creativity, but also for their ability to go beyond the “here and now”: we can discuss not just the present place and time, but also the past, the future, and even alternative possibilities, how things might have been, how we hope they might be, what we think, and what we believe must be true. What is particularly remarkable about this ability in human language is that we can discuss these possibilities with precision and make inferences about them, including entailments, presuppositions, and implicatures, just like we do when we share information to help narrow down the particular world we might currently be in. Consider, for example, the relationship between (207a) and (207b): in every situation in which there has to be a rainbow (207a) is true, and because it is also true that there can be a rainbow, (207b) is true, so the first entails the second.

- (207) a. *There must be a rainbow.*

Entails:

- b. *There might be a rainbow.*

We find a similar pattern when we use attitude verbs: (208a) entails (208b). Both have a bit of the feeling we found with quantification, where we have to ignore the pragmatically strengthened reading of the second/entailed/(b) sentence (209); the point is that we can clearly derive inferences that go beyond what is directly said, and so we want to understand the logic underlying these sentences using words like *must*, *might*, *know*, *think*, etc.

- (208) a. *The girl knows that is a rainbow.*

Entails:

- b. *The girl thinks that is a rainbow.*

- (209) a. *I see all of the rainbows.*

Entails:

- b. *I see some of the rainbows.*

Words like *must*, *might*, *know* and *think* (but not *some* or *all*) are part of a broader class of expressions known as **intensional operators** which induce us to consider possibilities/possible worlds other than the current one. Consider that to evaluate the non-intensional sentences in (209) we need only consider the here and now: do I see all/some of the relevant rainbows? But to evaluate the sentences in (207) or (208) we need to consider other possibilities. For (207a) it seems that we need to somehow consider every (relevant) possibility and check that there is a rainbow in every one. In (207b) we need to make sure that there is a rainbow in at least one possibility that we are considering: *There might be a rainbow* means roughly that in some possibility that we'll consider valid, there is a rainbow. We can reason similarly about attitude predicates, of the sort we saw in (208): if *The girl knows that is a rainbow*, then somehow in every possibility that the girl can access through her knowledge, it's a rainbow. The idea is that in *The girl thinks that is a rainbow*, then in some possibilities that are part of her knowledge, then it is a rainbow, but perhaps in some of them it is not; it seems strictly weaker than *know*.

This same intensionality is active in conditional statements like (210): roughly, we can think of its meaning as expressing the claim that in all of the possibilities in which the girl sees a rainbow, then in those possibilities she will run outside. In other words, we evaluate the consequent claim (*she'll run outside*) with respect to only the subset of possibilities in which she sees a rainbow; it doesn't say anything about the possibilities in which she doesn't see a rainbow.

- (210) *If the girl sees a rainbow, she'll run outside.*

Notice that at this point we seem to be introducing a pretty heterogeneous group of expressions in terms of their morpho-syntactic properties/parts of speech: *must*, *may*, *can*, *should*, etc. are functional auxiliary verbs in English (they require another verb to form a complete sentence), while *know*, *think*, *believe*, *hope*, etc. are content verbs in English that introduce arguments, and *if... then* pretty clearly doesn't involve any verbs. Kratzer (1981, 1977) describes this "notional category of modality", where here "modality" refers not to what mode the language occur in, but rather the presence of a "modal" expression. In turn, something being a "modal" expression is defined not by any particular syntactic role it plays in the sentence but rather whether it introduces quantification over sets of possibilities/other possible worlds. We can also talk about expressions that induce quantification over sets of possibilities as **intensional operators**, and since that

has no other meaning in sign linguistics (unlike “modality”), we will tend to use that expression more often than **modals** through the rest of this chapter. An intensional operator, then, is one which adds some complexity to the semantics by operating over possible worlds: this includes but is not limited to conditionals (e.g. *if... then* in English), attitude predicates (e.g. *think, know, hope, want*), and modal auxiliary verbs (e.g. *can, must, might, should*).

Intensional operators are particularly interesting from the point of view that we have been exploring in this book, of contributing both to representations of particular events and to representations of propositions and their alternatives. On the eventive side of things, intensional operators can be especially evocative, allowing us to “paint a picture” of how something might have been if things were otherwise, or how we really hope things will be. For example, in the case of the conditional statement in (210), this might paint a picture of some sorts for the interlocutor with multiple parts, a bit like a movie: first we might envision her looking out a window, and then we might see her running outside. In fact, precisely because we sometimes tend to see both sides of the conditional as highly related, they have often been used as evidence for theories of meaning that involve constructing models that we reason about through simulation (Johnson-Laird, 1980). For example, if we are reasoning about this through simulation we might (erroneously, but naturally) infer from this that if she ran outside, it’s because she saw a rainbow, since we’re thinking about them as causally connected (but of course, that inference isn’t entailed by the sentence).

$$(211) \quad (\text{If she sees a rainbow, she'll run outside.}) = \begin{array}{|c|} \hline \begin{array}{c} \text{[Window view of rainbow]} \\ \text{[Person looking out]} \end{array} \end{array} \rightarrow \begin{array}{|c|} \hline \begin{array}{c} \text{[Rainbow outside]} \\ \text{[Person running]} \end{array} \\ \hline \end{array}$$

On the propositional side of things, we can model this relationship as one of quantification over possible worlds. In this case, the antecedent is the restriction; the consequent is the scope of the quantifier, and we simply require that for any world in which she sees a rainbow, then that world is also a world in which she runs outside (212).

$$(212) \quad \llbracket \text{If she sees a rainbow, she'll run outside.} \rrbracket \\ = [\forall w. w \in \{w. \text{She sees a rainbow in } w\} \rightarrow w \in \{w. \text{she runs outside in } w\}]$$

Domain restrictions for intensional operators are not always explicit in the same way that they are in conditionals. Sometimes the restriction for these worlds comes from the intensional operators, as we see in *wants* and *needs* in (213).

- (213) a. $\llbracket \text{She wants to go outside.} \rrbracket$
 $= \forall w.w \in \{w \text{ is compatible with her desires}\} \rightarrow w \in \{w.\text{she is outside in } w\}$
 ‘In every world compatible with her desires, she is outside in that world.’
- b. $\llbracket \text{She needs to go outside.} \rrbracket$
 $= \forall w.w \in \{w \text{ is compatible with her needs}\} \rightarrow w \in \{w.\text{she is outside in } w\}$
 ‘In every world compatible with her needs, she is outside in that world.’

