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EMERGING DEICTIC SYSTEMS SHAPED BY LANGUAGE, MODALITY, AND SOCIAL INTERACTION

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ABSTRACT

To achieve social actions and coordination, we communicate different types of meanings that vary in how they relate to the world. Some form-meaning mappings are arbitrarily linked to the world, but other types of communicative forms need to be interpreted within context. This dissertation examines how we learn to integrate these various representations, focusing on deixis. The first part of this dissertation attempts to understand a long-standing theoretical question of whether pointing in signed languages has similar forms and functions as deixis in spoken languages. In Chapter 1, using naturalistic corpus data involving children communicating in spoken and signed languages, I compare the form and function of pointing and spoken pronouns over development from ages 1;06 to 4;02. Signers apply a functional analysis to their pointing in a similar way that speakers do with their deictic systems, showing similar distributions of 1) displaced references, 2) referentiality, and 3) productive combinations of deictic expressions with words. Crucially, signers' use of pointing closely resembles speakers' deictic system as a whole, encompassing both speech and gesture. Chapter 2 focuses on modality and linguistic factors influencing pointing. In sign, pointing forms are more reduced and are more likely to be slotted in the utterance compared to speech. There is no clear evidence for formational contrasts according to distinct pragmatic functions in either groups. In Chapter 3, I ask how the presence of a shared linguistic system shapes deixis by studying homesigners, deaf children who do not share a linguistic system with their parents. They develop a sophisticated system, however, a partial one relative to signers, which reveals that linguistic input may be essential for some properties of deixis to develop and not for others. Taken together, this work demonstrates that some aspects of deixis universally develop within a wide range of environments, while other functions may be linguistically mediated systems that emerge early in ontogeny.

Introduction: Literature Review on Development of Deixis in Spoken and Signed Languages

Within a dynamic framework of social interaction, we constantly initiate chains of social actions, and react to others' actions in turn (Levinson & Enfield, 2006; Casillas, Bobb, & Clark, 2016). In doing so, we communicate using multilayered and composite forms (Enfield, 2009), such as uttering a string of words, showing a diagram representing an event, producing a word while co-producing a gesture, or pointing at a drawing to highlight a specific feature (Clark, 1996; Ferrara & Hodge, 2018). Making meaning does not start solely with conventionalized symbols, but goes beyond these abstract representations; we also depict and indicate, allowing the listener to imagine a scene or make a spatial connection between a sign and its object. We are beginning to acknowledge the reductionist approach of confining communication to only linguistic representations by recognizing that communication comprises all of these modes of signaling (Pierce, 1955; Clark, 1996; Ferrara & Hodge, 2018). But less is known about how we interweave these different types of communicative signals in the earliest stages of communicative development, and whether this process is influenced by the structure of the language we speak, the modality in which we communicate, and the types of language models we have access to.

This dissertation explores the emergence of reference that relies on context – deixis – and its relationship with symbolic representations within young children who are learning to become competent communicators. It empirically investigates whether this indexical and symbolic relationship generalizes across different types of communicative settings marked by different modality demands and linguistic systems. As a mark of the very first intentional forms of communication, infants produce their first deictic forms by pointing (Bates & Dick, 2002;

Tomasello, 2008), and continue pointing throughout the lifespan in all across cultures and in spoken and signed languages (Clark, 2003; Cooperrider, 2011; Kita, 2003; Pfau, 2010). Human infants also develop multiple communicative functions to make requests, inform others, make comments, and make displaced references. When comparing infants with other organisms, such as the great apes, infants' communicative repertoire is prodigious; great apes are only limited to making requests when they point (see Brentari & Coppola, 2012 for a review; Tomasello, 2008). Unlike other aspects of language characterized by displacement and disembodiment, deixis is a unique property of our communicative system that requires intentional, attentional, and context-dependent interpretation (Levinson, 2004). It has been proposed that this type of pre-linguistic communication is a tool for social interaction and shared joint attention, and thus underlies and shapes language (Bates, 1979, Bruner, 1981; Levinson, 2006; Macnamara, 1972; Tomasello, 2008).

Eventually, children acquiring spoken languages transition to symbolic forms of communication as they get linguistic input – when they know the word for an intended object, they are more likely to produce the word than point (Iverson & Goldin-Meadow, 2005; Yurovsky, Meyers, Burke, & Goldin-Meadow, 2018). Moreover, their early pointing selectively predicts the onset of symbolic deictic forms in the forms of determiners (Cartmill, Hunsicker, & Goldin-Meadow, 2014), pronouns, and demonstratives (Clark, 1978). Based on this previous research, there is an intricate dance between these forms of communication – description and indication – in speaking children acquiring a spoken language, where a conventional symbolic system emerges out of early gestural pointing.

Some early work on sign languages has attempted to understand whether children acquiring signed languages undergo a similar developmental progression from producing gesture

and then eventually applying linguistic structure to their gestures, particularly with respect to pointing (see Newport & Meier, 1985 for a review; Pettito, 1987; Lillo-Martin & Chen-Pichler, 2018a, 2018b, 2019; Hoiting & Slobin, 2007). Answering this question poses theoretical and methodological challenges as it is particularly difficult to characterize distinctions between linguistic and non-linguistic forms within signed languages when everything is expressed only through the manual modality (Okrent, 2002; Goldin-Meadow & Brentari, 2017). To characterize how linguistic and non-linguistic properties combine within signed languages, sign language needs to be compared with speech and gesture (Goldin-Meadow & Brentari, 2017). However, for describing and characterizing deixis, previous work has only studied deixis within spoken and signed languages separately or compared only co-speech gesture with sign, rather than comparing speech + gesture with sign. A systematic comparison between speaking children's deictic system as a whole – including both pronouns and pointing – and signing children's pointing would shed light on these questions.

If pointing in signed language takes on similar formational and functional qualities as deixis in speech and gesture, we can then turn to questions about the role of linguistic input in shaping deixis. There are deaf children born to hearing parents, whose hearing losses prevent them from acquiring spoken language and whose hearing parents have not exposed them to sign language. The children use homemade gestures, called *homesigns,* with the hearing people in their worlds. They do not share a conventional language with their parents; however, they are engaged with their parents in a social interaction. Even without input to sign language, they develop gestural systems that have many properties of natural language (Feldman, Goldin-Meadow, & Gleitman, 1978; Goldin-Meadow & Feldman, 1977; Goldin-Meadow & Mylander, 1983; Goldin-Meadow & Mylander, 1990). Comparing homesigners' points with native signing

and speaking children's points would illuminate how having a language model influences early pointing. One possibility is that deixis develops in the same trajectory in the manual modality, regardless of whether children have a linguistic model to guide their development; another possibility is that some or all aspects of deixis will fail to develop in the absence of a linguistic model. By examining homesigners alongside signing and speaking children, we can begin to understand how modality and linguistic input shape this type of early and context-dependent form of communication.

Indexical and symbolic representations throughout communicative development

Acquiring a deictic system in spoken languages, in contrast with other aspects of language, is a unique developmental process because of its symbolic and indexical properties. Many words can be used in an abstract, decontextualized way; however, deixis – whether in the form of pointing or conventionalized pronominal or demonstrative terms (e.g., *he, she, there, this*) – are only understood and interpreted within context. The listener has to know what the index point or the symbolic pronominal term points to within the speech situation. Ontogenetically, indexical references precede other kinds of referential communication – hearing infants typically point before they can speak. Then, gradually, these children move away from using gestural pointing and acquire conventional deictic terms, which have shifting references, in a piecemeal fashion. Children need to learn how to integrate these two planes of references, which may be a prolonged process (Clark, 1978).

Philosophers and linguists have recognized the importance of indexicality for understanding communicative reference more broadly and as the source of reference (Lyons, 1975). Pointing gestures are characterized by their indexicality – the relationship between the

sign and object is defined by a causal and spatial connection. Indexical relationships can be found through other signs beyond pointing: a sundial indexes the time of the day, a weathercock indexes the wind direction, and the calluses on a man's thumb index his occupation as shoemaker, for example (Peirce, 1955; see Clark, 1996 for a further summary). The terms 'deixis' and 'indexicality' come from different fields (Bühler, 1934; Peirce, 1955). Levinson (2004) makes the distinction by using indexicality to describe contextual dependency and deixis to refer to linguistic aspects of indexicality, and I will make the same distinction going forward. For instance, smoke is indexical of the fire and the crown is indexical of the queen; in contrast, demonstrative terms, such as *this/ that* are deictic.

An index contrasts with other types of signs that have different relationships to their referents, such as icons and symbols. An icon is characterized by its resemblance to its referent – Holbein's portrait of Henry VIII is an icon by resembling Henry VIII (Peirce, 1955; Clark, 1996). Icons can also vary in the complexity and quality of the object they represent, such as diagrams representing analogical relationships between features of a model and what they represent, equations, or metaphors. Finally, a symbol contrasts with an index and icon in that it does not have a relationship with an object by a perceptual or physical connection, but rather by an arbitrary, conventional rule. Words such as "give," "bird," "marriage" are examples of a symbol, and we cannot infer the meaning of these words by looking at their form alone but need to learn these conventions. As we communicate, we often combine these different types of signs, building up composite utterances (Enfield, 2009; Clark, 1996). Recent research on signed languages and spoken languages has realized the limitations of the Saussurean 'form-meaning mapping' account of meaning, and has used Peircean semiotics as a tool to gain a better understanding how we combine these distinct representations and, in the process, make links

between our sensory experiences and language (Shintel, Nusbaum, & Okrent, 2006; Okrent, 2002; Perniss, Thompson, & Vigliocco, 2010; Ferrara & Hodge, 2018).

When we study indexicality in language and communication, are we looking at something as simple as animal calls signaling an intruder or sundial telling us the time? The short answer is no. Essentially, we have to learn a complex referential system where there is, in Peirce's words, "an intersection of the indexical plane into the symbolic one" (Peirce, 1955). Pointing with the index finger is indexical and considered to be gesture. In contrast to pointing gestures, pronouns and demonstratives that we use in spoken languages are symbolic, but also have indexical function. These kinds of referential indexes have also been referred to as *shifters* or *duplex signs* (Jakobson, 1957), as the reference shifts depending on the speech situation. According to Pierce (1955), a symbol is associated with the represented object by a conventional rule, while an index is in "existential relation" with the object it represents. Shifters combine both functions – the indexical and symbolic. As such, the pronoun *I* is a symbol, however, it cannot represent its object without "being in existential relation" with this object – the word *I* designating the speaker is existentially related to his utterance and functions as an index.

Pointing gestures often co-occur with speech by directing the addressee's attention to the target feature of the environment (Clark, 2003; Engle, 1998; McNeill, 1992). Often, we use linguistic expressions that are "semantically insufficient" for understanding referentiality without context – for instance, the linguistic expression "that cup" does not give us enough information about which cup the speaker is referencing unless this expression is coupled with gesture or gaze (Levinson, 2004). The following is an example of an utterance that has both indexical and symbolic reference: a man walking with a child points his arm up into the air and says, "there is a balloon." Peirce describes this utterance as having a mixture of symbols and indices: "the

pointing arm [an index] is an essential part of the symbol without which the latter would convey no information" (p.112 as cited in Clark, 1996). Lastly, indexicality is organized as an *intentional* and *attentional* event (Levinson, 2004). What makes the causal relationship between the communicative utterance and referent possible is the addressee's attention to some aspect of the spatio-temporal physical context (such as attending to the cup while the speaker says *that cup*).

Children acquiring a spoken language go through the process of integrating gestural, indexical pointing with the linguistic deictic system they are acquiring. Clark (1978) and Bates (1976) highlight pointing as having similar communicative function as their deictic equivalents in speech – children use this form of expression when they have not yet acquired deictic terms. Children's early pointing verbal deictic words (*here, there, you, me*) emerge out of early pointing gestures in a natural, continuous progression. By the age of one, children point with clear communicative intention, such as staring at an object while pointing at it, gazing at the listener to see if they are attending, and then returning their gaze back at the object. As they continue to point, they start to produce deictic terms like *there* or *that* with the form [e], [a], or [da] which tend to appear in the first ten words in English-speaking children (Nelson, 1973, Nice, 1915), and are frequently produced early in development (e.g., Bloom, 1970). Later, they combine points with longer utterances like *that shoe* or *that mine.*

The onset of pointing predicts first words (Carpenter, Nagell, & Tomasello, 1998; Fenson et al. 1994; Harris, Barlow-Brown, & Chasin, 1995) and early productions of pointing gesture and spoken word combinations predict two-word combinations (Iverson & Goldin-Meadow, 2005). In a study by Iverson and Goldin-Meadow (2005), children who first produced gesture-plus-word combinations (point at bird and say "nap") were the ones who produced two word

combinations the earliest ("bird nap"). When children become increasingly competent with their vocabulary, their gesture use decreases over time (Stefanini, Caselli, & Volterra, 2007). Because gesture appears in a different, visuo-spatial representational format, it may be cognitively easier for children to express themselves through gesture than through speech. Also, parents may be sensitive to the child's gesture and tailor their verbal input accordingly. For example, if a child points to the father's hat while saying "dada," the parent might respond "Yes, that's daddy's hat" (Goldin-Meadow, Goodrich, Sauer, & Iverson, 2007). By providing verbal equivalents of the child's gesture and speech combinations, parents prepare their child to learn more vocabulary.

In another similar analysis, Cartmill, Hunsicker, and Goldin-Meadow (2014) asked if children's early pointing gestures had similar communicative function as determiners, such as *a, the, this,* or *that.* They coded for children's early pointing gestures (from 14 to 58 months) in combination with nouns (e.g., pointing at a bottle while saying "bottle"), and found that the age at which children produced these gesture and unmodified noun combinations predicted the onset age for determiner + noun combinations (e.g., "that bottle"). They also coded for points + other speech combinations as a control, and these combinations did not predict the onset of determiner + noun combinations. Moreover, the cross-modal combinations decreased as the determiner + noun constructions increased over time. These findings demonstrate that gestural pointing and linguistic pronouns and demonstratives share the same underlying communicative meaning.

Acquiring a linguistic deictic system and their internal contrasts

Children acquiring a spoken language undergo a developmental period where they point to single out and draw attention to objects using pointing gestures, and then become more specific in their deictic references as they rely on symbolic, deictic resources in spoken

languages. Deictic terms differ from pointing gestures as they are symbolic and characterized by their internal contrasts, but, like pointing gestures, they also 'point' to things in relation to the participants in the speech situation (Clark, 1978).

For example, person deixis, using pronouns like *we, I, you,* or *they* point to different participants and people referred to in a conversation. Place deixis uses locative or demonstrative terms like *here* or *that* to point to places and objects, and verbs like *come* and *go* index motion towards or away from a point of reference (Fillmore, 1966; 1971; Clark, 1978). Similarly, time deixis uses verb tense and adverbs like *now* and *yesterday*. Deictic terms differ from other types of words as they anchor each utterance by referring to the speaker in the here and now. The pronoun *I* refers to the speaker in contrast to *you* which refers to the addressee.

Unlike proper names and category names such as *Katherine* or the noun *table,* which remain static regardless of the speaker, deictic reference shifts based on who is speaking (Clark, 1978). The referents for "I" and "you" change depending on the speaker. Similar to personal pronouns, spatial adverbs such as *here, there, this,* and *that* are used with shifting boundaries. *Here* can be used within different contexts to indicate the speaker's precise location (*here where I am*), the room he is in (*here in the study*), or the country he is in (*here in Britain*). *There* is used contrastively to *here* and is constrained by the boundary that is established when the speaker determines the radius of reference for *here.*

Pronouns in spoken languages have a clear systematic mapping of form onto function. Grammatical categories are often organized by person, number, gender, and case markings. There is considerable variation in how languages encode different categories of deictics (Williams, 2019). Languages vary in their grammatical categories of deictic expressions – for instance, English has personal pronouns (*I, you, she*), demonstrative pronouns, and modifiers

(*this* and *that*), spatial adverbs (*here* and *there*), temporal adverbs (*now, yesterday*), and tense marking. Some languages may lack verbal tense marking. Some languages may have additional grammatical categories such as manner indexicals ("like this" or "like that") and presentatives ("here it is!"). Another way in which languages vary in their deictic systems is the number of contrastive items within each grammatical category. For example, English has two types of demonstrative determiners, *this* and *that* whereas other languages only have one (German *der*) or three (Spanish *este*, *ese*, *aquel*).

For person deixis, most languages mark grammatical distinctions between participant and non-participant roles. These categories are often grammaticalized as first (speaker), second (addressee), and third (neither speaker nor addressee) persons. Some languages mark three-way person distinctions (1^{st} vs 2^{nd} vs 3^{rd}), while other languages mark only two way distinctions (i.e., 1^{st} and 2^{nd} person vs 3^{rd} person (Cysouw, 2003). Also, some languages distinguish between first person plural inclusive (including the addressee) and exclusive (not including the addressee). Further, some languages make a distinction based on social status such as informal or formal pronouns (e.g., French forms *tu* = less formal/polite and *vous* = more formal/polite). English has a three-way distinction between person (1^{st}, 2^{nd}, and 3^{rd}).

Due to the shifting and categorically contrastive nature of deictic expressions, children show a prolonged acquisition of deictic terms (Clark, 1978). First, children may not use deictic contrast and only use one of the deictic pair – for instance, using *here* to point out objects that are either close or far away. Gradually, they show some understanding of contrastive deictic terms, yet do not fully grasp the meanings – they may produce *there* in addition to *here* without full understanding of the deictic contrast. They may assume based on a few phrases such as *There you are,* that *there* indicates some completed action. Finally, they achieve adult-like

understanding of the deictic contrast, and have worked out their hypotheses about different deictic terms and their meanings.

With respect to personal pronouns, pronouns vary in how often they shift in meaning, which influences their order of acquisition (Clark, 1978; Girouard, Ricard, & Décarie, 1997). For instance, pronouns referring to the self (*I*) may be easier to acquire than *you*, whose reference shifts more frequently than references to the self. First-person pronouns appear in speech fairly early at around 18 months, followed by 2nd person pronouns 2-3 months later (Clark, 1978). Then, *He, she, it,* and *they* are often acquired later because their meaning shifts more frequently than the first and second person pronouns. The whole pronominal system is typically in place by 2;06 years old. Taken together, previous literature shows that speaking children acquiring spoken languages often produce deictic forms, both pointing and pronouns, alone early in development, and then gradually integrate them with other linguistic forms. Also, children show stage-like acquisition of different pronominal terms, and have to work out the different internal contrasts within different deictic categories.

Is the indexical-symbolic deictic system found in signed languages?

In early communicative development, speaking children rely on gestural pointing, and then gradually turn to more linguistic pointing through the use of pronouns and demonstratives, revealing an intricate link between the indexical and symbolic. Also, the different grammatical categories of deixis and their internal contrasts are clearly marked by different categorical forms in the spoken language lexicon. The developmental process is a prolonged one, as children need to also understand the meaning of deictic contrasts within each grammatical category and continuously map deictic expressions onto different referents tied to the speech situation.

For speaking children, it is easy for us to distinguish gestural pointing from linguistic pronominal references as they map onto manual and vocal modalities, respectively. However, it becomes an interesting question in contexts where children develop a deictic system that is produced only within the manual modality, such in cases of sign language development. In this context, the pointing gesture takes on the full communicative burden of communicating about the here-and-now. It is an open question whether signing children undergo a similar developmental progression of gestural pointing, and then eventually transition to a linguistic analysis of points, moving up to higher levels of generalization and abstraction. Do signers eventually apply the same functions and categorize points that speakers do with their pronouns?

This problem of distinguishing gestural and linguistic dimensions of signed languages is not new, and is still part of ongoing discussions (Emmorey, 2003; Liddell, 2003; Taub, 2001; Goldin-Meadow & Brentari, 2017; Lu & Goldin-Meadow, 2018). Hoiting and Slobin (2007) have posed this question in their observations of signing children acquiring Dutch Sign Language (SLN): "When do iconic and indexical gestures become symbolic?" They hypothesize that the form of pointing, its integration within the sign language prosodic structure, and its level of abstraction as measured through physical distancing could be qualities of symbolic pointing. For instance, in one parent-child interaction, a 2-year-old child was struggling to fit her doll into a toy washtub, and the mother places the doll in the bath and signs DOLL. The child points with a crisp, quick execution, while looking at a doll and then back to her mother to attract attention to the doll. The mother responds, YES DOLL. Based on this observation, Hoiting and Slobin (2007) comment that the child is marking the object as the conversational topic through the point, and produces the point with short, quick movement which integrates well with sign language prosody, and the eye gaze from the object to the interlocutor, which are all indicators of

a "sign-like" production. In addition to potential linguistic marker of points through form, signing children integrate points with gaze and lexical items in a fluid construction. For instance, one girl of 2;8 complains about her brother to her mother, accusing him of having taken a paper crown from her head. She says, BOY GRAB POINT SHAME, while pointing and gazing at her mother and reporting that her brother has grabbed her hat without permission and should be ashamed. These two examples, Hoiting and Slobin (2007) claim, are signs of "language-specific shaping of a basic indexical gesture" (p. 7). These preliminary observations are a good starting place for this dissertation.

The role of a shared linguistic system in the emergence of a deictic system

This dissertation work will explore whether signers and speakers develop similar deictic functions, focusing on a number of parameters. It will also ask whether these functions emerge in a situation where there is no shared linguistic code between the child and their parents. This question can be explored with deaf homesigning children, who cannot learn speech and whose hearing parents do not know a signed language (Feldman, Goldin-Meadow, & Gleitman, 1978; Goldin-Meadow & Feldman, 1977; Goldin-Meadow & Mylander, 1983; Goldin-Meadow & Mylander, 1990).

Homesigners' great reliance on pointing to communicate their intentions with their parents speaks to the power of the point with respect to communication efficiency. Previous work has shown than homesigners develop some properties of pointing found in signed languages, such as developing displaced references and assigning different types of semantic roles to their points (Morford & Goldin-Meadow, 1997; Goldin-Meadow & Mylander, 1983; Goldin-Meadow, 2005). On individual word level, they create alternations in their gesture forms, showing emergent morphological contrasts. They also produce gestures to signify transitive

actor, patient, and intransitive actor, and exhibit an ergative pattern in their gesture order (see Goldin-Meadow, 2005 for a review). They can construct complex noun phrases containing a demonstrative point at a particular object, say, a bird, followed by a noun iconic gesture identifying the category of the object, a bird. This phrase is followed by a verb, pedals, that describes what the bird is doing, e.g., [that bird] PEDALS) (Hunsicker & Goldin-Meadow, 2012). They also integrate points with predicate nominals (e.g., producing a demonstrative point followed by a noun iconic gesture to identify a bird, *that's a bird*). We do not know much about the developmental trajectory homesigners follow, particularly in comparison with signers and speakers.

