Horton, Laura. 2022. Lexical overlap in young sign languages from Guatemala. *Glossa: a journal of general linguistics* 7(1), pp. 1–44. DOI: https://doi.org/10.16995/glossa.5829

Lexical overlap in young sign languages from Guatemala

Laura Horton, Stony Brook University, US, laura.horton@stonybrook.edu

In communities without older standardized sign languages, deaf people develop their own sign languages and strategies for communicating. These languages vary across several dimensions, including their age, their distribution within the wider spoken linguistic community, and the size of the signing community. Each of these characteristics interacts with the formal and distributional properties of the sign languages that emerge. This study concerns one property of young sign languages used in Nebaj, a community in Guatemala. Specifically, I document the degree of lexical overlap between signers who interact in small local ecologies as well as signers who are part of the same larger linguistic community but do not interact with each other directly. I use the Jaccard similarity index to quantify lexical overlap and find that signers who interact frequently have higher rates of lexical overlap than rates of lexical overlap for all signers. This adds to a growing literature that documents sign languages in diverse communicative settings and suggests that interaction is associated with different levels of lexical overlap or variation. Unique features of the communicative histories of signers of young sign languages are also discussed as factors that contribute to variable rates of lexical overlap in this community.

> At any given period, however far back in time we go, a language is always an inheritance from the past. The initial assignment of names to things, establishing a contract between concepts and sound patterns, is an act we can conceive in the imagination, but no one has ever observed it taking place… no society has ever known its language to be anything other than something inherited from previous generations, which it has no choice but to accept. (Saussure [1916: 105] 1983: 71–2).

1 Introduction

Communities of language users typically encounter their language as a social fact and rarely come together to establish lexical or grammatical conventions. However, contrary to Saussure's assertion that, "no society has ever known its language to be anything other than something inherited from previous generations, which it has no choice but to accept" (1916/1983: 71–2) there are instances of new or young languages around the world. They are created when communities of deaf[1] people come together and innovate novel sign languages. This process has been described for, among others, Nicaraguan Sign Language (NSL) (Senghas & Coppola 2001; Polich 2005), Al-Sayyid Bedouin Sign Language (ABSL) in Israel (Kisch 2008; 2012; Meir et al. 2012), and Kata Kolok (KK) in Bali (Marsaja 2008; de Vos 2012). In these examples, groups of deaf people created a new language that is now used by both deaf and hearing signers and transmitted to new generations of signers. The study of young sign languages offers an opportunity to document the process through which a new language comes to be used by a community and affords an ecological validity that is difficult to simulate in a laboratory or computer model. Prior work has documented the changes that occur as a sign language is transmitted across cohorts of students in a school setting (Senghas 2011; Coppola & Brentari 2014; Goldin-Meadow et al. 2015) as well as within families in communities with a high incidence of deafness (Aronoff et al. 2008; de Vos 2012; Nonaka 2012; Mudd et al. 2020). These studies underscore the diversity of circumstances in which young sign languages[2] emerge when there are a significant number

[1] For some time, researchers used d/Deaf to distinguish between "deaf" individuals who had a hearing loss and "Deaf" individuals who were part of the deaf community and primarily use sign language to communicate. This has become less common in recent scholarship. I follow this trend and do not capitalize "deaf" here (A.Kusters et al. 2017a)

[2] There is a large set of terms that have been used to describe the types of sign languages studied here. Some of these focus on the context in which the languages exist, e.g. rural home sign (Nyst et al. 2012) and indigenous sign languages (Nonaka 2009). Other terminology focuses on the size and scope of the language, e.g. family sign language (Nyst et al. 2012; Hou 2016) communal home sign (Zeshan 2011), and shared homesign (Horton 2018; 2020b). The mixed use of terminology has been discussed in Nyst (2012), Green (2014), de Vos and Pfau (2015), and Safar (2019). I use the term "young sign languages" in this study because I do not have evidence that these sign languages have been in use for multiple generations beyond the current signers. I describe them as languages, rather than homesign systems or sign systems because they are used by signers for the same functional purposes as other languages. I do not have strict criteria to determine whether they should be considered separate languages, dialects, or one local sign language.

of deaf signers or when deaf signers constitute a substantive percentage of the population, however, recent studies document young sign languages in places with a lower density of deaf people (Nyst et al. 2012; Green 2014; Hou 2016; Neveu 2019; Braithwaite 2020; Haviland 2020; Safar 2020; Reed 2021). The small number of fluent users and the spatial distribution of signers distinguishes these young "low-density" sign languages from some of the other documented young sign languages (e.g., NSL, ABSL, KK). Each of these characteristics interacts with a variety of formal and distributional properties of the sign languages that emerge, but in this study I focus on the lexicon.