Compositionally, intensional operators can get complicated for several reasons, in part due to the inherent complexity of introducing other possible worlds, and in part due to the notional category of modality and thus the heterogeneity in the syntactic instantiation. Therefore, in this chapter we will focus less on the compositional properties than in other chapters; the interested reader can find more in a review by Hacquard (2010) and lecture notes by von Fintel and Heim (2002). Instead, we will discuss different semantic puzzles that arise with intensional operators throughout sign languages, and attempt a better understanding through the interplay of different kinds of meaning and the quantification over possibilities introduced by intensional operators.

1 Conditionals

One of the simplest intensional structures are conditional statements. In the DGS example in (214) we see a pattern familiar to many other sign languages of the world (including ASL) in which the conditional can be expressed through nonmanual marking. In the conditional statement in (214a), the antecedent TOMORROW RAIN is expressed with raised eyebrow nonmanuals, and the meaning is that the consequent WE PARTY CANCEL MUST holds in all of the restriction worlds, i.e. the worlds in which it rains tomorrow. In other words, the utterance in (214a) is going to be judged true in a scenario in which we’re not sure what the weather will be tomorrow, but we know that we won’t hold a party in the rain. This contrasts with the (not conditional) utterance in (214b), which will be unacceptable in that situation, since it is not a conditional statement but rather two independent statements, the first claiming that it *will* rain tomorrow (and thus, unacceptable in a scenario in which we do not know whether it will rain).

- (214) (DGS, Pfau and Steinbach 2016)
- a. $\overline{\text{raised brow}}$ TOMORROW RAIN, WE PARTY CANCEL MUST.
 ‘If it rains tomorrow, we will have to cancel the party.’
- b. TOMORROW RAIN, WE PARTY CANCEL MUST.
 ‘It will rain tomorrow. We must cancel the party.’

One important point that this contrast highlights is that nonmanual marking has important semantic consequences when it comes to intensionality: with raised brows the sentence is interpreted as a conditional, as in (215a), while without the raised eyebrow nonmanual marking, we simply conjoin the two propositions (215b).

- (215) a. $\llbracket \overline{\text{TOMORROW RAIN}}, \text{WE PARTY CANCEL MUST} \rrbracket$
 $= \forall w. w \in \{w. \textit{it rains tomorrow in } w\} \rightarrow w \in \{w. \textit{we cancel party in } w\}$
 ‘For all worlds w in which it rains tomorrow, we will cancel the party in w .’
- b. $\llbracket \text{TOMORROW RAIN}, \text{WE PARTY CANCEL MUST} \rrbracket$
 $= \lambda w \forall p. p \in \{\text{It rains tomorrow, We cancel party}\} \rightarrow p(w) = 1$
 ‘The proposition expressed by the worlds in which it is both true that it rains tomorrow and it is true that we cancel the party.’

There are several interesting takeaways from even this very simple discussion of conditionals. First, we see a new perspective on the broad notion of intensionality: sign languages show that Kratzer’s “notional category of modality” can be expressed through the multi-modal use of nonmanual marking in sign languages, since this is the only distinction in form between (215a-b). Second, nonmanual marking, although able to express lots of experiential content like emotions, etc., is certainly also able to contribute propositional content through symbolic means, as we have seen earlier in Chapter 3 with negation and here with the expression of a conditional. Thus, as Pfau and Steinbach (2016) note, nonmanual marking needs to be an integral part of formal semantic analyses in sign languages, including and especially in the intensional domain. This doesn’t necessary mean that nonmanual marking and intensional operators necessarily go together in a privileged way: in fact, negation shows us immediately that nonmanual marking expresses non-intensional meaning. Furthermore, the use of nonmanual marking in conditionals might rather be attributed to the syntactic structure of conditional statements: Wilbur and Patschke (1999) argues that brow raising is indicative of subordinate syntactic structures. Similarly, many sign languages have manual signs that introduce conditionals, including American Sign Language. The conclusion thus is not that the nonmanual expression is because of the intensional semantics, then, but rather that intensional operators can come in forms that include nonmanual markings. Finally, we see the use of another modal expression, *MUST*, in the consequent in (214). As von Stechow and Heim (2002) note following Kratzer (1981), conditionals are set up to interact naturally with other modals like these auxiliaries.

2 Attitude verbs

Intensionality can be expressed by main verbs, as we saw above in spoken languages, and perhaps one of the simplest examples come from verbs of desire, such as WANT. Consider the example from the previous Chapter 6; then we focused on the countability of expressions like THREE APPLES; here we can incorporate modal semantics for the verb WANT (217).

(216)



‘I want three apples.’

- (217) $\llbracket \text{IX-1 WANT THREE APPLE} \rrbracket$
 $= \forall w [w \in \{w. w \text{ is compatible with my desires}\} \rightarrow w \in \{w. I \text{ have three apples in } w\}]$
 ‘If w is in my desire worlds, then I have three apples in w ’

We’ve already introduced quite a bit about attitude verbs and nonmanual marking in Chapter 5, when we discussed role shift introduced by verbs like THINK, SAY, etc, but had not focused on their own semantic contribution and the difference between embedding clauses vs. more demonstration-like structures. Consider the example of the attitude predicate THINK in (218). Here, we gain a window into Alex’s thoughts: the meaning seems to be a bit different than the English sentence *Alex thought his sister has a book* which implicates that he would agree that she does; in the ASL example in (218) it seems less a claim about his belief and more a claim about the content of his thoughts, that he was thinking/wondering about whether his sister has a book. As a first pass, we might model this as in (219).

(218)



‘Alex was thinking that his sister might have a book.’

- (219) $\llbracket \text{fs(Alex) THINK MY SISTER HAVE BOOK} \rrbracket$
 $= \forall w. w \in \{w \text{ is compatible with Alex's thoughts}\} \rightarrow w \in \{w. \text{his sister has a book } w\}$

However, the analysis in (219) seems to fall short in a couple of ways. For one thing, it doesn’t seem quite right that in all of Alex’s thought worlds, his sister has a book. That’s probably something like the right semantics for the English sentence *Alex thinks his sister has a book*, but as we noted, this ASL utterance seems to have different truth conditions. Instead, we seem to want to express the idea that Alex is considering this possibility, that it is possible, not necessary, in his thought worlds. Thus, we might want to model this as an existential quantifier, like in (220).