Overview of the dissertation

This dissertation involves a multi-dimensional analysis of how language, modality, and input influence children's emerging deictic references. In Chapter 1, I review the sign language literature that provides various evidence for a linguistic analysis of pointing in sign language, including some previous developmental work on pointing. Then, I describe in detail the current study, which involves systematic comparisons between speaking children's deictic system as a whole – including both pronouns and pointing – and signing children's pointing, using naturalistic corpus data. I focus my analyses on the following deictic functions: 1) referentiality, 2) displacement, and 3) productivity of deictic expressions with other linguistic units. Chapter 2 focuses on form-to-function mappings, asking whether speakers and signers show differentiated pointing forms according to different information functions, which would be evidence for an organized system of contrasts. Chapter 3 of this dissertation attempts to understand which aspects of deixis emerge in face of wide variability in children's linguistic environments. This is the first known study that compares homesigners with native signers and speakers.

Chapter 1: Development of Deictic Functions in Spoken and Signed Languages

There has been a long-standing theoretical interest in the linguistic status of pointing in signed languages. The form of pointing signs resembles non-signers' pointing gestures. It has been claimed that sign languages "lack pronouns" and use pointing instead (Evans & Levinson, 2009). However, most sign linguists have claimed that pointing share many similar functions as pronouns in spoken languages (Klima & Bellugi, 1979; Padden, 1983; Meier & Lillo-Martin, 2010).

Given the historical context of trying to prove sign languages as real languages, not merely a system of gestures or pantomimes, many linguistic phenomena in signed languages have been examined within the framework of spoken language linguistics. Pronouns are a good example. Many linguists have assumed that pronominal signs are distinct from pointing gestures used by non-signers by imposing an analysis of pronouns on pointing signs (e.g., Berenz, 2002; Bos, 1995; Engberg-Pederson, 1993; Hatzopoulou, 2008; Klima & Bellugi, 1979; Lillo-Martin & Klima, 1990). As sign languages became recognized as legitimate, researchers started to explore the role of gesture in signed languages (Liddell & Metzger, 1998; Schembri, Jones, & Burnham, 2005; Goldin-Meadow & Brentari, 2017). More recently, a new perspective has emerged -- pointing in signed languages may have features that are both linguistic and gestural (Cormier, Schembri, & Woll, 2013).

Pointing has been claimed to have many functions within sign languages, such as pronominal, adverbial (locative), and determiner functions. Locative pointing signs point to a location and have an adverbial function (meaning 'here', 'there', 'in this/that location'). Determiners tend to be produced with nouns and occur within a noun phrase, and the point can be used to establish a location in space that could be later referred to. Demonstrative pointing

signs point to a location to refer to an object or concept (meaning 'this' and 'that'). Pointing signs can also be used for personal pronominal uses, which point to present referents or locations to refer to speech act participants. However, distinguishing these functions often involves a lot of uncertainty (Emmorey, 2002; Fenlon, Schembri, Rentelis, & Cormier, 2013; Johnston, 2013).

Arguments for a linguistic analysis of points

Person/participant roles in sign languages. Pronouns in spoken language have clear grammatical categories, where their form systematically varies with function. Whether sign languages have a three-person system found in many spoken languages has been a central question within sign language linguistics. Researchers have approached this question from two levels of analysis: 1) looking at the form of pointing to mark participant roles and 2) syntactic distribution of pointing. Earlier work on American Sign Language (ASL) has assumed sign has a pronominal system just like in spoken languages with a three-person distinction (a point to the addressee is equivalent to a second person pronoun, a point to a non-addressed participant is equivalent to a third person pronoun, and a point to the body is equivalent to the first person; Friedman, 1975; Padden, 1983; Lillo-Martin & Meier, 2011). However, this analysis has been challenged since there seems to be no "finite, listable set of non-first person forms or location values" (Meier, 1990; Rathmann & Mathur, 2002).

Another analysis put forth by Meier (1990) has argued for a two-person system that distinguishes first person and non first-person pronouns as first person pronouns behave differently compared to non-first person pronouns. First-person pronouns have a specific place of articulation – points to the chest, unlike non first-person pronouns, which don't seem to have a fixed place of articulation. Second, signers can use the first person pronoun to refer to

themselves and also another character, particularly in situations where they are taking on the role of another person (known as 'constructed action' or 'role shift'). Meier (1990) has argued that because first-person references can allow for shifting references, ASL has a clear distinct behavior for first-person pronouns. Lastly, first person plural forms take on a different form with a double point on the chest ('we'), which is different from non-first singular and plural forms that point towards locations tied to the referent. Currently the two-person system is accepted by many sign linguists in the field. Developmental work may be able to help us understand whether signing children acquiring signed languages show similar stage-like acquisition of references to self, addressee, and non-addressee, comparable to speaking children's acquisition of different pronouns. If so, this would be some evidence supporting that signing children are differentiating these references in a categorical way (e.g., Lillo-Martin & Chen-Pichler, 2018a; 2018b; 2019).

Productivity and syntactic distribution of pointing signs. Formationally, pointing signs are similar to pointing gestures, especially with respect to non-first marking. However, functionally, pointing gestures seem to behave similarly to pronominals (Cormier et al., 2013). Pronominal signs serve as verbal arguments and can substitute for noun phrases (e.g., $INDEX_a$ NOT LIKE $INDEX_b$ – "She/he_a doesn't like him/her_b"). Speakers can also use pointing gestures to mark pronouns, but it is very rare that they would replace a spoken pronoun with a pointing gesture in a sentence (Cormier et al., 2013). Most of the time, speakers would supplement a pronoun in speech with a pointing gesture (McNeill, 1992). Pointing signs, in contrast to pointing gestures, are often produced with other signs to signify relationships between agent, action, and objects, although null arguments can be allowed (Lillo-Martin, 1986).

Displaced pointing. Pointing signs are often transparent by indexing to objects or persons in the immediate environment, but they can also be used to reference things that are imagined and not present in the here-and-now (Lillo-Martin & Quadros, 2011). Signs that mark first-person tend to be lexically specified by pointing to the chest (Meier, 1990), however, non-first-person pointing signs make use of loci in the signing space in front of the signer. A referent can be established and be associated with a locus arbitrarily, and then pronouns/pointing signs will be used to index this locus. It is possible to use an actual or imagined location of a referent (Figure 1; Lillo-Martin & Quadros, 2011). In the latter case, pointing signs, just like pronouns and pointing gestures in spoken languages, can be used to reference absent and imagined referents. The fact that pointing signs can refer to non-present entities has been argued to be a characteristic of pronouns, and the transition from real-world pointing to abstract pointing is a sign of grammaticalization (Senghas & Coppola, 2010). However, pointing gestures can also be used to refer to imagined referents, which should also be taken into consideration (McNeill, 1992).

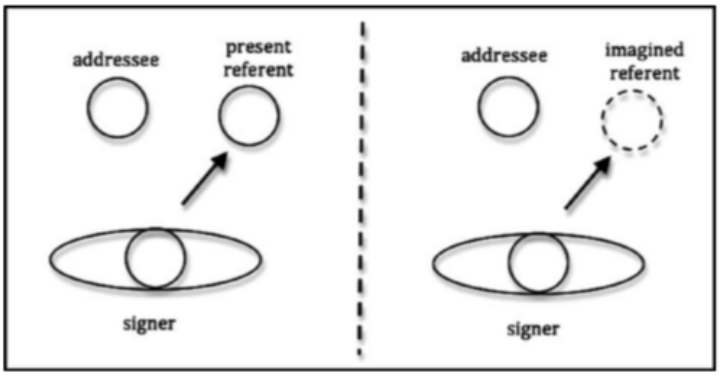

Fig. 1. Use of real-world (left) or abstract/imagined (right) loci.

Figure 1. Use of real-world (left) or abstract/imagined (right) loci (image from Lillo-Martin & Quadros, 2011)

Shifted indexicals. One fundamental property of deictic references in speech involves shifting references despite having consistent symbolic forms. Pointing signs' referents can also shift, especially in cases of using a particular device in signed language, known as role shift (RS) to convey someone else's viewpoint (Padden, 1986). In colloquial spoken English, speakers often quote another speaker while mimicking the facial expression and intonation of that speaker, such as in the following example, where the quotation is introduced by a phrase *be + like* (Clark & Gerrig, 1990):

1) She was like, "I can't believe you said that!"

In signed languages, signers can achieve quotation of similar effect by shifting the body associated with an arbitrarily assigned locus of the speaker and producing facial expressions of that speaker.[1] While quoting another person, first-person pronouns and other indexicals' referents effectively shift as well. Like in example 1 in spoken English, example 2 (from Lillo-Martin & Quadros, 2011) includes the signer showing the same effect of shifted reference by shifting the body toward the locus associated with the quoted speaker, while pointing to the self, which refers to the speaker of the quoted material, not the actual speaker.

2) _____RS:student

STUDENT (SAY) <IX(self) PASS TEST>

'The student was like, "I passed the test!"

(Lillo-Martin & Quadros, 2011)

Meier (1990) has maintained that because first-person references can allow for shifting references, ASL has a clear distinct behavior for first-person pronouns. The pointing sign to the

1. Role shift can also be used for non-quotative functions, such as mimicking the action of a character of referent, which is often referred to as constructed action (Liddell & Metzger, 1998). Usually, in constructed action sequence, there is no first-person pronoun shift (Engberg-Pedersen, 1995).

self carries the meaning 'animate being in the role of signer or sender.' It is worth noting that it is also possible for a hearing non-signer to shift their pointing gestures while they quote another speaker, as previously reported by McClave (2001) and Cooperrider (2011). This function of shifting reference appears to be possible with pronouns, pointing signs, and pointing gestures.

Empirical investigations on pointing signs and pointing gestures

Even though pointing is prevalent in both signed and spoken communication and appears to be strikingly similar in form, this indexical expression has been analyzed under different theoretical perspectives and within different historical landscapes. Pointing signs have been described as being part of a linguistic, pronominal system (e.g., Meier & Lillo-Martin, 2010), while pointing gestures have been assumed to be non-linguistic and external to language (Kita, 2003). Some argue that pointing signs have some linguistic and gestural properties (Cormier et al., 2013).

Some comparative studies noted differences in the form and function of points in signers and speakers. Zwets (2014) compared the functions of pointing signs of Sign Language of the Netherlands (NGT) signers and pointing gestures of Dutch speakers, and signers use arbitrary locations in space to refer to non-present referents more often than speakers. Signers and speakers in San Juan Quiahije Chatino use different handshapes for distant locations (Mesh, 2017). Building on this previous work, Fenlon, Copperrider, Keane, Brentari, and Goldin-Meadow (2019) did a more comprehensive analysis comparing pointing gestures and signs using television interview and corpus data. They used formational criteria that may be markers of *conventionalization*, *reduction*, and *integration*. A conventionalized form tends to be more stable and less variable for a given meaning; this has been an important criterion for distinguishing

gesture from language. In the study, they examined several features such as handshapes, use of one or two hands, hand preference (dominant vs subordinate hand), and contact with the chest (for self-points) in pointing signs and gestures. If pointing signs are more conventionalized, signers should show more consistency in the production of their pointing signs according to these parameters, compared to speakers.

The second criterion was reduction in form, which could be a marker for grammaticalization. Grammaticalization of many forms within signed languages may trace back to the gestures used by the surrounding speech community (Janzen & Shaffer, 2002; Pfau & Steinbach, 2006). Pfau & Steinbach (2006) proposed that pointing signs may have become grammaticalized from pointing gestures over time, such that pointing gestures become locative signs, then demonstrative pronominal signs, and finally personal pronominal signs. Points that are articulated quickly and with small movements may indicate that they have become more grammaticalized. In an emerging language, Nicaraguan Sign Language (NSL), locative pointing signs appear more frequently in homesigners and earlier cohorts, and then gradually the later cohorts produce more pronominal pointing signs. Pronominal points also appear to more reduced in form compared to locative points; however, this was not systematically measured (Coppola & Senghas, 2010). Similarly, Fenlon et al. (2013) noted, based on BSL corpus data, pronominal signs appear to be shorter in duration relative to adverbial locative pointing signs, and exhibit greater assimilation effects (i.e., the 1-handshape with pronominal functions is more likely to assimilate to the handshape of a subsequent sign). Based on these speculations, pointing signs may be more reduced than pointing gestures.

Finally, in Fenlon et al. (2019)'s study, the degree of pointing signs' integration with the language was measured by examining the role of pointing signs in the syntactic and prosodic

structure. If pointing signs behave like pronouns, they should show high level of syntactic integration (de Vos, 2015). If pointing signs are fully integrated within the grammar of sign language, they should show some prosodic characteristics typically found in sign language. For instance, signs that appear at the ends of intonational phrases tend to be longer in duration than signs appearing in other positions. Pointing signs may elongate in duration when they appear in phrase-final position.

On many dimensions, adult signers showed a clear patterning of preferences for many formational features; gesturers showed less patterning and more variability (Fenlon et al., 2019). Signers showed a strong preference for 1 handshape when pointing to self, addressee, and other-entity; gesturers preferred the B handshape for points to the self and mixed preferences for addressee and other-entity. Signers also strongly preferred one hand for pointing to self, addressee, other-entity; gesturers showed more variability for one hand, and preferred two hands for pointing to self. Signers also showed a much stronger preference for their dominant hands, and consistently produced shorter points compared to gesturers. As a sign of integration, pointing signs were more likely to be shorter in non-final positions than final positions; pointing gestures did not show a difference in duration between final and non-final positions. These findings are evidence that pointing signs are more reduced and integrated with utterances than pointing gestures.

Based on these findings, the authors offer two explanations: 1) pointing signs are more linguistic and conventionalized than pointing gestures; 2) there is a modality effect, where pointing signs are produced in the same modality as the signs they accompany (because of this funneling effect, pointing signs are reduced in form); pointing gestures are produced in a different modality from the words they accompany, and there is a modality affordance for points

to be held longer. Reduction could also be influenced by frequency – it is known that the more frequent a communicative form, the more reduced it tends to be (Zipf, 1949), which could be related to efforts to conserve energy during communication. These results highlight the fundamental differences between pointing signs and gestures in their formational qualities and level of integration with other linguistic units. However, the sources that give rise to these differences remain unclear.

Pointing in sign language development

To address some of these theoretical issues on pointing, linguists have turned to child language development. Sign linguists have approached this question by 1) examining whether signing children make errors with pointing despite their transparency, and 2) comparing signing and speaking children's pointing to different referents, as well as their spoken pronominal references.

Petitto (1987) claimed that signing children apply a formal analysis to pointing signs with evidence there is discontinuity from gestural to linguistic pointing. Two signing children were studied longitudinally; from 10 to 12 months, they pointed at all types of references, including persons and objects. But then, between 12 and 18 months, they dropped a particular pointing function, points to persons. Instead, name signs or nouns were used. Previous studies on spoken language acquisition have demonstrated a similar phenomenon, where difficult phonological constructions are avoided during a certain period of development. Signing children also surprisingly made reversal errors by pointing towards an addressee to refer to themselves, but then by 27 months, all of the points were produced correctly. These reversal errors also have been found in hearing children acquiring pronouns (Clark, 1987). Similarly, Morgenstern et al.

(2010) examined a deaf child acquiring French Sign Language (LSF) and a hearing bilingual child acquiring LSF and French, and found a similar pattern with disappearance of points to the self (11-19 months), although this pattern was not explicitly discussed in the paper. They did not find any reversals of points like Petitto (1987) reports. Petitto (1987) makes the case that the disappearance of points to people is evidence for discontinuity between non-linguistic pointing and linguistic "pronouns" – during this avoidance period, children are working out the multiple semantic and grammatical properties of personal pronouns and re-analyzing gestural points as linguistic.

However, the disappearance of this particular function could have been confounded by the circumstances or development of other aspects of ASL, such as spatial verbs, which was not considered in Petitto (1987)'s study. ASL and other sign languages have rich verb agreement systems, where noun phrases are first assigned to spatial loci, and then inflecting verbs can agree with these loci without overtly renaming the NPs (Lillo-Martin, 1986). These children may have started to drop person references as they learned how to coordinate agreement verbs. Previous work on agreement verbs has shown mixed results on signing children's use of agreement verbs at a young age. Meier (1982; 1987) has reported using longitudinal study with 3 children ages 2;0-3;8 acquiring ASL that children showed errors in their agreement verbs, such as omitting the inflections. They did not acquire verb agreement until about 3;0-3;06 years old. They also were more likely to omit inflection for subject agreement verbs, which involve movement from the spatial location of the subject toward the object's location (e.g., ASL verb GIVE), than object agreement verb, which involves movement from the object to the subject (e.g., ASL verb TAKE). These errors can be explained by the fact that agreement with the subject is optional, but

object agreement is obligatory in ASL, and children are omitting inflection whenever it is not obligatory (Meier, 1987).

However, other studies examining children ages 1;2-2;8, such as Quadros and Lillo-Martin (2007) found very few errors in child production of verb agreements, although these verb types tend to be low in frequency compared to other verb types, including plain verbs, which do not require inflection. The fact that children preferentially use verbs, such as plain verbs, that do not require agreement over agreement verbs is noteworthy. Similarly, Casey (2003) observed six children acquiring ASL, and found that agreement was used in non-conventional gestures as early as 0;8-1;0 years old and in conventional signs as early as 1;11 years old. These age periods happen to be around the same period when children are dropping points to persons, as reported in Petitto (1987)'s work. Future work should follow up on Petitto's (1987)'s study with an investigation on children's use of agreement verbs and pointing, as the disappearance phase of points to persons could coincide with the development of spatial agreement.

Other studies looking at signing children's pointing did not replicate Petitto (1987)'s data. Hatzopoulou (2008)'s work on Greek Sign Language did not find a clear break in pointing towards persons or pointing reversals. The child showed a continuity of referring to persons throughout development, although they did show a slight decrease in frequency of points to persons and self between 16 and 20 months. Hatzopoulou (2008) also looked at variation in pointing referents over development, and the child produced proportionally more points to the self out all points. She concludes that children gradually discover different functions of pointing as they develop, but there is no clear evidence of specific pointing functions dropping out during their development.

Lillo-Martin and Chen-Pichler (2018a; 2018b; 2019) also looked at different functions of pointing in sign, predicting that different personal references might emerge at the same time point or in sequential order resembling speaking children's acquisition of personal pronouns in spoken languages. In addition, they examined speaking children's pointing references to persons, which has been rarely reported in previous work. Only Caselli et al. (1983) noted that speaking children point to self at 20-24 months after they have started using first-person pronouns in speech, and Pizzuto and Capobianco (2008) found that 3 out of 7 children pointed to self or addressee, but rarely to objects and locations. Using corpus data of deaf and hearing children's pointing from ages 1;05 to 3 years old, the frequency of points and their referents to self, things/location, addressee, and non-addressee was analyzed. Based on this data, Lillo-Martin and Chen-Pichler (2018a; 2018b; 2019) argue that signing children have multiple pointing functions, but speaking children use pointing for a limited set of functions. Signing children pointed to both things/location and people (addressees and non-addressees), but speaking children predominately pointed to objects, but rarely to people. Moreover, references to the self, things/location, addressees, and non-addressees appeared at different time points for signing children. Points to inanimate objects appeared first, and then points to the self at a later time point. Points to addressees and non-addressees appeared even later, albeit infrequently. Due to the different timing of these pointing references, they argued that signing children are analyzing these points as having distinct functions, and addressee and non-addressee points may have distinct grammatical contrasts (cf. Meier, 1990).

The lack of pointing references to people by speaking children could be due to the fact that they resort to spoken pronominals instead. Morgenstern, Caët, and Limousin (2016) observed a deaf child's pointing and hearing child's deictic references in *both* speech and

gesture. From 1;7 to 2;7 years, the deaf child, Charlotte produced significantly more points per minute compared to the hearing child, Madeline. Charlotte produced a significant number of points to non-first persons and the self, compared to Madeline, but Madeline used verbal resources to refer to herself and others (such as names or pronouns in speech). Morgenstern et al. (2016) also compared these two children's use of pointing and spoken pronouns, referring to the self, in combination with other lexical materials. Charlotte produced many points with predicates just like Madeline who produced many verbal self-references in combination with predicates. This study, along with Lillo-Martin and Chen-Pichler (2018a; 2018b; 2019)'s work, reveals that modality has a strong influence on deictic reference – Charlotte relied exclusively on points for reference, especially to the self, but Madeline channeled this reference through the verbal modality with her pronouns. When considering all indexical references including spoken and gestural references, both signing and speaking children seem to develop deictic systems with comparable functions and co-construct them with other linguistic elements they are acquiring. Yet this developmental trajectory has not been studied systematically.

Current study

Pointing signs and gestures have been traditionally studied within separate threads, and pointing signs have often been compared only to pointing gestures. The current study focuses on deixis in *both* speech and gesture and compares this system with pointing in sign. Using naturalistic corpus data, I document 1) what children are referring to (referentiality), 2) how they productively combine pronouns and points with other lexical materials (productivity), and 3) whether they can abstract beyond the here-and-now by referring to things non-literally or to absent referents (displacement). I expect to see differences between pointing gestures and

pointing signs based on earlier studies with children, but when the hearing children's verbal pronouns are included in the analyses, these differences may disappear. More specifically, pointing signs may behave more like pronouns in speech than like pointing gestures with respect to referentiality, productivity, and displacement. This pattern would suggest that pointing in signed language is functionally similar to the symbolic and indexical system in spoken languages. Alternatively, pointing in sign might still not develop all of the functions when pronouns are added to the analysis, suggesting that pointing in sign language is a fundamentally distinct system from the symbolic-indexical system in spoken languages, and might be characterized as more gestural, rather than linguistic. One final point is worth making—pointing signs not only have to play pronominal roles, but they also have to accomplish gestural goals. If pointing signs are compared only to gestures, their linguistic function is ignored. But if they are compared only to verbal pronominals, their gestural function is ignored. In my study, I compare signers' pointing signs to speakers' pronominal word *and* gestures.

Methods

Signing participants. All of the pointing data were extracted from naturalistic, spontaneous productions of three signing children born to Deaf parents, ABY, JIL, and NED (2 females, 1 male; Table 1). The data come from samples of spontaneous production (the SLAAASH database, Lillo-Martin & Chen-Pichler, 2008)[2], which was collected by filming the children interacting with their parents and other fluent signers in naturalistic activities, such as

[2] The research reported here was supported in part by the National Institute on Deafness and Other Communication Disorders of the National Institutes of Health under Award Number R01DC013578 to PI Diane Lillo-Martin. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

playing with toys and looking at books. The videos were transcribed and checked by fluent signers, and the points were previously coded by Lillo-Martin and Chen-Pichler (2018). We hand-searched for these points and coded for formational and function information. Data for children ages 1;06 to 4;02 with approximately 4 months breaks in between were collected. Not all of the children had complete sessions for this entire range (see Table 1).

Speaking participants. Participants were drawn from a longitudinal study of language development at the University of Chicago (described in more detail in Rowe & Goldin-Meadow, 2009; Goldin-Meadow et al., 2014). Our sample consisted of 10 children (6 females, 4 males) who were videotaped in the Chicago area. All children were exposed to monolingual English speakers. They were taped every four months beginning at 14 months, for the longitudinal project. I selected age ranges of 1;06 to 4;02 to match the deaf subjects. Transcription of points and speech in parents and children was previously coded and checked by fluent English speakers. As for the deaf participants, we hand-searched for all points and deictic references in speech and coded them for formational and functional information. One subject was missing one video session, so their points were not coded for that session (Subject 22 at 2;10) and there were two missing transcripts for two subjects so their pronouns were not coded for these sessions (Subject 27 at 1;06 and Subject 38 at 3;10).

Table 1. Age ranges of 4 signing children from the SLAAASH database (Lillo-Martin & Chen-Pichler, 2018) and of 10 speaking children from the LDP database at the University of Chicago.

Time point	1	2	3	4	5	6	7	8	9
Signing children									
ABY	1;06	1;10	2;02	2;06	2;10	3;02	N/A	N/A	N/A
JIL	1;07	1;10	2;02	2;06	2;10	3;02	3;06	N/A	N/A
NED	1;06	1;10	2;02	2;06	2;10	3;02	3;06	3;10	4;02

Table 1 (continued)

Speaking children

All 10 subjects	1;06	1;10	2;02	2;06	2;10	3;02	3;06	4;00	4;02

Coding methods for pointing signs and gestures

Referentiality: identifying pointing signs and referents. Using ELAN (Wittenburg et al., 2006), all index finger points and their referents were annotated: 1) self, 2) addressee, 3) non-addressed person, 4) inanimate object/location. Whenever the child points to themselves, the point was coded as a reference to self; however, when the child points to a part of the body, such as their hand, the point was coded as a reference to inanimate object/location. For pointing to an addressee, we relied on eyegaze and context to determine whether the child was addressing another person directly (i.e., the child is gazing at their interlocutor and pointing at them). For non-addressed persons, the child typically points at another person, while looking at the interlocutor they're addressing and narrates about the other person. For objects, we coded whenever the child was pointing to an inanimate or animate object (such as a toy or animal); however, we could not always determine whether the child was referencing the object itself or the object's location with their pointing, which is clearly marked in speech (e.g., *there*, *here*), so they were categorized together as *inanimate object/location*. Points to books, pictures, or the television were counted as points to objects. There were cases where the child's reference to location became clear, such as in situations where the parent asks the child where a specific object is, and the child responds by pointing to the bedroom. Points to pictures, representations within books and television were also coded as inanimate object referents. Finally, plural points (e.g., *we, they*) or any indexes that incorporate manual numbers (e.g., *two of us*) were not included in the analysis.

Productivity of points with signs/speech. First, we identified whether a point was produced on its own or combined with other gestures, signs, or words. If there were no signs or words that followed or co-occurred with the point, or there was a clear pause between the point and the subsequent utterance, then they were identified as points being produced *Alone.* If the point was in a combination with other words, then we coded that as points embedded in *Multi-sign utterances*.

Points within complex utterances. A point could appear as part of an utterance with other words in several ways. Occasionally, the point refers to the person and combines with a sign representing their action (e.g., PT(picture-of-Mother) BEDpa, 'She is sleeping'). Sometimes, a point is combined with temporal signs without a verb (e.g., PT(microwave) SOON, "It is finished soon"). At other times, the point refers to the object or place performing the role of a locative adjunct in an utterance with a verb (e.g., GO PT(room), 'Go there'). Sometimes, the point is part of a copular or predicative structure (e.g., PT(picture-in-book) BIRD, 'This is a bird'; RED PT(toy) 'This is red'). In the data analyses, all of these examples were categorized as *Multi-sign utterances.* Figures 2 and 3 show examples of points within various contexts produced by signers and speakers.

Literal and displaced pointing. We distinguished between literal and abstract points. If the person/object is present in the context and the point is referring to this person/object, the point was coded as *Present literal*. If the person/object is assumed to be present in the context and the point is referring to this person/object even though it's not visible, the point was coded as *Present literal non-visible*. For example, one child points to the living room in a previous frame, and then, in the next frame, the child was taped in the hallway close to the living room; she points to the living room again, although the living room was no longer in the frame. Inferring

from the previous frame that the living room exists, we coded this point as present literal non-visible. For the final analysis, both present literal and present non-visible codes were collapsed into one category to represent *Present literal*.

If the person/object is present in the context, but the point is interpreted as referring to a person/object that is not present, we coded this point as *Present non-literal* (e.g., pointing to a toy animal to refer to a real animal or a dad's hat to refer to dad). *Present picture representation* was associated with references in books, pictures, or images on the TV. Finally, if the point refers to a person/object not present (and not assumed to be present) (e.g., pointing to a locus that has been associated with a referent; an empty location where a puzzle piece should go), this point was coded as *Absent.* For example, one child narrates about her friend at school, and says JULIE SCHOOL IX-SCHOOL – in this case, the child does not literally point to the school but establishes an abstract locus in her signing space to represent the school and refers to it with a point. For the data analyses, all absent and non-literal referents were collapsed as one category, *Displaced pointing* (non-literal points and points to absent objects).

We had one additional category *Discourse/relative deictic* where the point refers to something mentioned earlier in the discourse or clause (e.g., "This is the toy *that* makes loud noise"), which was eventually included in the *Displaced* category due to their small numbers, but future analyses can distinguish between truly displaced pointing (non-literal and absent references) and endophoric, discourse based deictic references.

Additional coding for pronominal references in speech

For the most part, coding spoken deictic references was similar to coding for signing children, except that we also coded for pronouns in speech in addition to pointing.

Identifying pronouns. All of the deictic expressions were pulled from the transcript by focusing on the following personal pronouns and demonstratives that complement the pointing functions that signing children use: first person singular referents (I, me) were categorized as first person, second person referents (you) were categorized as second person, third person referents (he, she, her, him), object/location (it, that, these, this, those, here, there) were categorized as third person. Plural pronominal referents (e.g., *we, they*) were not included in the analyses as they are marked by different phonological forms in ASL. After coding, we categorized the pronouns within the same categories used for signing children – self, addressee, non-addressee, and things/location.

Semantic roles of pronouns and points. We used the same criteria as for signing children's points to analyze the semantic role of pronouns (see the above section "Semantic role of points"). However, we did not apply the same syntactic analysis for points. Previous research shows that speakers do not integrate points in their spoken utterances in the same way as signers do as the points tend to co-occur with speech (Cormier et al., 2013). Instead, we coded for the relationship between points and speech content, rather than coding for their specific semantic role. We coded for points that occur by themselves (*Points alone*), and points that co-occur with pronouns (*Pronoun + point*), and points that co-occur with a noun or verb phrase (*Point + other speech content*). Sometimes, points extend over a whole noun or verb phrase or co-occur with a part of the phrase.

Reliability. Reliability of coding was assessed by having a second coder randomly select and code one participant from each group and code all of the sessions for that participant (~20% of the data). Below is the reliability for points identified by both coders for speakers: referent type (90%), literal vs. displaced points (82%), semantic role of points produced alone vs. with a

pronoun or noun/verb (78%). Reliability for all coding based on the transcript for all demonstratives and pronouns in speech is listed as the following: referentiality (99%), semantic analysis (95%), and literal vs. displaced references (93%). For signers, reliability reached 97% for identifying referents, 95% for identifying literal vs. displaced points, and 94% for semantic analysis of points.

Some of the disagreements arose when one coder put down a different code for semantic analysis from another coder, e.g., one coder identifies a point as appearing alone, while the other coder categorizes the point as appearing with another word in the utterance (e.g., identifying the point as having demonstrative/predicate role). Other times, discrepancies came up because one coder put down a point as a reference to a person, while the other coder assumed that the child was pointing to a body part or an article of clothing (e.g., inanimate object). Other times, one coder may not know how to code a particular instance, marking it as "Unclear," while the other coder picks a specific category. For judging literal and displaced pointing, some inconsistencies arose because one coder put down "present literal" while the other coder put down "present invisible." We discussed and resolved these disagreements.

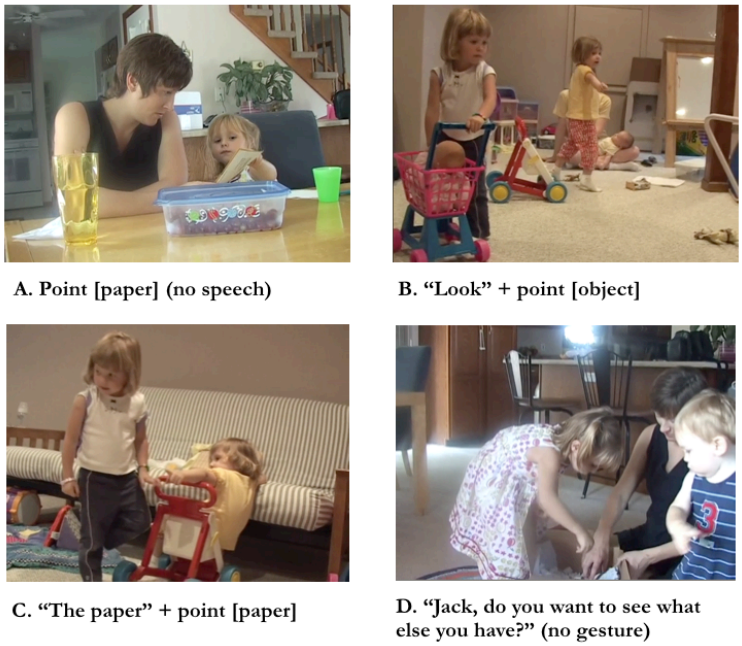

Figure 2. Examples of pointing and pronominal references in speech and gesture.
Note. A) The child points at a piece of paper without any speech. B) The child produces a point and verb combination by looking at an object while saying "look." C) The child produces a point by pointing at a piece of paper and uttering "the paper." D) The child produces a pronominal reference in speech referencing to second person, using the pronoun "you" to refer to her brother. All images come from the LDP database (Rowe & Goldin-Meadow, 2009; Goldin-Meadow et al., 2014).

Figure 3. Examples of pointing signs

Figure 3. Examples of pointing signs (continued)

Note. A) The child only produces a point to the chair. B) A pointing sign is produced following the lexical sign LOOK. C) The child points at the bucket and then produces the sign EXPLODE. D) A point to an arbitrary location (absent referent) is produced after the lexical signs NAME-SIGN HELP WASH. All images come from the SLAAASH database (Lillo-Martin & Chen-Pichler, 2008).

Results

Statistical analyses

For all of the analyses, I conducted linear mixed effects models (GLMMs) using the *lme4* package (Bates, Mächler, Bolker, & Walker, 2015). For some analyses, I created separate models for signers and speakers; however, for other analyses when they were compared, Language (sign vs. speech) was entered into the model. To account for non-independence, I used subjects as crossed random effects. Thus, we are assuming a different baseline rate of gestures or words for each subject, where each subject is assigned a different random intercept. For model selection, the models were evaluated with likelihood ratio tests, which compare the full model (e.g., including the fixed effect of interest or an interaction term) with a null model (e.g., excluding the fixed effect of interest or interaction term). If the full model vs. null model comparison reached significance, the term of interest must be a significant contributor to the model. The statistics report the chi-square value and *p*-value reflecting the results from the likelihood ratio tests.

Referentiality in spoken and signed language

Pronominal references in speech only. Figure 4 shows the mean proportion of deictic references in speech to four different referent types (things/location, self, addressee, and non-addressee). The following categories in speech included specific word referents: first person singular (I, me), second person (you), third person (he, she, her, him), object/location (it, that,

these, this, those, here, there). As expected, children produce more pronouns over development; age is a significant predictor of number of pronouns, after taking into account the random factor of subject (χ^2 (8) = 26.04, $p < .005$). The majority of children's points referred to objects/locations (*M* = 65.2 %, *SD* = 21.2%). Next, the most frequent points were points that referred to self (*M* = 20.4 %, *SD* = 16.3%), followed by points that referred to second-person (*M*= 8.9%, *SD* = 8.7%) or third-person (*M* = 5.5%, *SD* = 6.7%). The plot that captures the individual variation in distribution of pronominal references in speech over development can be found in the Supplementary section (Fig. 22; Appendix A). Early in development, references to the self or things/location, in either demonstratives or pronouns, predominated. Interestingly, there were no great delays in the onset of second and third person pronouns, but these pronouns were generally not produced as often as first person pronouns, especially in the earlier time window. There was a lot of variability among the children in the onset of 2nd and 3rd person pronouns; for some children, 2nd and 3rd person pronouns appeared at around the same time (4/10 children), and for others, 3rd person references followed 2nd person references (6/10 children).

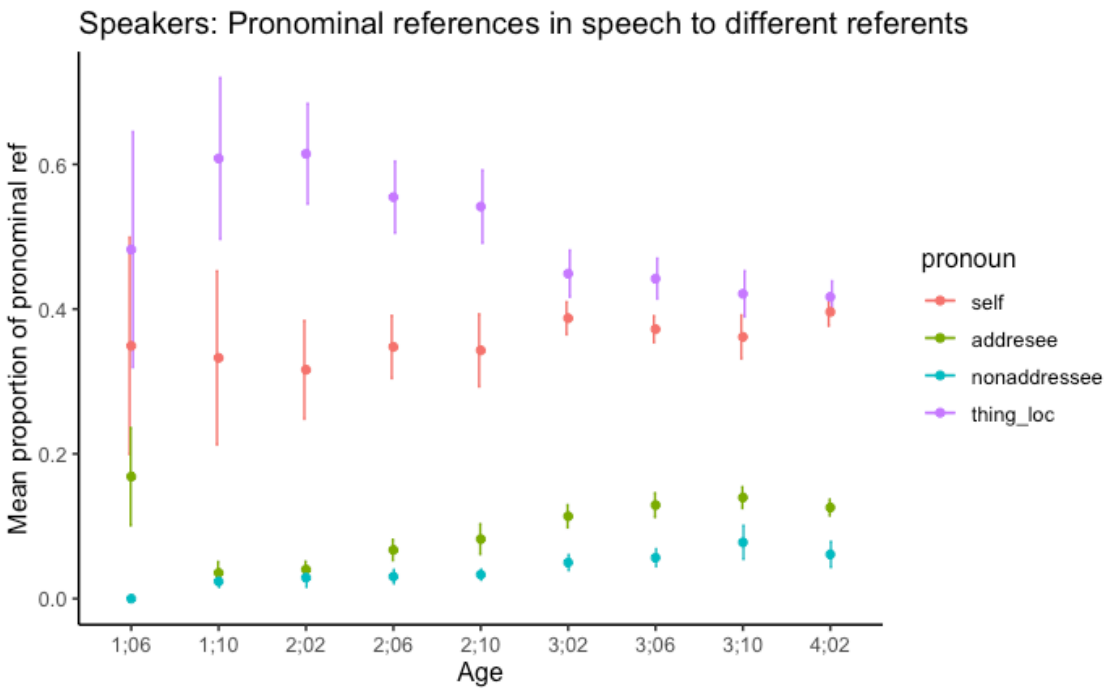

Figure 4. Speaking children's pronominal references in speech to different referents over development (excluding any pointing gesture references)

Comparing signing and speaking children's deictic references. I collapsed all of the speaking children's deictic references in speech and gesture, and compared the speaking children's deictic system as a whole to signing children's pointing references (cf. Goldin-Meadow & Brentari, 2017). For this analysis, I also collapsed addressee and non-addressee into one category, as they were infrequent relative to other references in both spoken and signed languages.

Figure 5 exhibits the raw mean counts of all pronouns and points that speaking and signing children produce over the 9 sessions, including unclear pointing references. There was a significant main effect of deictic type (pronouns, pointing gestures, and pointing signs; $\chi^2(2) = 150.25$, $p < .0005$). I also included in the model amount of talk in sign and speech, and used the total number of deictics as a proxy for overall speech and sign content, as there is a significant

correlation between number of deictics and number of words that children produce based on randomly selected data (60% of the data; $r(62) = .75$, $p < .005$). Overall, speaking children produce significantly more pronominal references in speech, compared to their own points or to deaf children's points (Tukey pairwise comparisons: $p < .0001$ for pronouns vs. pointing gestures, and $p < 0.05$ for pronouns vs. pointing signs). Signing children are pointing significantly more than speaking children, even after taking into account total number of deictic references and the random factor of subject ($p < .001$). As indicated by speaking children's large number of pronouns, they are producing more words than signing children, which may be a result of how signed and spoken languages are organized and structured. Generally, there were many signs that contained a high number of simultaneously produced information among the parameters, including indexical properties (e.g., directional verbs), while many spoken words did not have the same amount of information due to their sequential nature (see Brentari, 1998). These distinct characteristics explain the higher number of words produced by speakers accounted in the data.

Signing children also showed an increasing reliance on points over development (age as a significant predictor of number of points: χ^2 (10) = 26.16, $p < .005$), an effect not seen in speaking children (χ^2 (8) = 6.12, $p = 0.63$). Figure 7 displays all of the deictic referents in speech and gesture for speaking children, compared to signing children's deictic referents. Speaking children referred primarily to things/locations (M = 59.2 %, SD = 8.3%), followed by references to the self (M = 28.0 %, SD = 14.8%) and the non-addressee/addressee (M = 12.8 %, SD = 8.3%). Signing children also produced most of their references to things/locations (M = 75.7 %, SD = 20.8%), followed by references to the self (M = 17.5 %, SD = 19.0%), and non-addressee/addressee (M = 11.9 %, SD = 0.07%). There was some variability in signing children's points to these different referent types (Fig. 23 in Appendix A; a distinction was made

for non-addressee and addressee in this plot). In the earlier sessions, both JIL and NED produced only points to things/locations, and then eventually produced points to addressee and non-addressee. ABY produced points to things/location, self, and addressee at the start.