- (220) $\llbracket \text{fs(Alex) THINK MY SISTER HAVE BOOK} \rrbracket$
 $= \exists w. w \in \{w \text{ is compatible with Alex's thoughts}\} \wedge w \in \{w. \text{his sister has a book } w\}$
 ‘Alex thinks it possible that his sister has a book.’ Lit. ‘In some of the worlds in Alex’s thoughts (which I am showing you now), his sister has a book’

Moreover, this sentence has the use of a first person pronoun (MY) which is different from the English sentence, which uses a third person (*his*). This seems to be an example of indexical shift, of the sort that we discussed in Chapter 5. Like other shifted indexicals, it seems to require that Alex knows that the person he is talking about (his sister) is his sister. This is known as the *de se* interpretation, that is, this requires that Alex would be able to identify the person as his sister. All of these are introduced by the attitude predicate THINK. We find this kind of complexity with verbs of reporting, like ASL SAY, and they tend to be handled in different ways: *de se* interpretations under a quotation/demonstration analysis are expected since the speaker would not have used the first person if they could not express the

attitude *de se*. In the case of shifted indexicals it has remained somewhat more stipulative, although the *de se* interpretation of shifted indexicals is a cross-linguistically robust one (Deal, 2020), so sign languages would follow the same expectations as for spoken languages.

3 Modals

Compared to attitude predicates, there has been relatively less work on modal (auxiliary) verbs like CAN, CAN'T, SHOULD, etc. in ASL and in other sign languages. Perhaps this is because they look rather unsurprising: for example, the ASL modals SHOULD and CAN in (221) looks quite a lot like the English modals in conveying a similar meaning via a similar form, a standalone morpheme, and in a similar syntactic environment, preceding the main verb 1-DRIVE-B.

(221) a.



‘She should drive to visit the flowers.’

b.



‘I decided that I can drive to visit the flowers.’

They also seem to express semantic differences in a similar way, differentiating modal force through different lexical items: the first seems to be expressing a kind of necessity (universal quantification over possible worlds that are desired) while the second expresses a possibility (existential quantification over possible worlds of some accessible sort). Not all languages make this same distinction, so it’s not a necessary one (Deal, 2011), but it seems to be made roughly the same way in both ASL and in English, at

least; research on other sign languages might find variation of the sort seen in spoken languages.

That said, modals in ASL and other sign languages have some notable syntactic/semantic properties that have been discussed in prior literature. One of the most surprising, perhaps, is that they can sometimes be found “doubled” at the end of an utterance (222). Known within generative syntactic literature as “focus-doubling” Lillo-Martin and de Quadros (2004), they have been analyzed as occupying a similar syntactic position as clause-final negation of the sort we saw in Chapter 2.

- (222) a. GIRL CAN READ, CAN ‘The girl can read.’
 b. GIRL MUST READ, MUST ‘The girl must read.’

What is puzzling from a semantics perspective is why this set of expressions that occupy this sentence final position pattern together (negation, modals, wh-words, and main verbs). There is no obvious semantic class that would connect negation and modals, and that’s not even to consider that main verbs can be doubled too. Furthermore, although this is often called a “focus” position, it doesn’t usually seem like constituent focus of the sort that we saw occurring as the answers to the Question-Answer Clauses in Chapter 2; recall that while we can double a wh-word, we don’t generally double answers to a question, despite that being a classic diagnosis for focus.

One way to view these doubles is as a sort of verum focus (Davidson and Koulidobrova, 2015), where the semantic/pragmatic contribution is not focusing any particular constituent but instead expressing the semantic/pragmatic notion of the sort we see with stress on English auxiliaries, e.g. *She DID read the book, He CAN’T come to the party*. This is also consistent with (but not necessarily requiring) the idea that it would be expressed in a dedicated syntactic position for polarity (Geraci, 2005). If the doubling of these modals is indeed an expression of verum, we could analyze it following (Gutzmann et al., 2020) as a relation between the content and the question under discussion. This doesn’t entirely solve the question of why this particular set of items (negation, auxiliary verbs, etc.) expresses verum crosslinguistically, but it does move the puzzle in sign languages to part of the more general puzzle in a modality-independent way, since the same classes of expressions are found across languages.

4 Intensional predicates and iconicity

Finally, one place that intensionality has been discussed in experimental sign language literature regards the relationship of intensional meanings and their influence on word order. Napoli et al. (2017) observe that word order in sign languages is often flexible and seems to depend on aspects



Figure 8.1: Figure 1 from Napoli et al. 2017

of meaning, such as objects preceding verbs when there is an especially pictorial aspect to a verb (Liddell, 1980). Napoli et al. (2017) design an experiment to test one possible effect on word order, namely, whether the main verb is an intensional operator or not. This builds on a study which reported that predicates that seem to express intensional meanings lead to a change in word order for silent gesturers (Schouwstra and de Swart, 2014); Napoli et al. (2017) ask if word order in sign languages might be similarly influenced.

The task goes something like this: participants were presented with illustrations that are intended to evoke descriptions that involve intensional predicates like *WANT* or *THINK ABOUT*, and others that are intended to evoke non-intensional predicates like *SEE*. Examples are in Figure (8.1). Deaf signers of Libras (Brazilian sign language) were invited to describe the pictures, and their answers may include one or more clauses. Napoli et al. (2017) find results that are on the one hand quite compatible with Schouwstra and de Swart’s gesture study: the “intensional” predicates often involved word orders with the verb preceding the object (VO) (e.g. *COOK DREAM SAX* ‘The cooked was dreaming of the sax.’) while the “extensional” predicates had relatively more objects preceding the verb (OV) (e.g. *GNOME TOWER LOOK* ‘The gnome was looking at the tower.’)