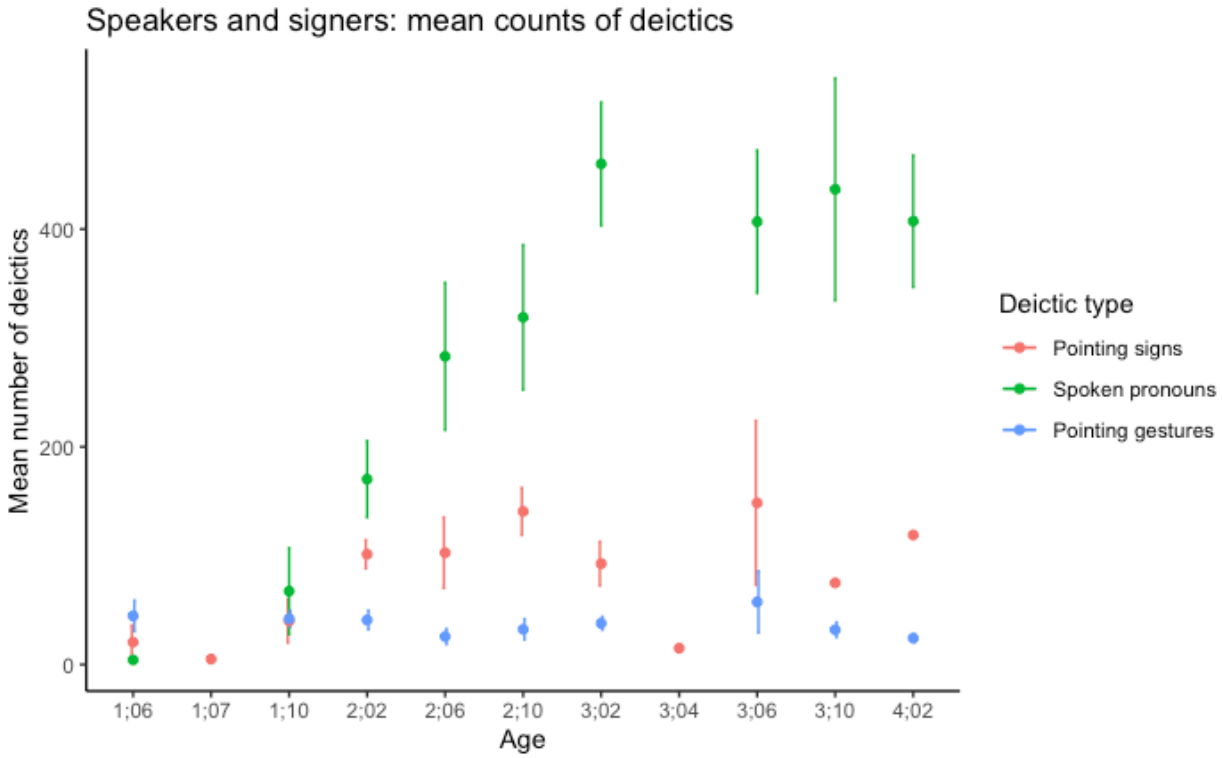

Figure 5. Mean counts of deictics, including pointing signs, pronouns in speech, and pointing gestures

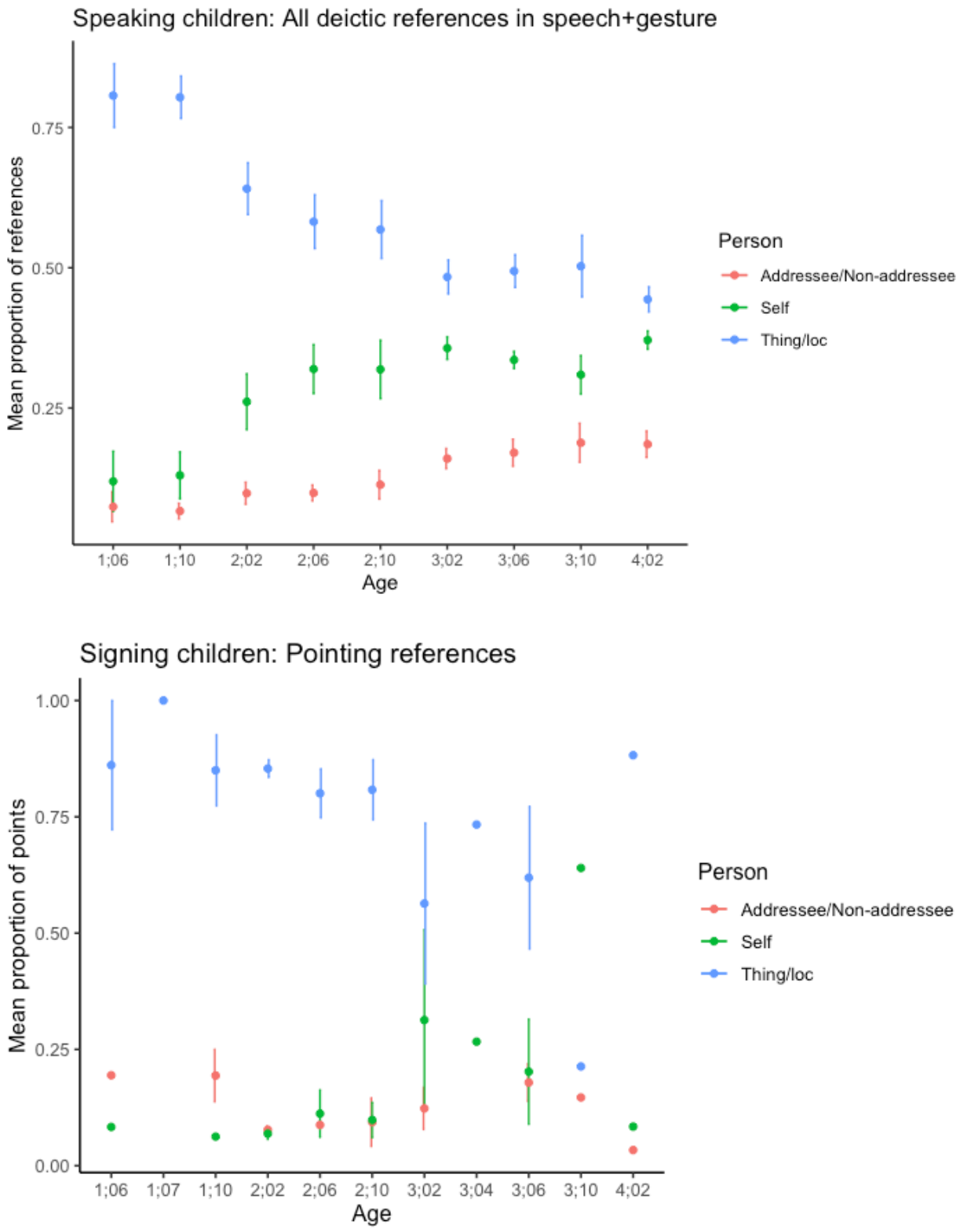

Figure 6. Top panel: mean proportion of references in speech and gesture to self, addressee/non-addressee, and things/location over development from 1;06 to 4;02 years of age. Bottom panel: mean proportions of references in pointing signs.

Figure 6 (continued). Top panel: mean proportion of references in speech and gesture to self, addressee/non-addressee, and things/location over development from 1;06 to 4;02 years of age. Bottom panel: mean proportions of references in pointing signs.

Note: In the bottom panel, for some age sessions, only one signing child is represented (as indicated with missing error bars). From ages 1;10-3;02, three children are represented. At ages 1;06 and 3;-6, two children are represented.

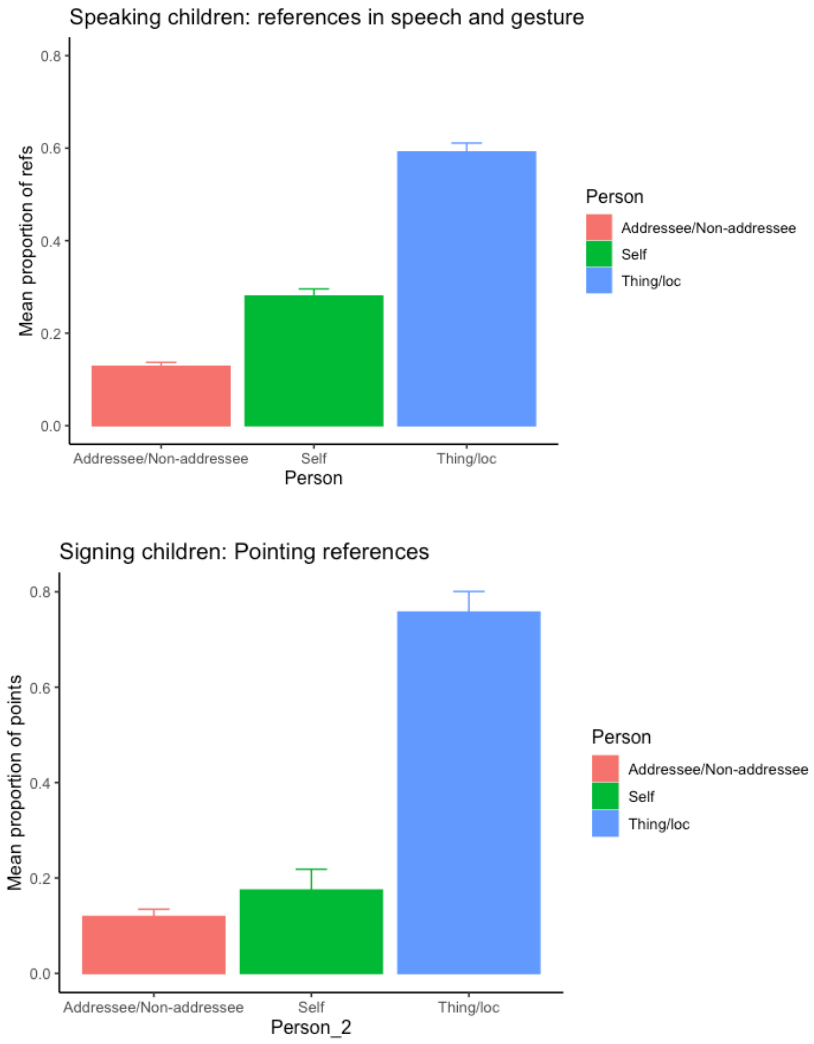

Figure 7. Mean proportion of references in pointing signs to self, addressee/non-addressee, and things/location in speech and pointing gestures (top) and pointing signs (bottom), collapsing across all ages.

Pointing to literal and non-literal/absent referents in speech and gesture

As expected during the early age range, the majority of signing and speaking children's deictic references were produced in the here-and-now, and literally to the objects and persons in their environments. When taking into account speech and gesture, we found that children's displaced references – references to absent referents and objects that serve as placeholders for the represented objects – increased over development (Figure 8). However, the majority of these displaced references was expressed through pronouns, rather than pointing. Hearing children rarely use points to refer to displaced objects or people.

The next analysis concerns signing children's points to things non-literally and arbitrary locations, and they are starting to use this function (Figure 8), albeit at a slightly delayed age. However, the dataset of signers is very small, so with a larger dataset, we might find a similar onset age for both groups. Signers start pointing at displaced things at 2;02 years old, which is relatively late compared to hearing children, who begin at 1;06 years old.

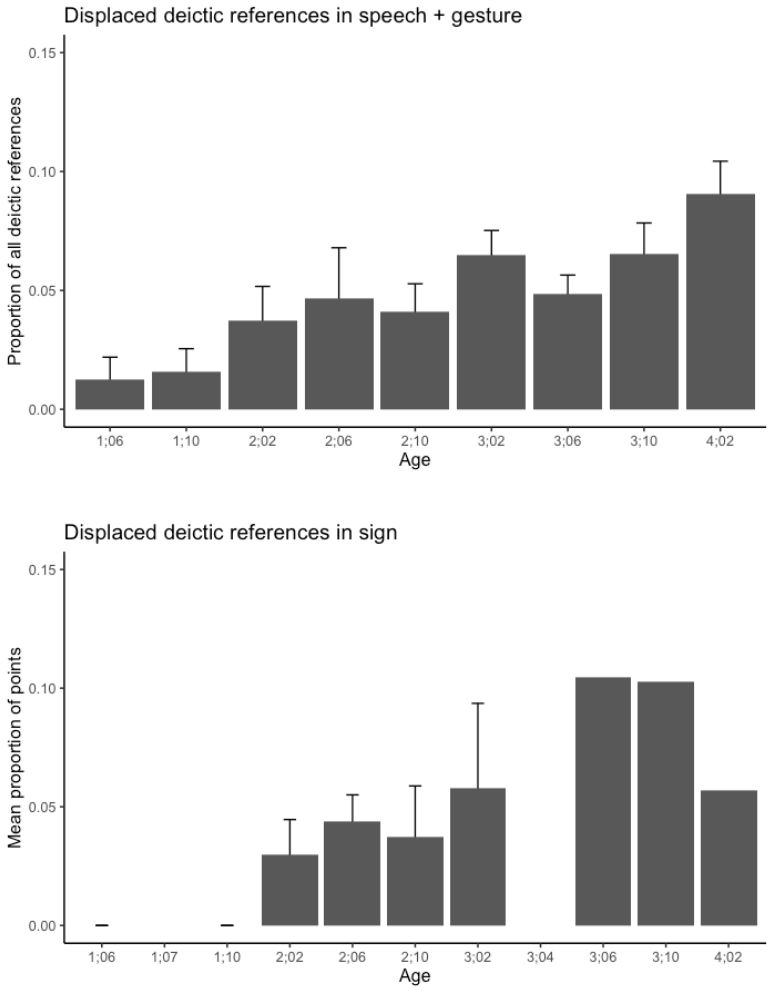

Figure 8. Mean proportion of displaced deictic references in speech and gesture (top) and sign (bottom)

Productive use of deixis with language

Figure 9 exhibits productive point + speech, point + pronoun, and pronoun + speech (e.g., noun/verb) combinations for speaking children over development. A productive point and speech combination might include a point + a noun (pt[cup] + cup) or a point + a verb (pt[cup] + look!). A productive point + pronoun combination would include utterances that for instance have a point paired with a demonstrative term or a pronoun (e.g., pt[cup] that one!) Finally, a pronoun + speech combination includes a pronominal reference in combination with other linguistic terms

in speech (e.g., "*I* want ice-cream"). Speaking children produced significantly more pronoun + speech combinations, compared to any other combinations (χ^2 (2) = 150.47, p <.005, significant contrasts between pronoun + speech combination – point + speech combinations; pronoun + speech combinations – point + pronoun combinations)

Figure 9 illustrates signing children's use of any productive points, including any referents, in combination with other signs, showing a reliable increase over time (χ^2 (10) = 20.7, p <.05). Signing children's productive point + sign combinations follows the same pattern as speaking children's pronoun + speech combinations, but not their point + speech combinations over development. Speaking children display the productivity found in signing children only with their pronominal system in speech, and not with their gesture.

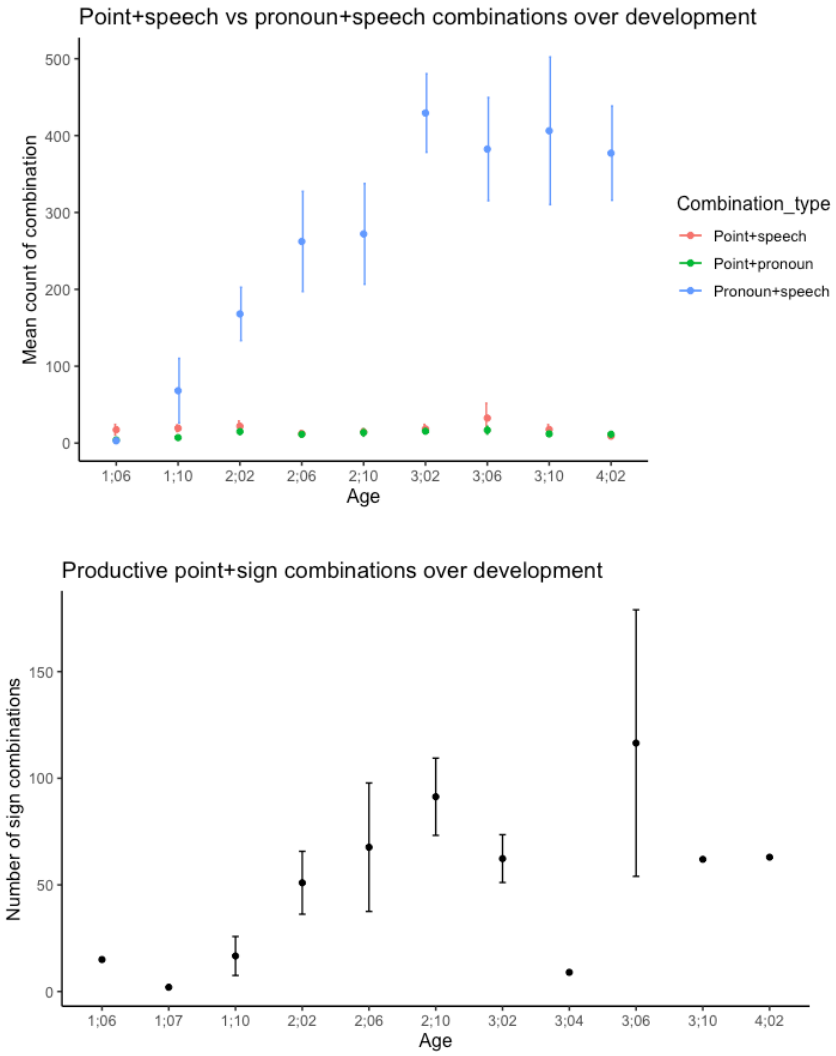

Figure 9. Top panel: Mean count of point + speech, point + pronoun, and pronoun + speech combinations over development.

Bottom panel: mean proportion of point + sign combinations over development. At ages 1;06, 1;07, 3;04, 3;10, 4;02, only one child is represented. At age 3;06, two children are sampled. From ages 1;10 to 3;02, all three children are represented in the data.

Discussion

Both hearing and signing children showed remarkably similar patterns as their deictic systems emerged, but more particularly when speaking children's deictic references in speech and gesture are compared with signing children's pointing signs. The patterns in their referentiality, productivity, and displaced references tell us that signing children's pointing develops strikingly analogous functions as speaking children's deictic system as a whole (see Table 2 for a visual summary).

With respect to referentiality, there are comparable distributions in speaking and signing children's referents, including self, addressee/non-addressee, and objects/location. Both groups showed a strong preference for references to things and locations, but less so for the self or addressee/non-addressee. Following Clark (1978)'s hypothesis about ordering of pronoun acquisition, speaking children show a clear early emergence in using references to things/location, and then self (I, me) and addressee (you), and finally, third person references. The ordering of acquisition is less clear with signing children with the current dataset as they seem to show more variability, but it is worth noting that they refer to the self more frequently than the addressee/non-addressee. Lillo-Martin and Chen-Pichler (2018) have reported with a larger dataset and more sessions accounted for, that signers show a sequential acquisition of points to 1) things/location, 2) self, 3) addressee, and then 4) non-addressee. They have also assessed pointing gestures and signs, and found that speaking children mainly pointed at objects and locations, but almost never pointed at people. When spoken pronouns are painted in the picture, almost all of the hearing children's deictic references to people, including the self, appear in speech. This finding lends additional support to the notion that the pointing signs that signing children produce might be functionally organized in a similar way to speaking children's

deictic system, and may be best compared with speaking children's development of spoken pronominal + gesture system, rather than only their pointing gestures.

One interesting difference worth noting is that speaking children produced more pronouns referring to people than did signing children. There are two possible explanations for these differences. ASL is known to be a pro-drop language, where pronouns are omitted as they can be inferred pragmatically, and locations of referents can be implicitly marked through agreement, spatial verbs (Lillo-Martin, 1986). ASL verb agreement consists of changes in orientation or path movement in the verb, and takes advantage of the spatial loci that are also used for pronominal reference. For instance, the agreeing verb GIVE is produced by moving between two loci in a path. The signer has associated the two loci with previously established referents, so the addressee can infer the subject and object when they are not overtly expressed.

Another possibility has to do with the structure of the child-parent interactions and affordances of the visual modality. For instance, the deaf child could repeatedly point at an object they want, while gazing at the parent to initiate the joint attention episode without producing any explicit expressions of references to the self. In contrast, a speaking child could use the spoken channel to refer to the self (*I, me*) while pointing at the object that they want (e.g., *I want that!*). Supporting these explanations, Morgenstern et al. (2016) also found that one deaf child, Charlotte, often produced predicates without an overt subject (e.g., points to self) up to age 3;0. She produced overt subjects with predicates about 65% of the time at age 3; in contrast, the hearing child, Madeline, produced an overt subject 95% of the time in spoken French at the same age. Future work should include an analysis of the types of verbs, including agreement verbs, that signing children produce, and how they pattern against the presence of pointing signs in their conversations. There may be a trade-off between the presence of pointing signs and spatial

agreement verbs, such that, as agreement is mastered, overt referential forms slowly drop out because the information is conveyed in the verb.

The findings on speaking and signing children's productive use of deictic references again highlight that pointing signs are best compared with speaking children's pronouns. The patterns of signing children's points – from simplistic one-unit production to more complex multi-sign utterances – parallel speaking children's productive use of pronouns with speech over development. More crucially, speaking children did not show a great increase in productive pointing gestures with speech combinations over development because they preferred to use spoken pronominal references in combination with speech. Cartmill et al. (2014) found a similar pattern, where children show a rise and fall of point + noun combinations – once they have mastered the determiner + noun combination in speech, they were less likely to use pointing gestures to specify nouns, showing a decline of point + noun combinations as determiner + noun combinations in speech increased. Signing children, on the other hand, did not show this same decline in their pointing + sign combinations, but showed a steady increase over development, indicating that they are mastering the integration of pointing signs into the language they are acquiring, just like speaking children do with their pronominal system. Pointing gestures, in contrast, do not play a large role in contributing to the development of more complex utterances. in speaking children.

Within both groups, the majority of their points is exophoric, linking to elements of the real world. Displaced pointing or indirect deixis, such as pointing or pronominal references to non-present people, places, and times, were rare, but steadily increased over development. The majority of displaced deictic references for speaking children appeared within speech with their pronoun use, but not with their pointing gestures. They occasionally point at absent things – one

child points at a potato head, and said “Oh mama, (points at the potato head), xxx a hat,” but there is no hat that exists on the potato head. But, overall, speaking children were more likely to point to things their environments to refer to those things, but not to refer to absent objects. When they have access to a conventional language in speech, they preferentially use speech to communicate about the non-present. Signing children, however, eventually extend their pointing functions by pointing at displaced items. For example, one deaf child, JIL points at a tape cassette plastic box, and then produces a palm-up sign, asking where the missing tape was. Another child, NED, narrates about a friend or family member, and says D (name sign) HELP WASH POINT PT (either the person or location of the car washing site). He points to an arbitrary location in the room, but not to the car washing site. The earliest use of displaced references appears relatively early for speaking children at age 1;06, mostly appearing with their pronouns in speech. However, the earliest use of displaced references appears nearly a year later at 2;02 for signers. As pointing is often non-arbitrarily related to the referents in the here-and-how, it may take time for signing children to learn how to distance themselves from their points and use them to refer to objects that stand for something else or to absent objects. The notion that pointing signs can refer to non-present entities has been argued to be a characteristic of pronouns and a sign of grammaticalization (e.g., Senghas & Coppola, 2010). Signing children acquiring signed languages are beginning to make that transition as they develop.

Pointing signs behave like spoken pronouns in how they integrate with language. However, we still do not have the full story on whether signing children’s pointing signs have symbolic mappings like pronouns, which have clear categorical contrasts in their forms. For the majority of the time, signing children use points indexically by showing a consistent isomorphic relationship between their points and their referents. There are no signs of pointing reversals in

the current data (cf. Petitto, 1987); however, there are some signs of shifting references, especially within discourses involving narration. Signers produce quotations by shifting the body associated with an arbitrarily assigned locus of the speaker and producing facial expressions of that speaker. In this process, the referents of first-person pronouns and other indexicals effectively shift as well (Lillo-Martin & Quadros, 2011). One child, NED, often produces quotations and constructed action by taking on another character and pointing to himself, which effectively points at the quoted speaker. For instance, he narrates about a monster running and hiding in a small cave. First, he establishes the location of the cave, and then takes on the role of the monster by using his face, body, and hands to represent the monster's, enacting the monster running and banging on the walls of the cave, trying to escape from the cave. Then, after producing the constructed action of banging, while taking on the role of the monster, NED quotes the character and points to himself and says PT [self] CANNOT GET-OUT + DEPICTING SIGN [banging on the wall]. He points to himself, but he is actually indexing the monster, a role that he is enacting at that moment. One could argue that these shifted indexicals function like pronouns, which also shift according to the speech situation. However, the first signs of such shifted references come relatively late for NED and were not observed for ABY or JIL during this time range. ABY and JIL produced other types of displaced references, such as pointing to non-present objects or places. Speaking children produce pronouns, which have shifting properties, as early as 1;06 years old.

Table 2. Summary of speakers and signers' deictic functions within speech + gesture and sign.