There is much to build on related to this study, first with regards to terminology: it’s not at all clear that the difference between the verb classes here is truly about intensionality, since many of the so-called “intensional” verbs do not involve intensionality in any formal semantic sense, especially verbs of creation (e.g. *KNIT*, *DRAW*). That said, there does seem to be something real about the tendency that this experiment draws out: word order is semantically influenced by properties of the event. Napoli et al. (2017) provide several possible explanations, including the age of sign languages (and thus subjective to different constraints in terms of change) as well as the “heaviness” of the verb (many of the “extensional” verbs involve more morphological complexity and depiction, such as *LOOK* - see Hou (2022))

or “iconicity” in a broad sense. It is of course, as they note, possible that these factors are interrelated as well: highly depictive verbs might occur sentence-finally precisely because they are so heavy, for example, although these are also in principle dissociable. Schlenker et al. (2022) make a convincing case in recent work also for the role of iconicity, showing that two extensional predicates that differ in whether the object was visible before or after the event (EAT-UP vs. SPIT-OUT) show the same distinction, and that the pattern holds both in ASL and in silent gesture.

5 De dicto/de re

One final topic worth mentioning that is related both to attitude predicates and to the word order distinction from the last section deals with the interpretation of objects under the scope of intensional operators. Consider, for example, the noun phrase THREE APPLE in (223). Interestingly, three apples don’t even need to exist at all in the world in which this sentence is expressed, and yet this sentence is acceptable; what matters for acceptability is that three apples exist in all of the signer’s “desire worlds”, e.g. the signer really wants three apples.

- (223) Context: It’s unclear if there are any apples around, but the signer really needs three apples to make her recipe.



‘I want three apples.’
(acceptable in this context)

We call this the *de dicto* interpretation of the object, which can exist in the worlds invoked by the intensional operator (in this case, the desire worlds of the signer) without necessarily existing in the actual world.

In formal semantic theories, *de dicto* interpretations of noun phrases under intensional operators have been traditionally modeled as an effect of scope. Consider, for example, two very different ways to understand the noun phrase *a prince* in the English example in (224). In one (“*de dicto*”) interpretation the sentence is unacceptable since Aurora’s desires need not include princehood for her future husband; yet under another (“*de re*”) interpretation the sentence is fine, if by *a prince* we mean the specific person who we know to be a prince.

- (224) Context: In the story *Sleeping Beauty*, the princess Aurora wants to marry a man she met in the woods; her family wants her to marry the prince of the neighboring kingdom. Aurore doesn't realize that the man she met is actually the very same prince of the neighboring kingdom.

Sentence: *Aurora wants to marry a prince.*

- a. (Not acceptable, if we interpret *a prince* de dicto, since her desire worlds include marrying this particular man, and she thinks he's not a prince)
- b. (Acceptable, if we interpret *a prince* de re, that is, by the way that the participants in the conversation could describe him from their perspective, as in fact he is the prince of the neighboring kingdom)

We can, glossing over many details and complications we can't get into here, model this as scope, with the idea that in the de re case we have *a* (specific) *prince*, and say something about him (namely, that Aurore wants to marry him) (225a). In contrast, in the de dicto case we are saying something about Aurora's desires, namely, that they include prince-marrying (225b).

- (225) a. $\exists x[\text{prince}(x) \wedge \forall w[w \in \{w.w \text{ is compatible with Aurora's desires}\} \rightarrow \text{marries}(\text{Aurore}, x) \text{ in } w]]$ **de re**
- b. $\forall w[w \in \{w.w \text{ is compatible with Aurora's desires}\} \rightarrow \exists x(\text{prince}(x) \wedge \text{marries}(\text{Aurore}, x) \text{ in } w)]$ **de dicto**

The important takeaway for current purposes is that the English sentence seems to have two different interpretations, one of which has the object interpreted "outside" of the verb and another in which the object is interpreted entirely "inside"/in the scope of the attitude verb, despite having the same word order for both interpretations *marry a prince*. The reason this is relevant to sign linguistics is that we might expect word order effects to care about this difference, since many sign languages seem to have more flexible word order with respect to argument structure that changes in a way that can reflect semantic scope. Consider (226), where the difference is naturally expressed in the de dicto case by taking Aurore's desires as the topic, and in the de re case by topicalizing the prince: here, word order seems to reflect scope order, resulting in a lack of ambiguity in ASL where one exists in English.

- (226) Context: In the story *Sleeping Beauty*, the princess Aurora wants to marry a man she met in the woods; her family wants her to marry the prince of the neighboring kingdom. Aurore doesn't realize that the man she met is actually the very same prince of the neighboring kingdom.

- a. FS(Aurore) WANT WHAT, MARRY PRINCE
(Not acceptable, if we interpret PRINCE *de dicto*, since her desire worlds include marrying this man, but she thinks he's not a prince.)
- b. PRINCE IX(at a), FS(Aurore) WANT MARRY IX(at a)
(Acceptable, if we interpret PRINCE *de re*, that is, by the way that we could describe him from our perspective, as in fact the prince of the neighboring kingdom)

The takeaway from (226) is not that ASL and other sign languages lack the *de re/de dicto* ambiguity, but rather that (as with many other languages) there are many ways to minimize ambiguity, and a word order/syntax that is sensitive to information structural differences is one way to disambiguate the scopal relationships of noun phrases and intensional operators. This might lead to word order differences in intensional contexts, perhaps yet one more pressure on the word order findings from Napoli et al. (2017) for Libras, not just iconicity but also semantic scope.

6 Conclusions

This chapter is perhaps the most speculative of this text, in part because the formalizations get much more complicated than we are able to go into in this context, and in part because there has been some of the least research done on intensionality in sign languages. Nevertheless, there are some important findings in this area, and great possibilities for future directions.

For one thing, although modals are more semantically complex than negation, there are interesting parallelisms between negation and modals in a couple of places in sign languages, and that parallelism is worth pursuing for further understanding. For one thing, negation and modals can both appear “doubled” in sentence-final position, perhaps both conveying *verum* focus. Negation and modals also seem to optionally induce word order variation based on scope. For example, we saw how *de re* readings seem to be highlighted by topicalizing the object in a sentence with an intensional verb; the same can be seen with negation, where placing, say, a depiction sentence-initially seems to ensure it is out of the scope of negation, as we saw in Chapter 5.

Understanding the role of scope, iconicity, and word order across sign languages is surely a future research path for formal semantics/pragmatics in sign languages. The more general topic of intensionality is even broader than conditionals, attitude verbs, and modal auxiliaries, encompassing a wide range of expressions and potentially (in fact, likely) nonmanual markings as well. In addition, Herrmann (2013) discusses modal-like meanings arising from discourse particles and inter-sentential operators in DGS, along with

their relationship with nonmanual marking, and more on this kind of work is surely due for other sign languages.

Conclusions

The goal of this book has been to showcase research that connects formal semantics and sign linguistics across a variety of phenomena and hopefully in doing so to potentially bring together different researchers across these two domains to work together on future projects.

1 Events and propositions

One of the main threads throughout this book, introduced in Chapter 1, has been the simultaneous contributions of meaning via depiction and description. We have used this to motivate a distinction in types of meaning: the content of iconic depiction can affect event representations (only), whereas the content of symbolic description can affect both representations of particular events as well as propositional content that supports reasoning over alternatives. This distinction allowed us to separate the depictive from the descriptive contributions of space in discourse anaphora in Chapter 3 and in Chapter 4. It allowed us to model quotation-like role shift along with depictive classifiers in Chapter 5. Finally, we were able to separate some of the conventionalized from less conventionalized aspects of quantification and countability in Chapters 6-7.

In terms of the relationship between iconicity and symbolic linguistic structures, the general picture pursued in this text is one in which depiction can exist first (say, in one's lifespan or in a community) independently of language: it requires no understanding of symbols and their composition to be understood but rather various kinds of mappings to particular events, although there may well be conventions to depiction within cultures and contexts. In addition, use of a particular form with a particular meaning can become conventionalized within a language community so that it becomes a symbol available for composition, abstracted away from any particular event representation. As part of this process, it takes on even more abstract meanings and participate in complex compositional semantic structures. It

can also, if it retains a (descriptively) iconic form, be used as support for



further depictions. This is the case with signs like ASL *TABLE* or words like English *knock*, which are symbols with full linguistic potential that also retain enough iconicity to easily support further depiction.

When we talk about a semantic analysis for ASL, we focus on separating propositional meaning from representations of events, and understanding how the two interact. To illustrate the power of this, we can return to an example from Chapter 1. Recall the sentence about students waiting in line at the library, in (227). In Chapter 1, we discussed important entailments of this sentence. Now that we have provided several examples of semantic analyses of various phenomena in the intervening chapters, we can understand what a simple semantic analysis would look like for this bit of language based on the analyses given at the end of Chapters 5 and 6, and also understand why those inferences follow.

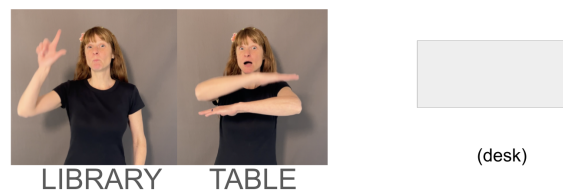
(227)



‘Ten students stood in a (perpendicular) line at the library desk.
None of them remembered a library card.’

The first part of this dialogue is the locational description *LIBRARY TABLE*, which sets up the location as a kind of topic. The topic-status is also reflected in the raised eyebrow nonmanuals. The propositional contribution is to raise the Question Under Discussion *What happened near the library desk?*, as in (228); it also naturally evokes an event representation that includes the library desk object.

(228)



Raises QUD: *What happened near the library desk?*

e.g. raises possibilities of this sort:

{The desk caught on fire, we ate pie on the library desk, the librarian cleaned the library desk, students lined up behind the desk, ...}

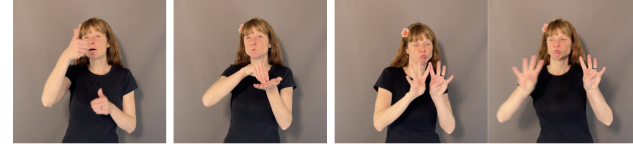
The continuation will move forward the dialogue to partially answer this question, eliminating possibilities via its propositional contributions, and simultaneously depicting aspects of the event.

In (229a), we provide the propositional contribution that we computed compositionally at the end of Chapter 5. This is the proposition that contains exactly those worlds in which there are at least ten members in the intersection of the set of students and the set of upright figures who are themes



of events demonstrated by the depicting sign. Naturally, this also adds details to our representation of an event, with approximately ten student objects arranged in the way demonstrated in the depicting sign, parallel to the desk (229b).

(229) a.



[[TEN STUDENT DS_4(students in line, at a)]]



$= \lambda w. | \{x. \exists v [demonstrate(\text{upright-figure}(x), v) \wedge theme(x, v) \wedge R(x, a) \wedge \text{upright-figure}(x)] \} \cap \{x. x \text{ is a student} \} | \geq 10 \text{ in } w$

lit. the proposition defined as the set of worlds in which there are at least ten individuals in the intersection of the set of students and the set of upright figures who were themes of events

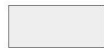


depicted by and are related to location a

b.



(TEN STUDENT DS_4(students in line, at a))



=


Similarly, in (230a), we provide the propositional contribution that we computed compositionally at the end of Chapter 6. This is the proposition consisting of exactly the worlds in which there is no individual that both remembered a card and that is in the plural individual related to the locus a (the lined up students). This is a claim of non-existence; no objects or events are entailed to exist by this sentence, and so (in keeping things simple without going into mental models of negation) the active mental model is not affected by this sentence, persisting as in (230b).

(230) a.

$$\begin{array}{c} \begin{array}{ccccc} \text{[Image 1]} & \text{[Image 2]} & \text{[Image 3]} & \text{[Image 4]} & \text{[Image 5]} \\ \text{IXarc(students, at a)} & \text{NONEsym} & \text{REMEMBER} & \text{CARD} & \end{array} \\ = \lambda w. \{x.x \leq \iota x.R(x, a)\} \cap \{x.\text{remembered card}\} = \emptyset \text{ in } w \end{array}$$

b.


$$\begin{array}{c} \begin{array}{ccccc} \text{[Image 1]} & \text{[Image 2]} & \text{[Image 3]} & \text{[Image 4]} & \text{[Image 5]} \\ \text{IXarc(students, at a)} & \text{NONEsym} & \text{REMEMBER} & \text{CARD} & \end{array} \\ = \begin{array}{c} \text{[Empty Box]} \\ \text{[Icons of 8 people]} \end{array} \end{array}$$

What does this gain us in terms of “meaning” and reasoning? For one thing, we can reason through simulation via the event representation encoded as some kind of model, e.g. . Such models may vary quite a bit between people in a conversation; the more detail provided in an utterance, including and especially via depiction, the more likely people will be to align on their representations of a particular event. The other kind of meaning is propositional, which we can model as a series of questions and answers. We take the topic to be raising the QUD in (231a), taken from above in (228). The answer/resolution comes from the dialogue that follows, in which we take the meaning in (231b) and (231c) and conjoin them as in (231d).