	Speakers Pronoun + points	Signers Points
Referentiality		
Displacement		
Productivity		

Note. Both groups show evidence for similar functions with respect to their distribution of different referents, displaced references, and productivity. The color green indicates that this function is present in the deictic system.

Future work can investigate the potential of pointing signs functioning as shifters or duplex signs by seeking evidence for categorical contrasts in the forms of points that map onto distinct functions. As such, pointing could be marked by having distinct symbolic forms, while also having an underlying indexical, existential relation with an object within the environment (Jakobson, 1957; Pierce, 1955). Previous work on signed languages has argued that it is possible for a linguistic form to be simultaneously categorical with a gestural, gradient overlay (Emmorey & Herzig, 2003; Duncan, 2005). A form is categorical and conventionalized when it has a stable meaning across different contexts arising through regular use and consistent pairing. Spoken or signed words such as "dog," or gesture emblems such as the "OK" sign, are conventionalized and categorical, and can be produced in isolation and understood by others. However, when a change in a form "leads to a concomitant change of meaning, and the nature of that change is different in different contexts," then that form is gradient (Okrent, 2002, p. 179). Similarly, in

speech, speakers often embed analog representations in their speech, such as adding pitch or elongating vowels, to emphasize and add meaning to the propositional content in speech; for example, producing a high pitch with the word “up” and a lower pitch with the word “down” (Shintel et al., 2006). I explore whether pointing signs also exhibit categorical patterning in addition to indexical representations in the next chapter of the dissertation. More specifically, I ask if there are changes in pointing forms as a function of distinct pragmatic functions within spoken and signed languages, and ask whether modality also shapes the pointing form.

Chapter 2: Form and Function of Deixis in Spoken and Signed Languages

Signers can gesture with their hands. They do so by making spontaneous and idiosyncratic adjustments to categorical handshapes of their signs (Duncan, 2005). For instance, in signed narratives in Taiwanese Sign Language, signers use a classifier handshape (thumb-and-pinky handshape) to represent an animal, the cat, and gradiently modify the handshape to represent the cat's ever-changing body form as it moves up the drainpipe. These modifications capture the same kind of information that hearing speakers convey in their co-speech gestures when describing these scenes. Similarly, Emmorey and Herzig (2003) argue that it is possible to overlay morphemic forms with analog, gestural representations within a specific class of signs, spatial classifier constructions. Like classifiers, pointing forms could categorically vary according to distinct meanings, while also carrying indexical connections to the referents.

Several sign language linguists have investigated functional and formal qualities of pointing signs to determine potential form to function mappings akin to what Emmorey and Herzig (2003) have claimed for classifier constructions. Using Auslan sign language corpus, Johnston (2013) coded for all of the points within their corpus and their distinct functions, such as identifying a person or location or a determiner function, and asked whether these functions are also marked by distinct forms. A large proportion of points that point to second person entities, third person entities, determiners, and locations tended to appear on the non-dominant, weak hands. In contrast, first person points including possessives tended to appear on the strong, dominant hand than the weak hand. A potential explanation for this is that all weak-hand points (e.g., with a locative function) tended to co-occur with a strong hand sign that does the job of identifying the referent, such as a noun sign or a dominant-hand point which nominates (pronominal). Johnston (2013) also found distinctive patterns in the duration of strong and weak

hand points. Weak hand points last longer than strong hand points with the exception of weak-hand first person points. Also, first person points generally have distinctive forms with very short articulation time compared to other points.

In addition, points according to distinctive functions patterned differently based on handshape (Johnston, 2013). There was some variation in the handshape types used for pointing, but in general, person points strongly preferred the index-point handshape. Third person points showed the least variation with the majority of points having index finger handshape perhaps because more clear, prominent pointing is necessary to clarify and single out the referent within the environment. First and second person points' targets are usually easy to interpret with the chest as a clear marker for first person and having an interlocutor "close at hand" for second person. Locative points and points that function as determiners had the greatest variation in handshape. Finally, there were also distinctions in the orientation of points (lateral/sideways vs. pronated/down orientation) according to the pointing's functions as pronominal or locative. Locative points tended to prefer pronated/downwards orientation, but pronominal points tended to be produced with a lateral orientation (see also Engberg-Pederson, 2003; Crasborn, van der Kooij, & Ros, 2006). However, this contrast in orientation could be explained by articulatory factors such that it is not possible to point to oneself with the palm oriented downwards but is best produced laterally (Johnston, 2013). In summary, this exploratory corpus analysis demonstrates some evidence that points may pattern in their forms – particularly in hand dominance, duration, and handshape distribution – according to distinct linguistic functions.

Pointing forms also change according to a specific set of pragmatic functions that mark distinct information in the discourse. For instance, Laos speakers often produce larger points with full arm extension and smaller points with quicker movements and casual articulation that

correspond with certain information functions (Enfield, Kita, & de Ruiter, 2007). The larger points tend to convey "informationally foregrounded information," and give all of the information about the location of specified a specific object, while speech works in the background. In contrast, the smaller points convey secondary, informationally backgrounded information, while the speech carries more informational weight. Following up on Enfield et al. (2007), Cooperrider et al. (2021) developed a controlled pointing task that elicits utterances that either informationally foregrounded or backgrounded location information; they then examined how the point was integrated with the utterance. A *load-bearing point* would fully specify location; a speaker might respond to the question "Where did you park?" with a point without any other signs, or along with an adverbial locative (e.g., "there"). In contrast, there might be a distribution of information about an object's location between the point and other lexical materials (e.g., a point with lexical description: "over on the left, in the far back"), which would be a *load-sharing point*.

Both signers and speakers were more likely to extend their arms for load-bearing location points, compared to load-sharing location points, even after controlling for the number of words. However, signers' points were longer in duration when they produced load-bearing points, compared to load-sharing points, but speakers did not show this distinction in duration. This difference could be explained by differences in the structural integration of points into signed vs. spoken utterances. Signers were more likely to slot their points within the signing stream than speakers and rarely co-produced points with signs. In contrast, the majority of speakers' points spanned across their speech. Unsurprisingly, these patterns mapped onto the patterns of duration, where speakers' points are held over a longer period of time than signers' points. The question still stands as to whether these patterns are entirely explained by the structure and modality of

signed and spoken languages, or are part of the conventional patterns they acquire as they become proficient in their languages. These hypotheses could be empirically investigated by examining young signers and speakers.

Current study

In the current study, I ask whether signing and speaking children demonstrate formational distinctions in their points according to a specific set of pragmatic functions (load-bearing vs. load-sharing), following Enfield et al. (2007) and Cooperrider et al. (2021)'s studies. Load-bearing points convey all of the information about the referent (e.g., PT [apple] EAT), while load-sharing points share the information about the referent with another lexical word in the utterance (e.g., [PT[apple] + APPLE]$_{NP}$ EAT). This current work does not do a linguistic analysis of points, but load-bearing points could correspond to constituents that make up noun or determiner phrases, where a noun is expressed with a constituent that specifies the particular member of a category (Lyons, 1991). These constituents often include determiners (articles, such as *the, a*) and demonstratives (e.g., *this, that*), quantifiers (e.g., *two, some*), and possessive pronouns (e.g., *my, his*), which tend to appear with nouns in utterances. However, demonstratives and pronouns can stand alone as pronominals (Dryer, 2005). For this paper, I use these neutral terms (load-sharing and load-bearing) to refer to the points' informational roles in the utterances.

I follow a similar analysis on the form of points as Cooperrider et al. (2021), focusing on their duration. In addition to this analysis, I also examine how the points are structurally integrated with the broader utterance (e.g., slot-in vs span-across other lexical words) and the number of words in the utterance and their potential impact on the pointing form. If either group of children exhibits distinct pointing forms according to their information functions as adults do, after controlling for these modality measurements, then pointing, although indexical, may have

some categorical contrasts that map onto these distinct information functions, and that are developed very early. Another possibility is that we may not see a clear distinction according to these information functions at this point in development, although we may see other differences between the groups, such as how they are structurally integrated with signed vs. spoken utterances.

Methods

Participants. The same participants from Chapter 1 were used for this analysis except we focused on a particular age range (2;06-2;10 years old). This age range was chosen as these children are starting to produce utterances that range from 2 to 10 words, and are integrating their deictic forms with other linguistic units.

Formational features. We focused on the formation of all index finger pointing using the same criteria as Cooperrider et al. (2021) and Fenlon et al. (2018). Duration of points was also coded. We identified the first frame where the hand started to articulate a point, which is the onset of the point. This starting point may be either when the hands are at rest and just beginning to move towards a point, or when the hands have completed a prior sign or gesture. If the point is produced after a previous gesture or sign, the change in handshape or path movement signals the start point. The end of a point was coded as the frame immediately prior to the frame in which the hand moves to articulate the next sign or gesture or change in handshape or path movement.

Information function. For each point, we identified how much information the point carries relative to other linguistic elements within the utterance, following criteria used by Cooperrider et al. (2021). All of the following analyses applied only for points produced alone (counted as 1 word) and also embedded within an utterance ranging from 2 to 11 words (which includes the point). A point is *load-bearing* when it stands on its own and bears the full information about

the referent. For example, a point to the apple with the word "EAT" (PT(apple) + EAT) would be load-bearing because the child does not mention anything about the apple in speech. A point is *load-sharing* when it is combined with other words that also convey information about the referent. For example, a point to the apple along with the word "APPLE" is considered to be a load-sharing ([PT(apple) + APPLE]$_{NP}$ EAT). The final category, *load-bearing + pronoun* is referred to when the point is also produced with a demonstrative or pronoun (applicable to spoken languages), yet does not convey anything about the referent (e.g., THAT PT(apple)). We analyzed the final category only for speakers because signers rarely used the lexical item THAT. *Load-bearing + pronouns* were generally rare, and thus were collapsed with load-bearing points for the analyses. Finally, points produced on their own (Points alone) without any surrounding words were coded as load-bearing.

Points were also coded for how they were structurally integrated with other lexical material, and this coding only focused on points embedded within utterances. If points were not produced at the same time as other words (e.g., "[___] that one") or signs (e.g., "PUT BOWL [___]"), they were coded as *slot in.* If the points co-occurred with words e.g., ("I want to eat that [apple]") then this was coded as *span across* (this could be done in sign by using the non-dominant hand to co-articulate the sign along with the point on the dominant hand). Finally, if the point endured across adjacent utterances ("I walked over to this [chair/ then I picked up the ball]), then this was coded as a *bridge over.* Finally, utterances were further coded for the number of words or signs, in addition to the point.

Reliability. Reliability between two coders for 20% of the data is as follows: information load of points (85%), structural integration of points into the utterance (99%), and number of words in the utterances, including points (100%). For duration of points, the two coders' duration

values were highly correlated with each other ($r = 0.42$, $p < .0005$). Duration of points was already previously coded and checked for signers (Lillo-Martin & Chen-Pichler, 2018).

Results

Structural integration of points in signed vs spoken languages

The majority of signing children's points was slotted into the sign stream (99%), and a tiny minority of points was co-articulated with another sign (1%). In contrast, the majority of speaking children's points spanned across the words that they uttered in speech (85%), and they rarely slotted in points in the speech stream (13%); the remaining points spanned across two different utterances (Bridge over points: 1%).

Given the great differences in the points' structural integration with sign vs. spoken utterances, there may be a relationship between the duration of points and number of words, especially for signed utterances. If points have more pressure to be slotted in between signs, then their duration might be significantly reduced. This data includes all points produced between 2;06-2;10 years old, and outliers outside of the 1.5 x interquartile range were excluded from the plots. Indeed, there was a significant negative correlation between the number of words and duration of points for signing children ($r(640) = -0.22$, $p < .005$), where points were more likely to be shorter in duration as the number of words increased. On the contrary, there was a significant positive correlation between the number of words and duration of points for speaking children ($r(486) = 0.12$, $p < .05$). Given this effect of number of words on duration, I included number of words in the models going forward, and plotted children's production of load-bearing and load-sharing points according to word count.

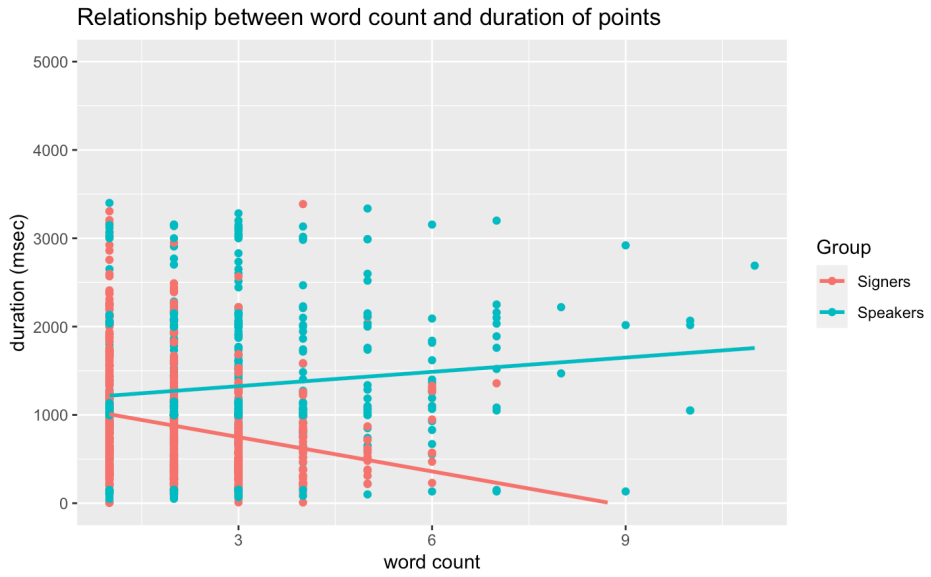

Figure 10. Correlation between word count and duration of points for signers (pink) and speakers (blue).
Note. Signers exhibit a significant negative correlation between word count and duration, and speakers exhibit a significant positive correlation between word count and duration.

Form and information function of points

Overall, speakers' points were much longer in duration (in milliseconds) than signers' points after controlling for the number of words for each utterance ($M_{speakers}$ = 1319.02 ms, *SD* = 770.47 ms; $M_{signers}$ = 867.43 ms, *SD* = 644.72; $\chi^2(1) = 7.74$, $p < .05$). Each point was coded for how much information it carries relative to other linguistic elements within the utterance (load-bearing vs. load-sharing points). All of the following analyses applied only for points embedded within an utterance ranging from 2 words to 10+ words.

There was no significant interaction between Language and Information Function after taking into account word count and random effect of Subject ($\chi^2(1) = 0.38$, $p = 0.54$). Both groups are on average producing longer load-bearing points compared to load-sharing points, but the main effect of Information Function was not significant after taking into account word count (Table 3; $\chi^2(1) = 0.09$, $p = .77$). Based on posthoc tests, speakers are producing significantly

longer load-bearing (p <.05) and load-sharing points (p <.05) compared to signers, with word count taken into consideration (see Table 3 for means). Note that, for signers, the majority of load-bearing points were produced alone, which strongly contributed to the effect of longer load-bearing points, but for many of their other points in longer utterances, their load-sharing points were longer than load-bearing points (Table 3). Table 4 exhibits the mean duration of load-bearing and load-sharing points as a function of word count. Signers ranged in word count from 1 to 7, while speakers ranged from 1 to 11 words. Both groups produced relatively few instances of utterances that contained more than 5 words.

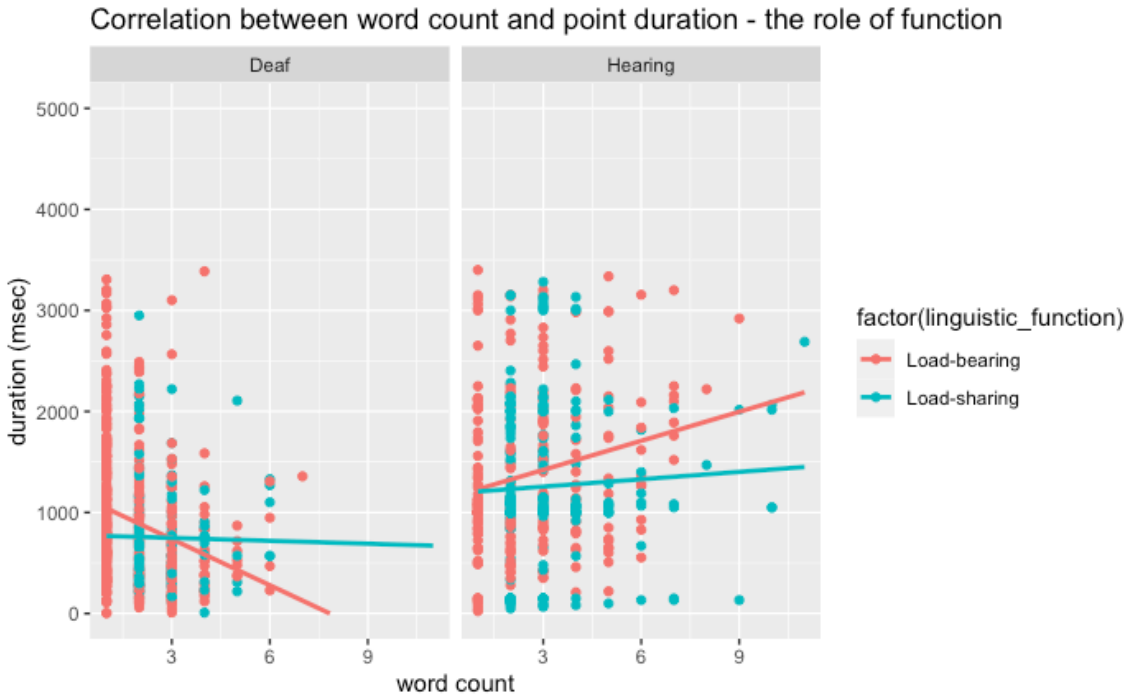

Figure 11. Correlation between word count and point duration as the function of information (Load-bearing vs. Load-sharing). The plots are split up according to Language (Signers vs. Speakers).

Table 3. Mean duration of points produced by signers and speakers based on their distinct information functions

Group	Information Function	Mean Duration (MS)	SD
Signers	Load-bearing	905.05	670.06
	Load-sharing	749.75	543.39
Speakers	Load-bearing	1383.35	809.24
	Load-sharing	1259.95	729.66

Based on models that were built separately for speaking and speaking children, signers did not show a significant interaction between Word count and Information Function ($\chi^2(4) = 0.60$, $p = 0.96$). For signers, there was no significant main effect of Information Function on duration, taking into account Word count ($\chi^2(1) = 0.08$, $p = 0.77$). Speakers showed a significant interaction between Word count and Information Function ($\chi^2(7) = 14.65$, $p < .05$; significant contrasts in utterances with 7 words and 9 words). They did not exhibit a main effect of Information Function on pointing form ($\chi^2(1) = 1.24$, $p = 0.27$).

Table 4. Mean duration of load-bearing and load-sharing points produced by signers and speakers as a function of word count (1-11 words).

Group	Information Function	Word Count	Points (*n*)	Mean Duration (MS)	SD
Signers					
	Load-bearing	1	222	1112.32	729.38
	Load-sharing	1	N/A	N/A	N/A
	Load-bearing	2	142	770.85	566.59
	Load-sharing	2	88	796.83	602.31
	Load-bearing	3	87	674.23	529.59
	Load-sharing	3	45	659.18	454.41
	Load-bearing	4	24	686.71	688.26
	Load-sharing	4	13	668.92	319.62
	Load-bearing	5	7	565.86	183.00
	Load-sharing	5	4	802.50	882.50
	Load-bearing	6	4	739.00	482.66
	Load-sharing	6	5	968.20	373.08
	Load-bearing	7	1	1358.00	N/A
	Load-sharing	7	0	N/A	N/A
Speakers					
	Load-bearing	1	86	1260.33	775.07
	Load-sharing	1	N/A	N/A	N/A
	Load-bearing	2	45	1257.71	815.70
	Load-sharing	2	121	1178.36	653.72
	Load-bearing	3	44	1544.32	798.72
	Load-sharing	3	72	1376.97	837.65
	Load-bearing	4	20	1255.65	687.01
	Load-sharing	4	29	1382.74	781.44
	Load-bearing	5	19	1556.95	984.35
	Load-sharing	5	13	1142.51	491.74
	Load-bearing	6	10	1492.10	746.38
	Load-sharing	6	7	1053.86	535.06
	Load-bearing	7	7	2125.71	536.59
	Load-sharing	7	5	890.00	789.04
	Load-bearing	8	1	2220.00	NA
	Load-sharing	8	1	1470.00	NA
	Load-bearing	9	1	2920.00	NA
	Load-sharing	9	2	1075.00	1331.72
	Load-sharing	10	4	1545.83	572.90
	Load-sharing	11	1	2690.00	N/A

Table 4 (continued). Mean duration of load-bearing and load-sharing points produced by signers and speakers as a function of word count (1-11 words).

Note: There are relatively few utterances with at least 5 words for both signers and speakers. Outliers outside of the 1.5 x interquartile range, as well as 7 data points with missing word count codes are not included in this analysis.

Discussion

Children's pointing forms are already shaped by intrinsic, structural qualities of signed and spoken languages at an early time point of their development as indicated by their pointing forms and their structural integration. First, signing children's points are more reduced relative to speaking children's points. Secondly, signers were more likely to slot in their points in the signing stream, while speakers showed a more even distribution of slot-in and span-across points. It remains an open question whether these qualities are shaped by the respective modalities they are communicating in or by the conventional practices of sign and spoken languages. These results are conceptual replications of Cooperrider et al. (2021)'s findings.

The rest of results are distinct from Cooperrider et al. (2021)'s data. There was a potential modality-specific pressure on the pointing forms. Signing children's points were shorter in longer utterances. In contrast, speakers' points were more likely to elongate when they produced more words in speech, which can be explained by their ability to simultaneously produce points along with speech. Therefore, the rest of the analyses took into account word count.

I investigated whether pointing signs and gestures have categorical contrasts based on distinct information functions. The story is more complicated and nuanced once we take into account number of words in the utterance. Speakers' utterances are generally longer compared to signers. Both signers and speakers do not show formational differences in their pointing forms according to their distinct information functions when taking into account of word count.