(231) a. QUD: What happened near the library desk?

{The desk caught on fire, we ate pie on the desk, the librarian cleaned the library desk, students lined up behind the desk, ...}

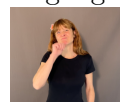
b. $\lambda w. \mid \{x.\exists v[\text{demonstrate}(\text{[Image 1]} \text{ [Image 2]}, v) \wedge \text{theme}(x, v) \wedge R(x, a) \wedge$

- upright-figure(x)]} \cap { $x.x$ is a student} ≥ 10 in w
- c. $\lambda w. \{x.x \leq \iota x.R(x, a)\} \cap \{x.\text{remembered card}\} = \emptyset$ in w
- d. $\lambda w. | \{x.\exists v[\text{demonstrate}(\text{img}, v) \wedge \text{theme}(x, v) \wedge R(x, a) \wedge \text{upright-figure}(x)]\} \cap \{x.x \text{ is a student}\} \geq 10 \wedge \{x.x \leq \iota x.R(x, a)\} \cap \{x.\text{remembered card}\} = \emptyset$ in w
- e. Answer to QUD: ‘The proposition consisting of the set of worlds in which there are at least ten individuals in the intersection of the set of students and the set of upright figures related to locus , and in which there is no individual that both remembered a card and that is in the plural individual related to locus a (the students)’

This is a painful paragraph to read, especially because it doesn’t allow for the scope clarity of the formalism in (231d) but the goal of (231e) is to give the reader a sense for what is expressed long form in (231d). Why don’t we just use the natural English, e.g. *Ten students stood in line next to the library desk. None remembered their card.*? Because this is far too ambiguous, and although perhaps a good translation equivalent, it doesn’t accurately capture the truth conditions of the ASL sentence. For example, it doesn’t convey the spatial relationship of the students and the desk, and has a somewhat different information structure, i.e. it doesn’t seem to be so clearly addressing a QUD about what happened at the desk. Recall that our goal is to accurately predict the entailments and acceptability judgements of the sort reported in Chapter 1, and this formalism is going to be much more successful in doing this for ASL than a translation into another language (e.g. English) could do. It also allows us to understand the semantics more directly without relation to English and its idiosyncracies, but instead with respect to a logical language that is more plausibly shared between human languages (and, perhaps, present also in non-linguistic thought). For example, in a situation/world in which only seven students were near the desk, this world would return FALSE for the proposition expressed by (231e), and in that context, the utterance is predictably unacceptable. Similarly, in a situation/world in which there is a student among a group standing near the desk who did remember their library card, this world will return FALSE for the meeting expressed in (231e), and fittingly, the sentence is unacceptable. These propositions/functions seem to be roughly working as they should.

This proposal of strongly separating model meaning from propositional meaning is in some opposition to various other ways of accounting for iconicity in language, broadly, and in sign languages, specifically. For example, in Cognitive Linguistic approaches, meaning from iconic depictions and mean-

ing from descriptions both contribute to the same kind of model-like representations of events (Liddell, 2003; Taub, 2001). These approaches naturally emphasize iconicity in language, as iconicity is expected under a view in which language (of all sorts) contributes to constructing a model of the world. Mental models are usually taken to be iconic representations in the human mind, with the idea that you can represent the world in the format in which you interact with it, and which allows you to investigate and test inferences about the world via simulation (Johnson-Laird, 1980). Naturally, using forms in language that also seem to mirror the world seems like a direct source for encoding features of the world in your mind and that of your interlocutor (i.e. to “paint a picture” in someone’s mind); what becomes much more challenging to model are the symbolic components of language,



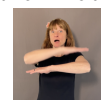
NOT

especially those that express relations difficult to simulate, such as



OR NONEsym .

On the other end of the spectrum, we find approaches to meaning which are purely truth conditional, and which incorporate iconicity as a new type of constraint on these truth conditions. One way to account for this is as a presupposition, as in the iconic presuppositions in Schlenker et al. (2013) and Schlenker (2021). Kuhn (2017b) proposes that language allows generally for an iconic function $Icon^\phi$ which can be used to map forms to meaning and imposes on them a mapping between their referent in the world (e.g. perhaps the timing of an event) and the form of a sign (e.g. the duration of a verb). This proposal manages nicely to capture the gradient meaning requirements encoded in depiction, but not so much why it doesn’t integrated with logical operators like negation. What is so different about iconic meaning? It also raises some unanswered general questions about how it integrates with the rest of the grammar: how do we know when $Icon^\phi$ is present or not?



TABLE

Is it inherent in descriptively iconic conventionalized symbols like , or only when iconicity is interpreted, i.e. in depictively iconic signs like



DS_4(students in line, at a)?

A third approach proposed by Ramchand (2019) is to divide model-like meaning for events and propositional meaning for clauses essentially by syntactic domain, following a larger research project of matching syntactic domains with semantic ontology. Her proposal is that within the syntac-

tic domain of the verb phrase (the predicate and its arguments, along with its adjuncts, but before tense and aspect are included), the event type is created through a system of meaning construction/mental model creation similar to that proposed in cognitive linguistics frameworks. Then, this enters as an argument into a function that maps the event into a truth conditional/possible worlds framework, creating a final representation that does have truth conditions, but is no longer interpreted as iconic. One problem with this approach is that it seems to overgenerate the iconicity interpreted



within the verb phrase. For example, both the ASL signs TABLE or VOTE and the English words *knock* and *chirp* have the potential to be used purely symbolically in a way that their form does not affect the representation of an event in which they participate, for example, we can use the same sign with the same form to talk about a table sitting on its side.

The approach in most of this text has taken both kinds of meaning to be in parallel, which has empirical advantages over the other three systems. The downside, clearly, is in theoretical parsimony: why have two theories of meaning when one will do? The argument for the dual approach (of event representations of particulars and of propositions for which we build alternatives) comes from empirical coverage crossed with parsimony: we could stretch a truth conditional approach to include iconic functions to account for both propositional and iconic aspects, but then we lose predictions for when and where this iconic function appears. We could also stretch a cognitive linguistic approach to cover proposition-like meaning but this loses an enormous amount of explanatory power that we focused on in Chapters 2-3, for which cognitive linguistics has little to say about, for example, negation, connections, and entailment. A dual approach allows more complete coverage of these phenomena while at the same time fitting in with a larger picture of the mind in cognitive science as making use of dual/parallel processes Kahneman and Tversky (2013), see Baggio (2021) for compositionality in particular.

2 On pragmatic universality

This book has mostly considered semantics and pragmatics as intertwined topics. For example, in Chapter 2 we looked at the semantics of phenomena like question-answer clauses by understanding their pragmatic roles and relation to a Question Under Discussion, and understood logical operators in Chapter 3 as part of a system that involves both functions over propositions and related scalar implicatures. But, we haven't addressed formal pragmatics in a head-on way: is there anything generally special about sign languages and pragmatics? In other words, do Gricean Maxims apply within

the sign language context (Henner, 2022)?

There is a component to the answer to this question that goes into variation among the users themselves, which, like everything about language context, is crucial to the underpinnings of meaning and yet is beyond the scope of this book. Henner and Robinson (2021) and the references therein are an excellent place to start in order to address any misguided normative aspects to a Gricean framework of modeling pragmatic meaning. They would seem to also agree that variation by individuals with respect to these frameworks is expected in any language modality. So putting aside the way that different people interact with a Gricean framework in language in general, whatever the language modality, is there in addition a principled reason related to the visual modality that might make one wonder about the applicability of formalizing pragmatics in this way in sign languages?

I would argue in part yes, but it is not because of the modality per se, but rather more directly due to semiotic contributions, and only indirectly via modality, since the visual modality is especially well suited to integrating depiction and description. Description via symbolic means is always going to be subject to some form of Gricean reasoning: provide truthful information in an efficient manner, whatever “efficient” means for a given group of participants in a given context. Sign languages are full of symbolic logical structure just like spoken languages, and sign language dialogues are similarly chock full of pragmatic inferences, just like spoken language. However, not all language is description and thus meant for efficiency: there is no similar need for efficiency in depiction. Consider, for example, that providing more or less detail in a picture is not going to violate maxims for quantity in the same way. Kita (1997) observes this asymmetry for depiction in spoken Japanese, for which he notes that two symbolic modifiers with similar meanings are taken by speakers to be redundant (and thus unacceptable due to pragmatics), while a depictive modifier with similar meaning to a symbolic modifier is not seen as redundant at all (232).

(232)

(Japanese, Kita 1997)

a. **Symbolic modifier**

Taro wa isogi -asi de arui -ta
 Top hurriedly feet with walk Past
 ‘Taro walked hurriedly’
 (lit. ‘Taro walked with hurried feet’).

b. **Depictive modifier**

Taro wa sutasuta to arui -ta
 Top mimetic walk Past
 (*sutasuta* = hurried walk of a human)
 ‘Taro walked hurriedly’

c. **Redundant symbolic modifiers**

**Taro wa isogi -asi de haya -aruki o si -ta*
 Top hurriedly feet with haste walk Acc do Past
 ‘Taro walked hastily hurriedly’
 (lit. ‘Taro did haste-walk with hurried feet’, unacceptable)

d. **Depictive and symbolic modifiers, no redundancy**

Taro wa sutasuta to haya -aruki o si -ta
 Top mimetic haste walk Acc do Past
 ‘Taro walked hurriedly’

Japanese mimetics/ideophones are a helpful example of depiction and its pragmatic/semantic consequences in the spoken language modality, and illustrate that similar phenomena in sign languages should be taken in consideration of their semiotic contribution. When we look at a piece of sign language discourse, we are not infrequently viewing both the descriptive and depictive components, only one part of which are going to be subject to pragmatic constraints like quantity maxims in the same way.

More broadly, formal pragmatics has relied extensively on written languages as a basis for theoretical analysis. Extending this analysis to spoken and signed languages is a welcome development, but in doing so we should keep our minds open to the possibility that contexts change, and semiotic repertoires change, in a way that may raise new questions obscured by the focus on written language.

3 Cross-linguistic typology

In some areas of linguistics, cross-linguistic variation has long been a driving question: phonology/phonetics naturally has been interested in how patterns vary from language to language below the level of stored morphemes/symbols, and studies in morphology and syntax have similarly long acknowledged the importance of understanding variation in lexical and syntactic structure (while, of course, all emphasizing similarities across languages as well). Semantics, on the other hand, has long been a less natural fit for crosslinguistic investigations. Partly this is because it connects with two external disciplines that are less focused on variation: logic, and psychology/psycholinguistics. But it is also partly because there is less obviously a case for variation, and in fact, one might reasonably imagine that semantics is a place where human languages are more similar to each other than they are different: the pieces of meaning might indeed be universal even if the ways that we express them vary. So it has been with excitement that recent work in formal semantics on crosslinguistic variation has raised many interesting questions about the burden of proof for arguing that languages have different semantics and/or what kinds of semantic interactions we expect to see across languages. There are two forms that this typically takes: 1) units

of meaning are basically the same, but the way that languages categorize and express them are different, or 2) units of meaning themselves vary, so that some languages are working with difference pieces than others.

An example of the first category is work on quantification, where the expectation and general understanding is that languages all seem to have the ability to express quantification, but how it gets mapped to linguistic forms can vary. Work on sign languages has shown similar variation to spoken languages, when comparing American Sign Language (Petronio, 1995; Abner and Wilbur, 2017) and Russian Sign Language (Kimmelman, 2017), for example, and evidence for quantification can be found in the much more recently conventionalized Nicaraguan Sign Language as well (Kocab et al., 2022). Work on logical connectives like conjunction, disjunction, and negation tends to take a similar form: the expectation is generally that languages have the same underlying logical organization that supports propositional meanings and operators on these meanings, but the way that they are expressed can differ. In sign languages we see these kinds of proposals for the use of boolean connectives (Davidson, 2013; Zorzi, 2018; Asada, 2019) and the interplay between manual and nonmanual negation across sign languages (Zeshan, 2006; Kuhn and Pasalskaya, 2019).