However, speakers are generally producing longer points – both load-bearing and load-sharing points – compared to signers. Based on the current data, there are differences in signers' and speakers' forms of points and their structural integration with signed vs spoken utterances, however, there is no clear evidence for form-to-function mappings. A much larger dataset capturing a wider age range and more data points dispersed across the word count spectrum is needed.

Both signing and speaking children should eventually reach adult-like patterns in their distinctions of pointing forms, as Cooperrider et al. (2021) demonstrate. Further analyses are needed, especially at older age ranges. But at this point, signing children are already resembling adult signers with respect to their more reduced pointing forms and their structural integration (e.g., slot in points), and likewise can be said for speaking children with their longer points.

Future directions. There may be an effect of discourse structure on the pointing forms, which should be further explored in future work. It might be the case that these pointing forms may modulate depending on their roles in the discourse, such as accessibility of topics. Languages tend to use overt nominal forms for referents that are not accessible in discourse, and reduced forms or covert null forms for referents that are accessible (Givón, 1983). Reduced or covert null forms are often recruited for the purpose of maintenance and re-introduction (see Example 1).

(1)

A. [*A man*] goes into a store. [Intro]

B. [*He*] wants milk and eggs [Maintenance]

C. The store clerk points to aisle 3. [Intro]

D. [*The man*] smile and [θ] heads there. [Re-intro] [Maintenance]

Narrative studies on ASL and German Sign Language (DGS) all typically categorize indexical pronouns as reduced forms, compared to full noun phrases (Frederiksen & Mayberry, 2016; Perniss & Özyürek, 2015). The use of load-bearing points corresponds to pronominal use (e.g., PT (apple) RED), and the use of load-sharing points corresponds to determiner-like constructions (e.g., PT (apple) APPLE RED); thus, it is possible that load-sharing points tend to be used within full noun phrases when introducing or re-introducing new referents, and load-bearing points within constructions where the referent is highly accessible and thus used within shorter utterances. There may be an interaction between points' information functions and their discourse roles – specifically, the newness of their information within the discourse – that influence their form, which should be further investigated in future work.

If we eventually see stronger changes in children's points according to distinct information functions, this effect would parallel with some diachronic changes that have been documented in grammaticalization processes in spoken and signed languages. Previous work has proposed that pronominal signs in sign languages have grammaticalized from locative pointing gestures (Pfau & Steinbach, 2006; Coppola & Senghas, 2010). Coppola and Senghas (2010) analyzed points to empty space and categorized them based on their functions – locative and nominal uses – within signers within distinct stages of language emergence in Nicaragua. They tested homesigners, first cohort, second cohort, and third cohort of signers of NSL. The earlier cohorts, the first and second cohorts, entered the earliest periods of NSL's emergence from the late 1970s to late 1980s (they are now adults and adolescents). Those who arrived in the 1990s, who were children at the time, and inherited the emergent language from the first and second cohorts constitute the third cohort. Locative pointing signs appear more frequently in homesigners and the first cohort

of NSL signers, and then gradually the second and third cohorts produce more pointing signs with nominal functions, expanding their repertoire of pointing functions. Nominal points also appear to be more reduced in form compared to locative points, and were more likely to appear first in combination with nouns or verbs (Coppola & Senghas, 2010).

Similarly, Fenlon et al. (2013) note, based on BSL corpus data, pronominal signs appear to be shorter in duration relative to adverbial locative pointing signs. However, this study only investigates a particular set of functions and exophoric pointing. Once we expand our analyses to a wider set of functions, and analyze indirect and anaphoric deixis later in development, we could ask a similar set of questions with abstract, indirect deixis that carries locative and nominal functions.

One theoretical perspective on grammaticalization has focused on the roles of the spatial environment and bodily experiences as the original, concrete sources for abstracted linguistic forms (Bybee, 2003; Heine et al., 1991). For instance, it has been observed that terms for movement in space, such as "come" and "go" have evolved from representations of spatial movements to representations of future actions. At first, the meaning implicated in *be going to* is primarily spatial in nature (*They are going to Windsor to see the King*), but then the meaning has slowly changed to state intentions or future actions over time (*He's going to (gonna) buy a house*) (Bybee, 2003; p. 150). This process has also been called *bleaching* or *generalization of meaning,* where the original lexical meaning is more specific, but then becomes more general and applicable to a wider variety of contexts through repeated use, akin to non-linguistic, habitual procedures. Exophoric expressions might have gone through a similar process by relating to external objects in the world, and then eventually extending to non-spatial pointing. They become anaphoric, pointing internally to other constituents within the discourse structure

(Coppola & Senghas, 2010). Thus far, there is no evidence for anaphoric pointing within this age range, but the fact that pointing signs are becoming more reduced at this time point might foreshadow signing children's eventual transition to abstract, endophoric pointing. At this point, signing and speaking children both extensively use the pointing gesture in an exophoric manner, making links to the external world, but it still remains an open question, if, and when they develop contrasts in their pointing according to distinct functions.

Chapter 3: The Effect of Shared Linguistic Systems on Pointing

Pointing seems to be easy and intuitive. Children begin to point by their first birthday, and pointing is used in a wide variety of cultures and context. But do all of the possible functions of deixis develop when the child receives no or minimal linguistic input? This question can be explored with deaf children whose hearing losses prevent them from making use of the spoken language that surrounds them and whose hearing parents do not know a signed language. These children, called homesigners, use gesture to communicate with the hearing people around them. Homesigners heavily rely on iconicity and indexicality, especially pointing, when they communicate with their parents in order to be understood. They often use points in combination with other iconic signs that denote agent, action, and patient semantic roles. Homesigners develop the capacity to produce displaced references and assign different types of semantic roles to their points; however, we do not know the full range of their deictic functions (Feldman, Goldin-Meadow, & Gleitman, 1978; Goldin-Meadow & Feldman, 1977; Goldin-Meadow & Mylander, 1984; Goldin-Meadow & Mylander, 1990; Morford & Goldin-Meadow, 1997; Butcher et al., 1991).

Homesigners can communicate with points to refer to the here-and-now as well as displaced references. One homesigner, David began to consistently use pointing gestures to refer to absent objects at 3;3 years old (Butcher, Mylander, & Goldin-Meadow, 1991). For example, he produced a "fly" characterizing gesture and then pointed at the empty space on the puzzle board intended for the bird piece in order to request that piece from the experimenter. At age 3;5, David began to refer to absent objects by pointing at objects that were perceptually similar to the target referent he had in mind. For example, he pointed at his buttocks and produced an action sign "move over" to ask the experimenter to move her buttocks away from the toy area where

she was sitting so that David could play in that area. At age 3;11, David referred to absent objects by pointing at a space or object he had previously established as a placeholder for the target object.

In contrast, speaking children often used nouns and pronouns to refer to absent objects; however, they rarely used pointing gestures to refer to absent objects (Butcher et al., 1991). Unlike David, they did not leverage the potential to use pointing gestures for displaced referents as they preferred to use words, especially pronouns. However, without a language model, there seems to be a delay in the age of onset in communicating about non-present objects – the three younger speaking children ranging from 2;2 to 2;6 produced words that referred to absent objects about 9-14% of the time, but at 2;10, David was still not reliably referring to absent objects with his points. Despite this delay, David showed the ability to distance himself from his own gestures, treating them as symbolic.

Homesigners also use points for a variety of different functions, such as using points in isolation to refer to entities or combining points with other related iconic gestures that refer to the same entity. Hunsicker and Goldin-Meadow (2012) argue that David are using pointing gestures (1) that function as a noun (e.g., point at penny in the room to refer to another penny) or demonstrative (*that)*, (2) that integrate into nominal constituents (e.g., a demonstrative point at a particular bird, followed by a noun iconic gesture identifying a bird, followed by a verb: e.g., [that bird] PEDALS), and (3) that integrate into predicate nominals (e.g., a demonstrative point followed by a noun iconic gesture to identify a bird, *that's a bird*). David also ordered his gestures within a nominal constituent (*that drum*) differently from when he produced predicate nominals (*that's a drum*), where the order is more constrained and predictable for predicate nominals (the point tends to come before the predicate nominal gesture). Beyond this evidence

for displacement and hierarchical constituent structure, more work needs to be done on how their system compares with children situated in typical linguistic environments.

Current study

Chapters 1 and 2 revealed resemblances in how signing and speaking children develop deixis when speaking children's deictic system as a whole (speech and gesture) is taken into account (speech+gesture); however, there are some fundamental differences in how these two groups use manual pointing on functional levels. We have seen in the previous two chapters that signing children develop a system with multiple functions, which is not strongly evidenced in speaking children's pointing gestures. Is having a linguistic model necessary for the development of a symbolic and indexical system in the manual modality? This question can be explored with deaf children who grow up in hearing households without any exposure to a conventional linguistic system and use their own homesigns to communicate.

This study compares pointing within three groups of children growing up in either typical linguistic environments (signers and speakers) or environments without a shared linguistic system (homesigners). One possibility is that deixis develops following the same trajectory in the manual modality, such that it is possible to develop and create a full deictic system without having a shared linguistic system. Homesigners may go beyond the gestural input they receive from their hearing parents by applying a similar analysis to their points as native signing children. Alternatively, pointing could also be uniquely shaped by having specific type of input. Because homesigners are exposed to the gestures that their hearing parents produce while speaking, their pointing might resemble speaking children's pointing. The last possibility is that they do not resemble either deaf or speaking children acquiring languages natively, but develop

an idiosyncratic system that has some characteristics that resemble pointing signs and others that mirror pointing gestures.

Methods

Participants. The participants include deaf, homesigning children in the US (2 females and 1 male) that ranged from ages 1;06 to 4;03 years old. The samples of signing and speaking children are described in Chapter 1. For homesigners, we selected the ages that best matched the range selected for signing and speaking children, but they did not always overlap (Table 5). None of the children was exposed to a sign language at home or school, and were instead educated within an oral deaf program that focused on intensive lip-reading and speech production. Each child was videotaped at home during play sessions once every 2-4 months. The primary caretaker interacted with her child for ½ hour of each session, and a large bag of toys, books, puzzles were provided. Each session lasted 1-2 hours and varied depending on the child's attention span, but we focused on coding only the first hour of each session.

Table 5. Age ranges of 3 homesigners from the Goldin-Meadow lab at the University of Chicago.

Time point	1	2	3	4	5	6	7
Homesigning children							
Chris	N/A	2;06	2;10	3;00	3;11	4;00	4;02
David	N/A	2;10	3;03	3;05	3;10	4;03	N/A
Kathy	1;06	1;10	2;02	2;05	3;03	3;09	4;03

Coding. The coding methods for all of the deictic functions and their forms used for signing and speaking children extended to the homesigners (see Chapters 1-2 methods). The following deictic functions were coded and analyzed: 1) referentiality, 2) displacement, 3) productivity,

and 4) duration of points and information functions. Points were also coded for their structural integration into utterances (e.g., slot-in vs. span across; see Chapter 2 methods). See Figure 12 for examples of points produced by homesigners within various contexts.

Identifying iconic gestures and ASL signs. For signing children, all of the signs we included in our analysis included signs that reside in the "native" components of the lexicon, both the core and spatial lexicons of ASL (Brentari & Padden, 2001). For homesigners, we followed Hunsicker and Goldin-Meadow (2012)'s coding methods in identifying gestures, and used previously transcribed codes and form glosses to identify iconic gestures and markers, which has been checked for reliability in previous studies (see Goldin-Meadow & Mylander, 1984). Generally, gestures are identified as hand movements that are intentionally communicative and are not a functional act on an object or person. Iconic gestures usually resemble features of an object or action – for instance, David produces and moves two fists as if he is drumming, and this gesture was glossed as BEAT or DRUM. Markers are conventional gestures that modulate other gesture's meaning, such as palm flips to mark questions or shaking the head to indicate negation. We only included markers that are manually produced, such as palm-ups, but not the other markers that are produced elsewhere on the body (e.g., headshakes) for analyses examining points' semantic roles in the utterance.

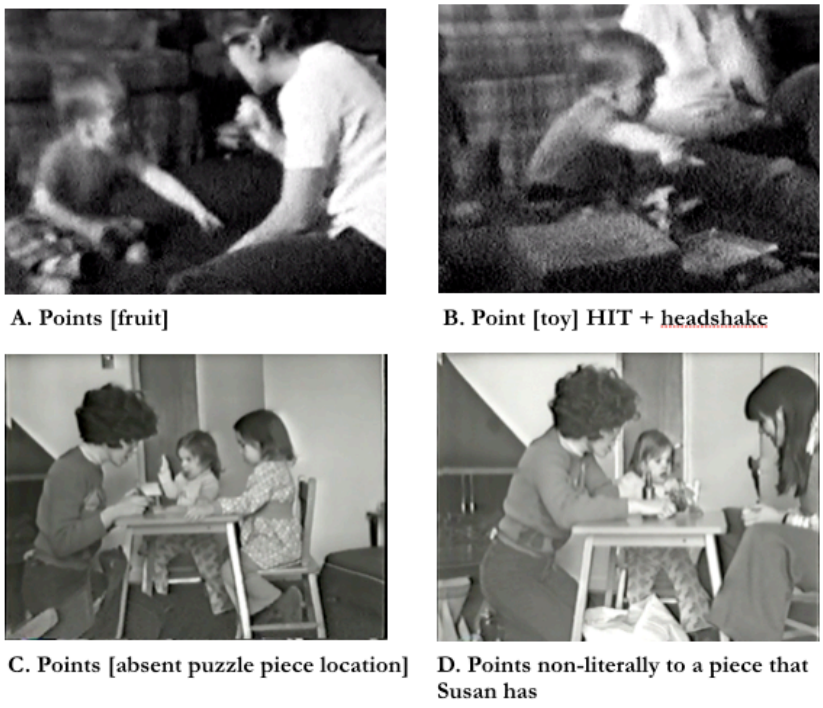

Figure 12. Examples of points in homesign.

Note. A) A singular point to a fruit produced by a homesigner. B) A homesigner produces a point to a toy, and then produces a characterizing gesture that represents an action for HIT, while also simultaneously shaking his head. C) A homesigner produces a displaced point by pointing to an absent puzzle piece. D) A non-literal point to an experimenter, Susan's toy in Susan's hand, which the child is uses to request a toy that looks like it. Images come from homesign data housed in the Goldin-Meadow lab at UChicago (Goldin-Meadow, 2005).

Results

Deictic functions in signers, speakers, and homesigners

Referentiality. All of the analyses within this chapter mainly focus on points that the three groups of children produce over development: speaking, homesigning and signing children. Note that the signers' data are repeated from Chapters 1-2, and inserted below for comparison purposes, but the speakers' data now only focus on points, not points + pronouns. Figure 13 exhibits age-related changes in references to self, addressee/non-addressee, and things/location in speakers, homesigners, and signers. Broadly, all three groups overwhelmingly point to

things/locations, but hearing and homesigning children showed relatively reduced rates of pointing to persons, including the self and addressee/non-addressee compared to signing children (Figure 14). Speaking children point to the self on average 3.69% (*SD* = 0.07%) of the time and addressee/non-addressee 8.67% of the time (*SD* = 10.32%). Homesigners point to the self on average 6.62% (*SD* = 6.70%) and addressee/non-addressee 7.84% of the time (*SD* = 6.53%). Signing children point to the self on average 17.5 % (*SD* = 19.0%) and non-addressee/addressee (11.9 %, *SD* = 0.07%) of the time.

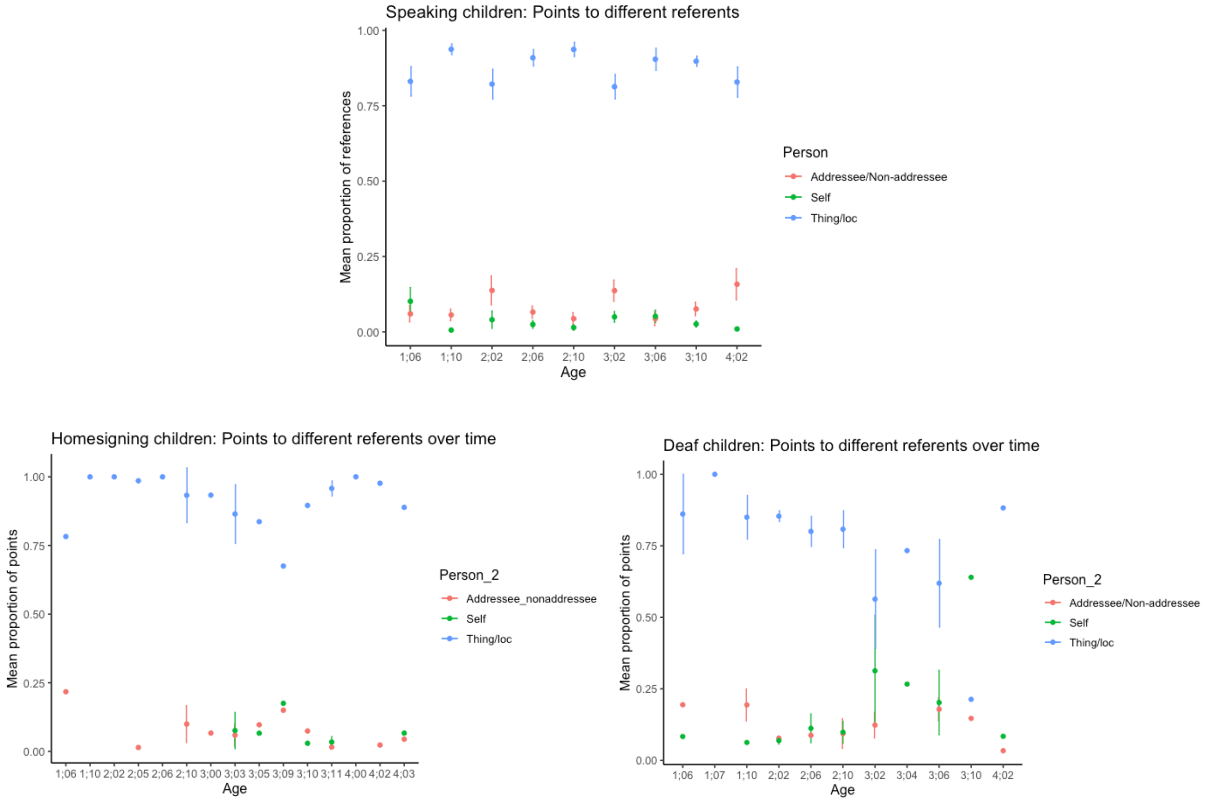

Figure 13. Mean proportion of references to self, addressee/non-addressee, and things/location over development from 1;06 to 4;02 years old in speaking children (top), homesigners, (bottom left), and signing children (bottom right).

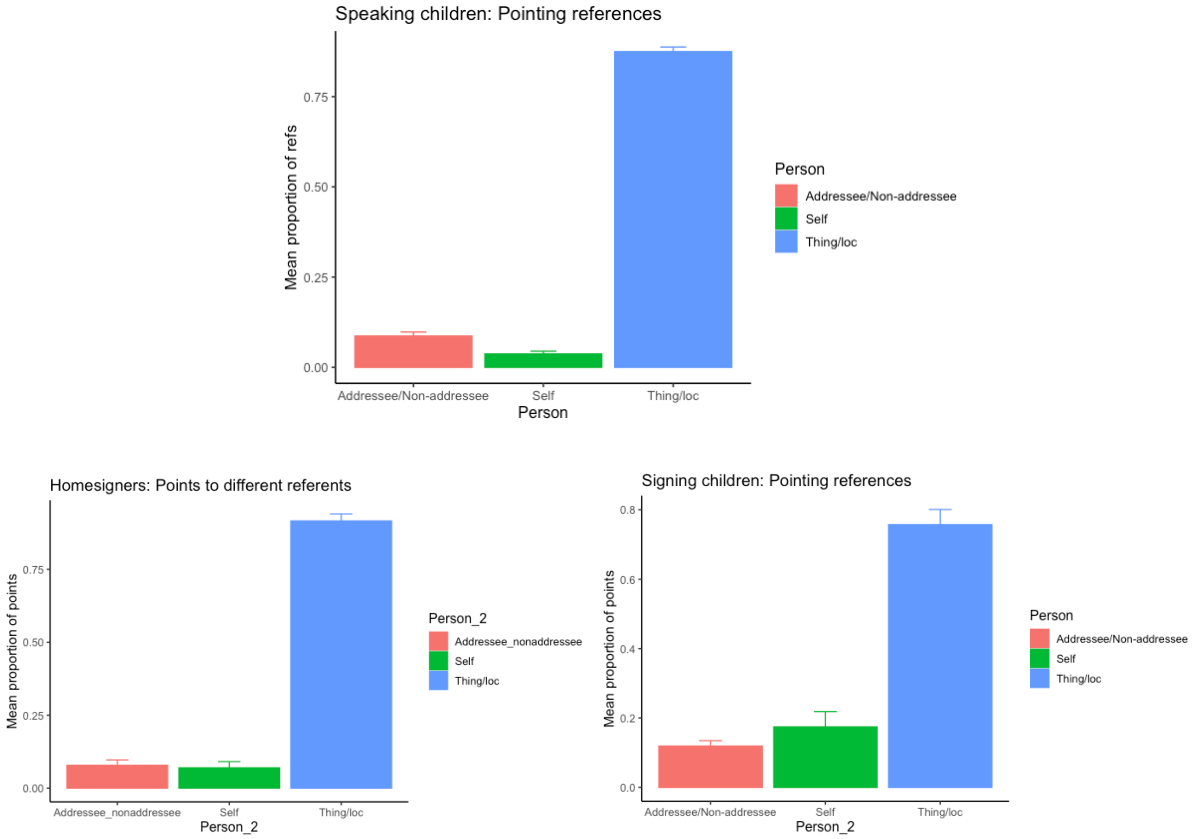

Figure 14. Mean proportion of references to self, addressee/non-addressee, and things/location in speaking children (top), homesigners, (bottom left), and signing children (bottom right).

Displaced pointing. Homesigners and signers show an increasing proportion of displaced references with their points by either pointing at things that stand for the intended references or arbitrary locations in space to absent references over development (Figure 16; M_{signers} = 3.8%, SD = 4.5%; $M_{\text{homesigners}}$ = 5.15%, SD = 9.3%). However, speakers' points are mostly constrained to the here-and-now (M_{speakers} = .07%, SD = 1.9%).

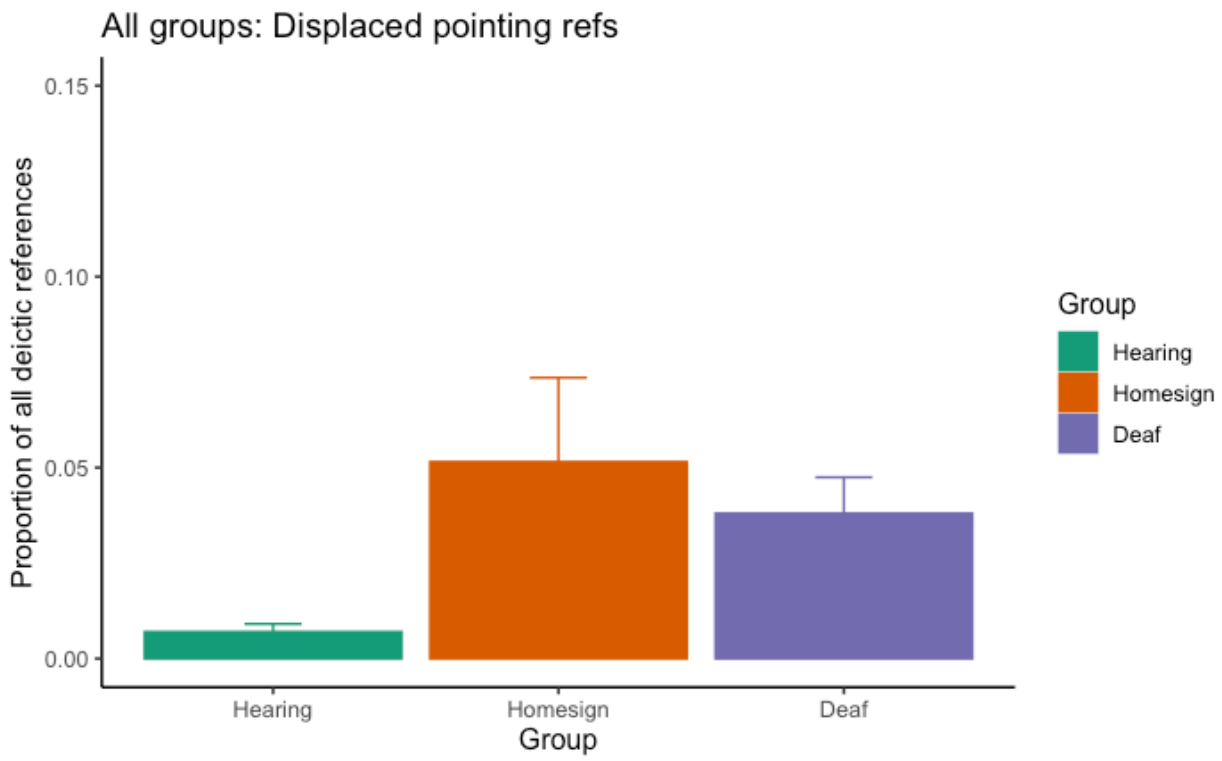

Figure 15. Mean proportion of displaced references in speaking children, homesigners, and signing children.

Productive use of deixis with words or gestures. Figure 16 illustrates the mean productive point + speech combinations in speaking children, point + gesture combinations in homesigners (these include iconic gestures and markers), and signing children's point + sign combinations over development. Speaking children do not show a significant age-related change in their rates of productive point + speech combinations ($\chi^2(8) = 6.07$, $p = 0.64$, but signing children (χ^2 (10) = 20.7, $p < .05$) and homesigners (χ^2 (15) = 55.13, $p < .005$) progressively become productive with their point and gesture/sign combinations over development.

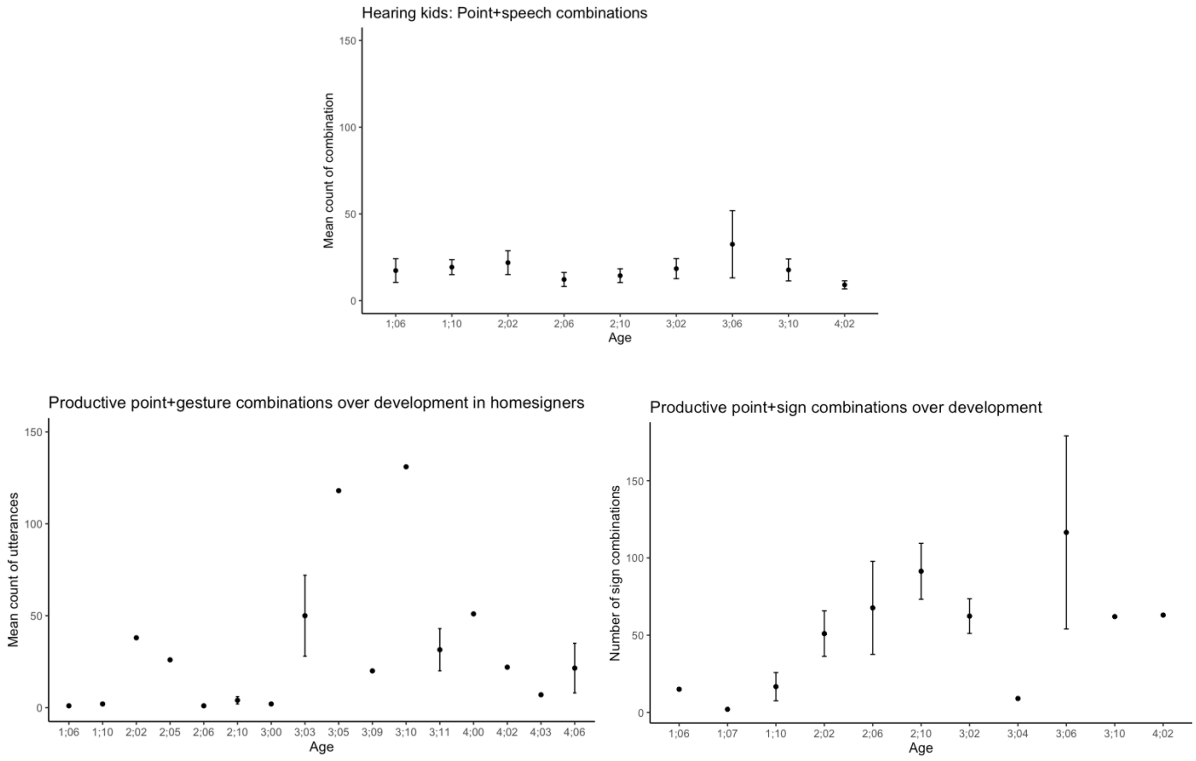

Figure 16. Mean count of point + speech/sign combinations in speakers (top), homesigners, (bottom left), and signers (bottom right)

Structural integration of points. Next, I address whether structural integration is dictated by modality-specific factors of communicating within signed vs. spoken channels, and the answer is yes. The majority of signing children's points were slotted in the sign stream (99%), and there was a tiny minority of points co-articulated with another sign (1%) – this is the exactly the same pattern found with homesigners (99% slot in, 1% span across). On the other hand, the majority of speaking children's points spanned across the words that they uttered in speech (85%), and they rarely slotted in points in the speech stream (13%); the remaining points also spanned across two different utterances (Bridge-over points: 1%).

Homesigners, like signers, are also more likely to produce shorter points within longer gesture utterances than shorter utterances. They show a negative relationship between the

duration of points and utterance length (Figure 17; $r(1158)= -0.22$, $p < .0005$; see Table 6 for information on which part of the dataset was included in the analysis).

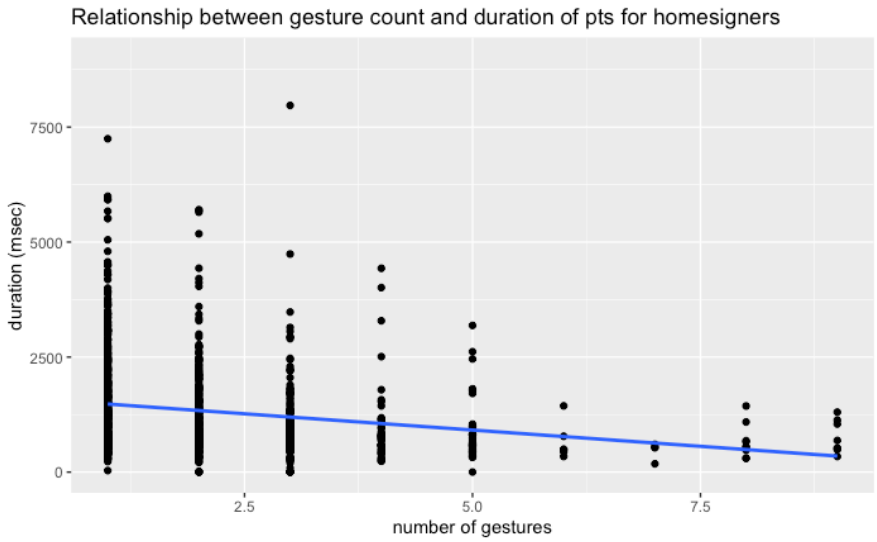

Figure 17. Relationship between gesture count and duration of points for homesigners

Form and information function of points. Finally, homesigners' pointing forms were compared with signers and speakers, and for this analysis, I included data focusing on ages 2;06 to 2;10 for signing and speaking children. However, because homesigners had a skewed distribution of load-sharing and load-bearing points with very few load-sharing points at an earlier age, I included a wider range of homesigning children in the dataset (see Table 6 for number of subjects within each age bin).

Table 6. Number of subjects within each age bin that were included in the data analysis for pointing forms produced by signers, speakers, and homesigners.

	Speakers	Homesigners	Signers
2;02		1	
2;05		1	
2;06	10	1	2
2;10	9	2	2
3;00			
3;03		2	
3;05		1	
3;10		1	
4;00		1	
4;02		1	

Since modality plays a significant role in influencing the forms of points for signers and speakers, in my next analysis, I focus only on points produced in isolation without any surrounding words. This context might provide a more comparable point of analysis as the points are not constrained by any potential modality effects due to combination. I find that, when points are produced on their own, relative to points that include all types of combinations (alone and multi-gesture utterances; Figure 18), the duration of points becomes comparable between signers, speakers, and homesigners with no significant differences in the duration of points (Figure 19; M_{Speakers} = 1614.71 ms, SD = 1296.36 ms, $M_{\text{Homesigners}}$ = 1520.61 ms; SD = 1159.62; M_{Signers} = 1362.15 ms; SD = 1268.14).

Next, I explored homesigners' distribution of load-bearing and load-sharing points, compared to signers and speakers'. Interestingly, homesigners and signers show a similar distribution of load-sharing and bearing points with a significantly higher number of load-bearing points than load-sharing points (Fig. 20). Speakers produce fewer points overall, and show an even distribution between load-bearing and sharing points. Because homesigners did not have enough load-sharing points due to having a more limited set of iconic gestures relative to signers' larger

lexicon, we cannot make definite conclusions about their production of load-bearing and load-sharing points. However, we can conclude that their load-bearing points are similar to what signers are producing (Fig. 21, 22).

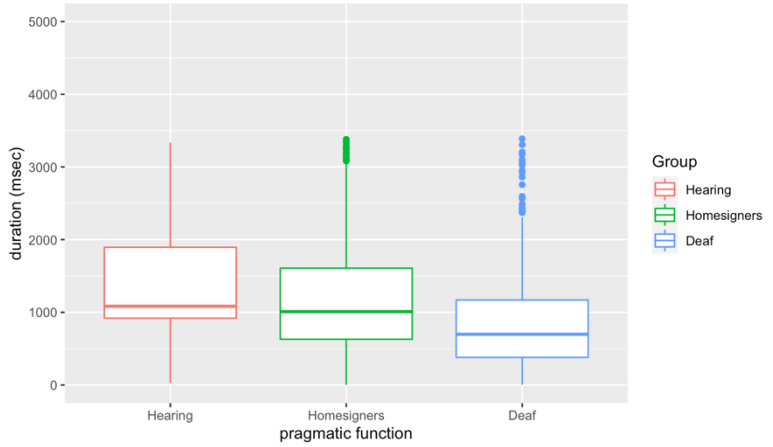

Figure 18. Duration of all points, including load-bearing and load-sharing points, for the three groups of children.

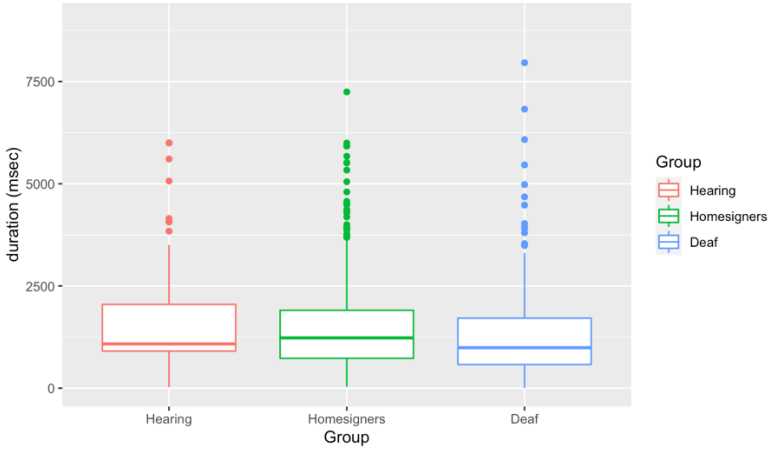

Figure 19. Duration of only points that are produced alone without any other spoken or signed words for the three groups within the age range of 2;06-4;02 years old.

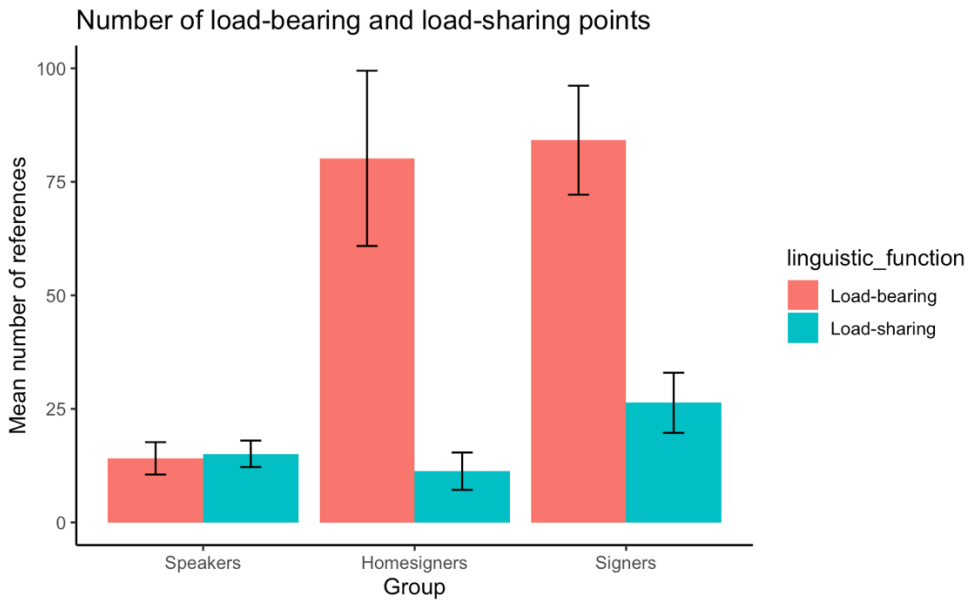

Figure 20. Mean number of load-sharing and load-bearing points produced by speakers, homesigners, and signers.

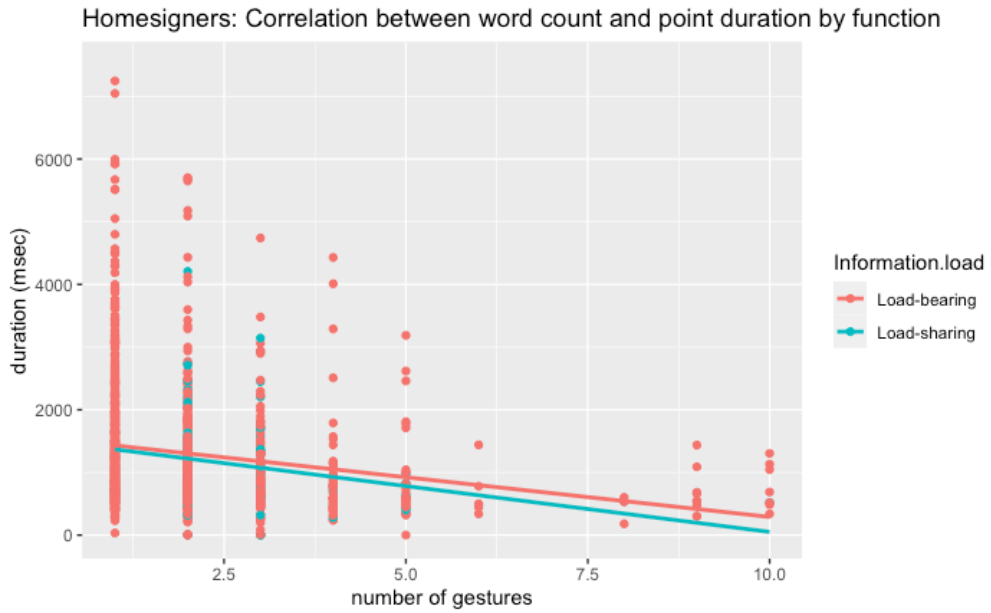

Figure 21. Correlation between word count and point duration by information function (load-bearing vs. load-sharing) in homesigners.

Note. Homesigners did not produce many load-sharing points, so at this point we can only conclude that they look like signers in their production of load-bearing points.

Discussion

This case study is the first to contextualize homesigners' deictic systems within children acquiring spoken and signed languages natively, reinforcing our understanding of the specific input necessary for the development of a full deictic system (see Table 7 for a visual summary). Like the signers, homesigners have the capacity for developing displaced functions, supporting findings by Butcher et al. (1991) and Morford and Goldin-Meadow (1997). Interestingly, homesigners show more displaced pointing compared to signers, which could be explained by their small gesture repertoire to reference to absent objects. In contrast, signers have a larger repertoire of signs, and can use names or nouns in addition to points, for this function.

Morford and Goldin-Meadow (1997) found that homesigners and speakers acquiring a spoken language show similar patterns in their development of displacement, but homesigners show a delay as they are generating a system completely from scratch. However, there is a possibility that displacement generally takes time to develop within the manual modality, especially that it might be a cognitively difficult process for children to learn how to abstract their pointing. To explore this possibility, I compared homesigners with signing children, and found that, indeed, both signing children and homesigners develop displacement at around the same age – at around 2;02 years old.

In addition to displacement, homesigners and signers have strikingly similar profiles for other aspects of pointing. Secondly, the manual modality primarily shapes the pointing form as homesigners slot in their points within their utterances as signers do. In contrast, speakers showed an increased number of points that spanned across their spoken utterances. There are some differences between homesigners and signers with respect to distributions of load-sharing and load-bearing points. Homesigners produce a higher number of load-bearing points compared

to signers, which could be explained by the availability of a large shared lexicon of lexical signs among signers. Therefore, with a higher number of noun references, signers produce a balanced distribution of load-sharing and load-bearing points. Homesigners, on the other hand, lean more heavily on deixis – putting more information weight on their pointing – for successful communication. Children develop a sensitive attunement to the time pressures of conversational structure with their partners, and selectively choose the most available communication form they know in order to take the floor and hold onto their turn (Sacks, Schegloff, & Jefferson 1974; Yurovsky et al. 2018). When they do not know a particular label for an object or are unable to retrieve it, they are more likely to produce a deictic gesture for efficient communication (Yurovsky et al. 2018). We see this kind of semiotic trade-off within deaf native signers and homesigners, where homesigners are more constrained to indexicality as they do not have as many iconic gestures in their system. Therefore, to keep communication efficient and flowing, homesigners rely more on pointing, rather than iconic gestures, which might not always be understood by their interlocutors. Signers do not carry the same risk for misunderstandings due to having a shared lexicon with their parents.

Deaf native signing children point to persons more often than the homesigners. The homesigners resemble the speakers in their distribution of referentiality by showing a prevalence in pointing to things/location and very rare instances of points to self or addressee/non-addressee. Homesigners may use their bodies as the subject, and it might take some time to develop deictic references to the self and others. Meir, Padden, Aronoff, and Sandler (2007) argue that in language emergence, the body can serve as the subject, particularly for iconic verbs that are produced on the body. For instance, the sign EAT is a body-anchored iconic sign that is produced at the mouth of the signer, and the body implicitly serves as the subject. Similarly, in

verbs such as TO-GIVE, where the sign originates at the signer's body and then traverses to the locus that represents the recipient, the body takes on the role of the subject marker in this type of verb agreement. In one scenario, Kathy points at a toy in her hand, which represents her sister's toy, and then produces a reaching gesture with wiggling hands towards her sister's toy, which represents her desire for it. In this utterance, she does not produce any points to the self to overtly mark subject, but could be using her body instead. Future analyses could compare the types of action representations that homesigners and signers use, and track their representation types (e.g., agreement vs. non-agreement), as well as the number of indexical points that co-occur with these representations. With the given data, it would not be surprising if there were fewer instances of points to persons along with these gestures in homesigners compared to native signers.

The limited variability in homesigners' pointing references is reminiscent of the patterns documented in emerging signed languages. Coppola and Senghas (2010) also found within narrative contexts with indirect deixis that homesigners in Nicaragua do not have the same distributions of points with locative and nominal functions compared to Cohort 1, 2, and 3 signers of Nicaraguan Sign Language, such that there was an increase in non-spatial, referential and nominal use of deixis across the language emergence continuum. Also, points to the chest increase along the continuum, which signifies that the nominal function takes time to develop. In their study, homesigners were also more likely to produce exophoric points, pointing at things in their immediate environments, compared to NSL signers. It is still possible that in the current study, homesigners may simply have a protracted development of a full referential system, so future analyses could capture their pointing within an older age range.