The second category of cross-linguistic variation in semantics concerns variation in the possible pieces of meaning themselves. One place this arises is in the study of the way that gradability is expressed. For example, Aristodemo and Geraci (2018) argue that Italian SL (LIS) not only has degrees as part of the semantic ontology (roughly, semantic units from which comparisons are made), but makes them “visible” through the use of gradient/iconic signing space. In contrast, Koulidobrova et al. (2022) argues that ASL patterns with spoken languages like Washo (Bochnak, 2015) in not having degrees in their ontology/as ingredients for semantic composition; as a consequence of this, comparison in ASL is expressed with a different set of expressions than would be possible if degrees were involved. Note that this doesn’t mean that comparison can’t be expressed in some way: it’s not a theory of expressability, but rather the *form* that comparison can be expressed being determined by the *semantic primitives* that it makes use of. Perhaps this is a case of sign languages having different semantic ingredients from each other, in the way that spoken languages have been argued to vary.

We can find similar discussions of crosslinguistic variation in semantic ingredients being made in the literature on tense, where all languages can clearly express that events happened in a past time even if they do not seem to have specialized elements of tense, or alternatively, we can postulate that they are universal but that there is not direct evidence for them in some languages (Matthewson, 2006). It can also be seen in the literature on mass/count, where cross-linguistic variation show distinct sets of patterns which can argue for languages beginning with different sets of semantic ingredients (Chierchia, 1998); in sign languages, similar analyses have been

applied to American Sign Language (Koulidobrova, 2021). Again: the claim throughout all of these works is that languages have the same potential for expression, but that in some cases the semantic primitives/units of meaning that they start with affect *how* they express these meanings.

Future work investigating cross-linguistic variation in semantics in sign languages can surely find fruitful ground in many of these areas, and many more besides. Moreover, sign languages also open up possible sources of variation that have themselves been overlooked in spoken languages such as the manual/non-manual (/suprasegmental vs. segmental) interplay. In this book we have clearly focused on a small number of sign languages, primarily American Sign Language, due to familiarity, yet there are hundreds of sign languages all over the world wherever small or large Deaf communities come together, so let this be a call for more work by researchers with or by members of these communities to investigate these questions in a broader set of languages.

4 Historical change

Like so much of linguistic theory on phonology, morphology, and syntax, the fields of formal semantics and pragmatics have both overwhelmingly focused on synchronic language from a particular time and place and language community, but of course, we know that language is always changing, always in flux, across all of these variables (time, place, and person). Clearly, there is interesting work to do to tie together formal approaches to meaning and language change, and in recent years there have been important advances in this domain in spoken languages, highlighted in the regular conference on Formal Approaches to Diachronic Semantics; see Deo (2015a) for an overview of this kind of work.

Given that historical linguistics and formal semantics have only very recently been connected in spoken languages it is perhaps not a surprise that there is also minimal work in this domain in signed languages. Nonetheless, what we do know suggests an extremely rich area for investigation. In one recent notable study, Sampson and Mayberry (2022) investigate changes



in meaning of the ASL sign SELF. Based on archival video footage of century-old sign language productions, they show that the sign originates



from a personal pronoun similar in use to the current IX-a, but with the handshake currently used in SELF. This pronominal form was interpreted by later generations of users of the signing community as a reflexive pronoun,

hence the current sense as ‘self’. Moreover, Sampson and Mayberry show based on analysis of current signing productions that among young current signers, the same sign can also be used as a copula (‘be’). On the one hand, this proposes a semantic trajectory of a language in flux of exactly of the sort we would expect to see in spoken languages in the pronominal domain; on the other hand, it illustrates especially careful synchronic work as well as archival work given the video format of historical data on sign languages, and hopefully will be a model for future work on sign language meaning change.

Another category of work that tackles the question of historical semantic change in sign languages focuses on languages in which changes across time can be studied through the generations of signers who still make up the language community today, such as work on Nicaraguan Sign Language that investigates the way that space is used in the grammar across successive generations (Senghas, 2010; Kocab et al., 2015) and the kinds of semantic/syntactic structures that are available in different generations of this new language (Kocab et al., 2016). Meir et al. (2010) discuss the process of emerging conventionalization in language communities more generally, and Tomita (2021) provides an in-depth look at change in formal and meaning (of indexical pointing signs) across three decades by a single individual signer of Japanese Sign Language. All of these provide insight into how the structure of a language community and the context of an individual influence the way that linguistic form and meaning change over time, and this more broadly bears on foundational questions in language and cognition. There is no question that work in this domain with respect to compositional semantics can help us better understand the relationship between language as mental and community activity, both in flux. Of course, the investigation should eventually comprise language in all modalities, most notably including the semantics of tactile languages of Deafblind communities (see Checchetto et al. 2018 for one example of change in modality from visual to tactile).

5 Future directions

Recall we began with the question: how do we know what other people “mean” when they share ideas using language? One thread through this book is that we need to think about this question across multiple dimensions: on the one hand, we have a logical-propositional system that seems to use logical structure to support the communication of information about the world. On the other hand, we seem to be able to “paint a picture” in someone’s mind in the sense that we can help them build up a model of a particular scenario or event that they can reason about through via experience. An approach to semantics that considers both of these ways

of representing meaning is useful in general, but especially useful for understanding the interplay of description and depiction in languages that go beyond text, and in the case of the focus of this book especially in sign languages.

This approach also makes predictions about language processing, especially as it might be mapped to neural architectures: we know that non-linguistic, non-compositional processing are seen as distinct from compositional/logical representations in the brain (Baggio, 2021; Frankland and Greene, 2020); hopefully this framework for thinking about depictive and descriptive aspects of meaning in sign languages clarify predictions for neuro-linguistics in sign languages going forward. This approach also makes predictions in terms of cross-linguistic variation: we might expect to find minimal variation in depiction, but a comparable level of variation in the symbolic/propositional component, since the latter is more conventionalized within a language community. Future directions to investigate include, but are not limited, to the psycho-linguistic and cross-linguistic pictures, and the interplays of these systems. Finally, language is tightly connected to culture; future work understanding how language ideologies interplay with linguistic expressions, especially across modalities (Kusters et al., 2017), promises to lead to much deeper understanding of sign language meaning.

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