With the given data, homesigners do not have the same distribution of functions and the same level of productivity with their points as signing children. While pointing is foundational for

their early communication, some of their functions may emerge later in development; alternatively, a linguistic model might be needed to tip them over to the side of a fully developed deictic system.

Table 7. Summary of results focusing on speakers, homesigners, and signers' pointing

	Speakers Points only	Homesigners Points only	Signers Points only
Referentiality			
Displacement			
Productivity			
Relationship between point duration and word count			
Integration of points (Slot-in vs. span-across)			

Note. Speakers and signers exhibit distinct properties in their pointing, indicated by their distinct colors. The color blue indicates gestural qualities of points and lack of linguistic function, while the red signifies having a linguistic function. Purple indicates that there are some emergent linguistic properties. Homesigners resemble speakers with respect to referentiality, and resemble signers with respect to displacement, point duration and word count relationship, and structural integration. However, homesigners look distinct from both groups for productivity, as designated in purple. The data on the effect of information function on pointing duration is inconclusive, as there were no significant differences detected between load-bearing and load-sharing points' duration.

Chapter 4: Conclusions and Theoretical Implications

This dissertation presents a series of case studies that clarify and solidify our understanding of long-standing theoretical questions on how deixis, a fundamental aspect of communication, unfolds and develops in contexts with radically distinct languages and varying degrees of available linguistic input. This semiotic tool lays the foundation for early communicative development regardless of the communicative environments the child is embedded in, and then becomes refined and shaped in a very similar way within spoken and signed languages, such that both systems develop an interface of indexical and symbolic functions. This work challenges the outstanding assumption that pointing in signed languages is just like pointing gestures. Signing children use pointing with the same set of functions found in speaking children's deictic systems. Considering these results together, I conclude that signers' pointing closely resembles the pronominal system in speech in terms of their functions. Finally, by studying homesigners, we gain insights into how indexicality integrates with a communication system when there is no available shared linguistic code. Homesigners develop a sophisticated system, albeit a partial one relative to signers, which suggests that linguistic input might be necessary for a fully elaborate deictic system.

Summary of Findings

Chapter 1 presents the first-of-kind systematic comparison between speaking children's deictic system as a whole (speech + gesture) and native signing children's pointing. Both groups of children develop analogous functions: 1) referentiality, 2) displacement, and 3) productivity – over development (see Table 3 for a visual summary). Only when we compare speech and gesture with sign language, do we start to witness how strikingly similar pointing signs are with

the pronominal system + pointing gesture system in spoken languages (see Goldin-Meadow & Brentari, 2017 for a similar argument). When focusing only on pointing gestures in hearing speakers, we find that pointing signs and pointing gestures behave differently. Signers use their indexical point for many functions that do not appear in speaking children's co-speech points. Instead, pointing signs are best compared to the spoken pronominal system in speech. These pieces of evidence suggest that pointing signs may have gone through conventionalization processes, and young deaf signers are already learning these functions very early on.

Chapter 2 focuses on modality and linguistic factors that shape signers and speakers' pointing. Children's pointing forms are already shaped by intrinsic, structural qualities of signed and spoken languages at an early time point of their development as indicated by their pointing forms and their structural integration. First, signing children's points are more reduced relative to speaking children's points. Signers were more likely to slot in their points in the signing stream, while speakers showed a more even distribution of slot-in and span-across points. These characteristics may be shaped by the respective modalities they are communicating in or by the conventional practices of sign and spoken languages.

Word count also matters – pointing tends to be shorter in longer utterances for signers and the opposite pattern appeared for speakers. Then, I asked whether they exhibit form-to-function mappings of points onto distinct information functions. I focus on a particular set of pragmatic functions following previous work done by Enfield et al. (2007) and Cooperrider et al. (2021), and replicating Cooperrider (2021). No differences were detected for the impact of information functions on pointing for both signing and speaking children when taking into account word count, although speakers' load-bearing and load-sharing points were longer than

signers' after controlling for word count. These children are still very young, so it may take some time for pointing forms to differentiate according to these information functions.

Chapter 3 of this dissertation attempts to understand which aspects of deixis emerge in face of wide variability in children's linguistic environments. I pursued this question by examining deaf homesigning children situated in a radically distinct linguistic environment compared to deaf native signing children; homesigners do not have any exposure to a signed language. Homesigners develop an idiosyncratic system that the is similar to the deaf native signing children's system, yet they do not develop all of the functions (see Table 5 for a summary of results). Thus, some aspects of deixis are "resilient" (Goldin-Meadow, 2005) and emerge in all types of environments, but other aspects may require learning from a language model and, possibly, intergenerational transmission. These facets of deixis could also develop on a delayed timetable, which needs to be further explored by expanding the age range for the homesigners.

Theoretical Implications

Starting at the same gestural origins. Despite their distinct linguistic and social environments, all children begin at the same gestural origin. At the earliest stages of development, they do not look all that different. They exhibit similar reliance on pointing in terms of sheer quantity of points and a strikingly analogous distribution in their referentiality and forms. As speaking children develop a wider repertoire of spoken words, they begin to transition to using deictic terms in speech, and their pointing drops off and becomes secondary to their deictic forms in speech. For instance, they do not continue to productively combine pointing gestures with nouns, verbs, or pronouns. Signing children steadily continue to use pointing,

eventually developing similar deictic functions on the individual level (referentiality and displacement) and on the sentence level (productivity) like children acquiring a spoken pronominal system. Homesigning children undergo a similar process as signing children do, but at a relatively slower pace.

Signers and homesigners go through a gradual process where their pointing is primarily indexical, but then expand their pointing's functions, and showing more reduced pointing forms. This reduction could be explained by modality and linguistic factors, which can be investigated further in the future. Mechanisms of grammaticalization that focus on language use and habituation could apply to the language acquisition process – pointing can start out as indexical by precisely singling out a referent in the environment, but through repeated use loses its transparency, akin to processes of bleaching, on the way of developing forms that are general and applicable to a wider variety of contexts (Bybee, 2003). During this process, these groups of children could eventually produce distinct pointing forms to mark their roles in the discourse (e.g., load-bearing vs. load-sharing) as well as other potential linguistic functions, but the developmental trajectories they undergo are still unknown.

Are pronouns and pointing part of the same communication system?

Pronouns and pointing in spoken languages may constitute the same communicative system, such that deictic terms in speech emerge out of early pointing, or they may be fundamentally distinct systems, where pointing plays a *causal* role in children's development of determiners and pronouns (Cartmill et al., 2014). Previous research has shown evidence that gesturing helps children acquire new vocabulary words (LeBarton, Raudenbush, & Goldin-Meadow, 2013) and solve math problems (Broaders, Wagner Cook, Mitchell, & Goldin-Meadow, 2007) because of gesture's imagistic representational format, which differs from the

linguistic format. This effect could apply to the relationship between pointing and pronouns, such that early pointing cognitively helps children acquire a pronominal system.

Or perhaps, both pointing and pronominal references have the same underlying meaning and make up the same communicative system (Clark, 1978; Bates et al., 1976). Capirci et al. (2008) argue that gestures and speech in the earliest stages of language development "share a common conceptual space as well as the activation of hand-mouth motor systems associated with specific objects or actions" (p. 34). In their study comparing 2-to-7 years old speaking children's speech and gesture with signing children's signs, they find that speaking children's gestural and speech productions seem to be tightly linked – in a picture naming task, children's gestural productions decrease when they have a greater number of labels for the intended objects (Capirci et al., 2008; Stefanini, Bello, Caselli, Iverson & Volterra, 2009). This finding parallels the current case study, where I find that pointing predominates in speaking children's early communicative development, and then becomes overtaken by demonstratives and pronouns in speech. Signers and speakers start with the same fundamental communication tools – gestural pointing – but then diverge as signers continue to use their original indexical resources and expand on the resources available to pointing, developing a system that inches closer to that of the adult signing model (e.g., Slobin et al., 2001).

The role of linguistic input in the development of deixis. The last piece of this work informs us about the role of the child's mind in driving the development of this communication system. This is the first case study that compares homesigners with native signers and speakers – previous work has primarily looked at them with the backdrop of children acquiring a spoken language (Morford & Goldin-Meadow, 1997; Butcher et al., 1991). I find that homesigners develop an idiosyncratic system that has some qualities that are found in the signers' system and

other qualities that are found in the speakers' system. Like signers, homesigners show a capacity for producing displaced references and develop them on the same timetable. However, homesigners do not show a clear pattern for form-to-function mappings or the same distribution of referents. The limited variability in homesigners' pointing references is reminiscent of the patterns documented in emerging signed languages. Adult Nicaraguan homesigners, for example, do not have the same distributions of points with locative and nominal functions compared to NSL signers within later cohorts (Coppola & Senghas, 2010). It is still possible that homesigners may simply have a delayed development of a full deictic system, so future analyses should capture their pointing within an older age range.

Limitations of Current Work

Methodological limitations. One of the greatest strengths of this work is that we get a glimpse into how children develop indexical references within naturalistic communicative settings, which is also its greatest weakness. With naturalistic data, there is a lack of control over children's referential opportunities, and differences that arise between these children could be partially explained by the natural variability in the types of conversations that children engage in. At times, it was also difficult to identify a particular point function, such as identifying a locative or entity point (e.g., a child pointing at an object at a distance in a hallway could be a point referering to a location or an entity). Experimental work, such as Cooperrider et al. (2021)'s paradigm, can elicit a specific range of deictic functions within controlled settings.

With a small sample of deaf signers and homesigners, it is at times challenging to make sense of the overall patterns in their deictic development. Each age point has a various number of sampled children ranging from 1 to 3 children. The large variability in the children's points and

the small samples at times obscures the clarity of the patterns (e.g., the analysis of point + gesture/sign combinations). By sampling from a larger population of signers and homesigners, more specific questions can be answered, such as whether there is a sequential emergence of different deictic functions, following up and replicating Lillo-Martin & Chen-Pichler (2018)'s analysis. Signers and homesigners may show a strong patterning for sequential emergence of points to the self, followed by points to addressee, and then finally to non-addressee, which would indicate that they are analyzing the points as having distinct functions like speaking children do with their pronouns (1st person pronouns tend to precede 2nd and 3rd person pronouns; Clark, 1978). Another possibility is that only signing children show this patterning, but not the homesigners.

Interactional patterns influencing communicative forms. This work primarily documents the structure and forms of deixis within different linguistic and social environments, but we do not have the full story on what drives and motivates these particular language uses. Studying interactional patterns between the parent and child would inform us about the pressures that shape children's specific communicative practices. Signing, speaking, and homesigning children are situated in different types of interactional structures and communicate within different modalities, which could give rise to these formational and functional differences. Hearing parents often do activities such as cooking and cleaning while speaking to their child; however, deaf dyads are often engaged in direct face-to-face interactions, making linguistic events predominately a mono-activity (Morgenstern et al., 2016). Secondly, how signing and speaking children establish joint attention with their parents is organized very differently. During book reading, speaking children can listen to speech while gazing at the object (the book) simultaneously, while deaf signing children need to access signs by switching their gaze between

the book and the parent (Lieberman, Hatrak, & Mayberry, 2014; Chasin & Harris, 2008). Children acquiring sign language master the ability to coordinate their attention by age two – during episodes of book reading, they look back at their caregiver more than a third of the time and frequently shift their gaze between the mother and the book.

Signed and spoken interactions also differ in their conversational structure, such as the number of conversational turns between the deaf and hearing dyads. The number of turns in the hearing dyads is at least twice as high as the number of turns exchanged in the signing dyad, which indicates differences in how children interact and coordinate with their parents in the visual vs. auditory modality (Morgenstern et al., 2016). As a result of these differences in attentional demands and constraints, from a processing and communication efficiency standpoint, pointing could have evolved to become more central within visual-dominated interactions than spoken interactions. Moreover, the specific interactional demands in the spoken modality may have put a different type of evolutionary pressure on the deictic system. For instance, it is easy for a speaker to use pointing when their addressee shares joint attention with them, but not when their listener is not visually engaging with them. In the latter situation, a spoken pronoun is more useful in order to get the message across. Pulling out interactional data and relating it to their communicative forms would help us understand how interaction and language use in context give rise to these patterns of deictic forms and frequency among signing, homesigning, and speaking children.

Using a conversational analysis approach could gain insights into the interaction patterns that influence children's deictic expressions. Laakso, Helasvuo, and Savinainen-Makkonen (2010) examined how parents and children coordinate using different multimodal devices, including pointing, proto-word expressions, and gazing, in a conversation. They analyzed the

grammatical structure of parental responses and the sequential structure of child-parent interactions. In their study, the child, Nuppu, often used a proto-word to initiate conversations, and then the mother would show candidate understanding of the meaning of Nuppu's proto-word and gesture combination. Within conversation analysis, a candidate understanding is a device that recipients use to express a tentative reading of a previous turn (cf. Schegloff, Jefferson, & Sacks 1977; Ochs, 1988). The mother sometimes interprets Nuppu's initiations as naming or requesting actions. For example, Nuppu points at the two butterflies at the window along with a proto-word and directed gaze, and then the mother expresses candidate understanding and responds with a point and the expression, "Yeah. These are those butterflies these in the window" (translated from Finnish). This example involves both pointing gesture and deictic references in speech that follow the child's pointing gesture. This method also captures any type of responses in the interaction – linguistic or non-linguistic responses – which is particularly useful especially with homesigners. Studying how deixis is used and embedded in conversations could give us a greater understanding of how language use and processing in the moment contributes to language development and emergence (Christiansen & Chater, 2008)

Future Directions

The role of parental feedback and interaction in the emergence of deixis. This work has demonstrated that homesigners build a sophisticated deictic system that has similar qualities as deaf native signing children, despite the fact that they are not exposed to a signed language. But does this system materialize in a vacuum? We need to consider whether homesigners' caregivers play a role at all – including a non-linguistic and social role – in driving their emerging deictic systems. Previous work on homesign has not taken into consideration how

children and their interlocutors use their immediate environments as a referential anchor for successful communication. Despite the fact that parents do not share a gesture system with their children, they could still respond contingently to their child's utterances with non-linguistic means, which could motivate their child's gesture creation. For example, one homesigner, Karen points at an empty jar of bubbles, and then gestures "blow" to tell her mother that she wants bubbles to be blown (Goldin-Meadow, 2005). If the mother responds by giving Karen a new, full bubble jar, then this would be evidence that their communication has reciprocity – the homesigner produces a communicative signal that has an intended effect on the addressee.

This "reciprocity of perspectives" has been argued to be a key requirement for language emergence (Edwards, 2014). People assume that others have the same access to objects, people, signs and events in the immediate environment, and act based on this assumption (Schutz, 1970; Edwards, 2014). For instance, I say "this" while pointing to an object, I assume that my addressee will perceive the object in the same way that I do. Edwards (2014) says "when a minimum threshold of reciprocity cannot be reached, participants do interactional work to converge on the object" (p. 18). It has been suggested that homesigners do not have a reciprocal communication system with their parents because their gesture output does not resemble their parents' gesture input (Goldin-Meadow, 2010; Goldin-Meadow, 2005). Their analysis thus far focuses on the semantic dimension of homesigners' gestures, but not the social interactional dimension, which takes into account the role of context and the parents' non-linguistic understanding and responses to the child's utterances (see Goldin-Meadow, 1984 and Goldin-Meadow & Mylander, 1983 for a similar point). Future work could address the following questions: What is the role of parental feedback in the building of a homesign system, and does it play a role at all? Is the child's gesture system a purely productive based system or a system

built to be perceived by others? Homesigners and their interactions with their parents could be re-analyzed by coding for episodes of shared joint attention between the child and parent, as well as the parents' communicative signals – both gestural and non-linguistic responses, such as actions that contingently result in response to the child's requests or comments.

Minimal requirements for the emergence of a deictic system. When the gap between perceptual experiences between two interlocutors widens, reciprocity is harder to achieve. We can also study children who experience their world differently from their parents – even more so compared to homesigners and their parents – such as those who are born deaf and blind to hearing sighted parents. Without full input to their environments, blind children show a slower development in understanding their own self in relation to their environments and also to others (Bigelow, 2003). Unlike sighted children, blind children do not have access to mutual gaze and facial expressions, and often miss out on observing others in social interactions (Bigelow, 2003; Brown, Hobson, Lee, & Stevenson, 1997), which affects their ability to build common ground with others. Blind children do not explore their physical environments in the same way as sighted children as they cannot readily perceive the physical layout of their environment – the objects in the environment, or the spatial relation of their own self to objects and the physical space. Parents cannot take this difference in their perception of their environments for granted. To ensure that the immediate environment is accessible to their DeafBlind children, they need to provide feedback and stimuli within the tactile modality. If the children can perceive that actions of others are contingent on their own behavior by accessing other's tactile responses, then they would be able to develop the ability to see relationships between their own self, others, and their environments. The variability in how much the parents and children achieve reciprocity, as

measured through their episodes of successful joint attention, could give rise to the variability in the complexity of the child's tactile-based communication system. This coordination may be a necessary foundation for an emerging deictic system. With these illuminating questions, we can probe and test for the minimal requirements necessary for scaffolding a deictic system.

Conclusion

In conclusion, the process of integrating indexical and symbolic forms is not all that different in spoken and signed languages. Even though children are acquiring languages in distinct modalities, they eventually develop the same set of functions in order to communicate about the here-and-now. Finally, as demonstrated with homesigners, this communicative act is not as simple or intuitive as it appears. In order to develop a sophisticated range of linguistic functions, pointing may need to be embedded in a shared linguistic system.

Appendix A: Figures of Individual Variability in Speaking, Signing, and Homesigning Children's Referentiality

Figure 22. Individual variation in speaking children's pronominal references over development. Each plot represents each child.

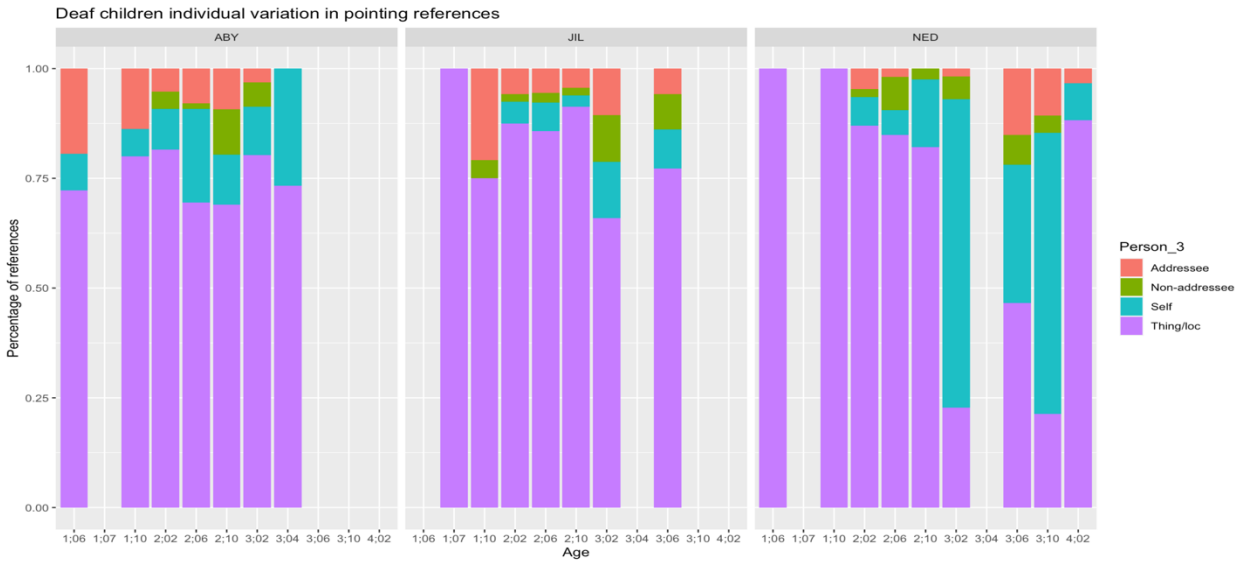

Figure 23. Individual variation in deaf signing children's deictic references over development. Each plot represents each child.

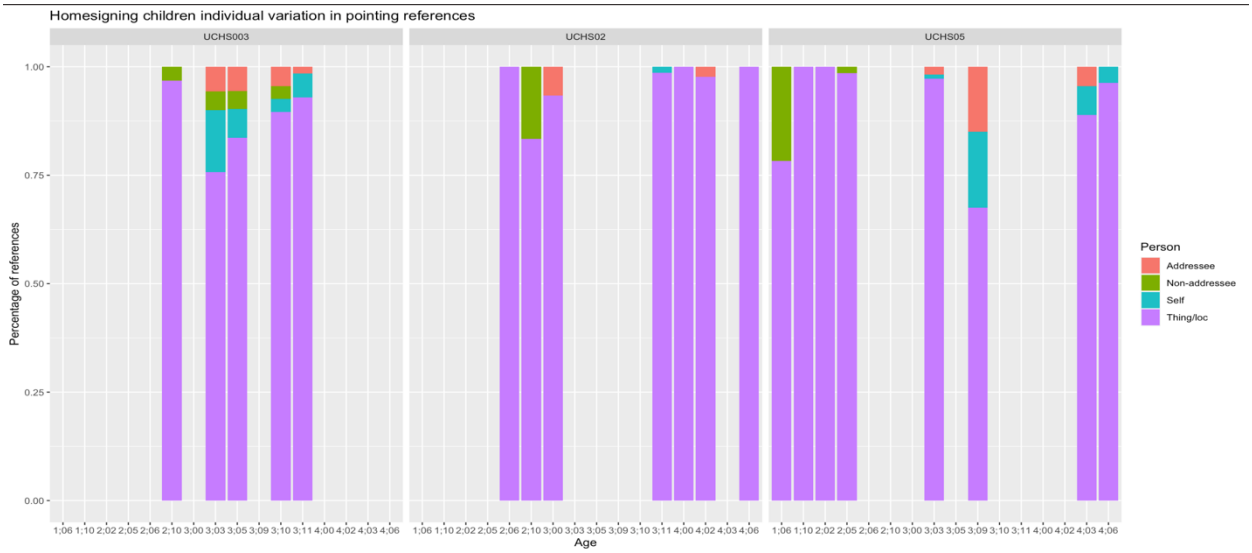

Figure 24. Individual variation in homesigning children's deictic references over development. Each plot represents each child.

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