I use the term lexical overlap instead of lexical variation or lexical convergence and ask whether lexical overlap – the propensity to use the same signs for the same referents – is associated with how much signers interact with each other. I work with a community of signers who have variable levels of interaction. Some signers interact frequently (daily) at home or school while other signers interact with each other sporadically, often as part of extended families who reside in separate households. Many of the signers who participated in the study do not interact and have never met each other to my knowledge. The variability of interaction across networks of signers in this community provides an opportunity to compare rates of lexical overlap between signers who have no interaction, signers who interact, but infrequently, and signers who interact almost every day. One limitation of this study is the absence of quantitative measures of interaction,[3] but several factors are considered as a proxy for interaction. These limitations are discussed further in the discussion section. This work contributes to our understanding of the lexicons of young sign languages and the nature of signers' interactions – do signers use the same signs when they interact or are distinct lexicons maintained by signers? How might the unique communicative circumstances of these signers contribute to higher or lower levels of lexical overlap with other signers?

Because there is no absolute scale of "high" or "low" lexical overlap, I compare rates of lexical overlap relatively, within this community. Lexical overlap is quantified at two scales – the wider linguistic community (community overlap) and local communicative ecologies (ecology overlap). *Community overlap* refers to the rate of lexical overlap for all signers in the sample. As indicated above, some signers know each other and many have never met, but all reside in the same community in Guatemala. *Ecology overlap* is a measure of the lexical overlap within small communicative ecologies or social networks of signers who are related or attend school together. In this analysis, community overlap is taken as the base rate of lexical overlap. I then

[3] One strategy for quantifying interaction used in socialization studies is termed "spot observation" (Johnson 1973; Munroe & Munroe 1971; Rogoff 1981) and involves checking in on target children or participants at different times of day and recording who else is present and whether they are interacting with anyone. "Upon locating the target child, the observer notices the child's activity, companions, and general location, usually requiring an extended glance to understand the context of the activity" (Rogoff 1981: 20).

ask whether the ecology overlap of the three types of ecologies: individual, low-frequency, and high-frequency, are higher or lower than the community overlap. This study also addresses the issue of multi-sign responses during lexical elicitation, a common methodological problem in the study of young sign languages. This work adds to our understanding of the variability in young sign languages and underscores the complicated relationship between ecology structure, social interaction, and lexical overlap.

Prior studies have documented rates of lexical variation and lexical convergence in young sign communities. They predict that there will be higher rates of lexical variation in young sign languages than older sign languages (Meir et al. 2012) and that community characteristics contribute to variable rates of lexical variation in sign languages with equal time depths (de Vos 2011; Meir et al. 2012; Mudd et al. 2020). Findings from these studies suggest that esoteric communities that are smaller and more homogenous will be characterized by higher levels of variation while exoteric communities that are larger and more heterogeneous will have lower levels of lexical variation (Wray & Grace 2007).

Although many community characteristics contribute to patterns of lexical variation, this study focuses on the amount of direct interaction between language users and whether this is related to their use of the same lexical items. Based on previous work mentioned above, we might anticipate that lexical overlap will be low in this community (that lexical variation will be high), both because of the relatively young age of the languages in use and the small size of the communities using these local sign languages.

It is important to note two factors that impact measures of lexical overlap or variation, these include: (1) how the data are collected – specifically, what type of elicitation materials are used[4] – and (2) how the data are coded and analyzed – specifically, what criteria are used to compare signs. I discuss the elicitation materials for this study further in section 3.2.2., and data coding and analysis in section 3.4, but note here that this study used a photo elicitation method and compared signs based on their iconic motivation or prototype. Both of these decisions affect the rates of overlap reported. It is possible, for example, that signers were more likely to produce iconic forms because the elicitation materials were images and it is likely that there would be less overlap if signs were compared based on formal criteria like handshape and place of articulation. I discuss the reasons for these choices, and their limitations, further in section 2.2.2. However, given these parameters, these data provide a measure of variation and overlap in a local sign language and, together with other studies of similar communities, contribute to our understanding of the relationship between social interaction and language form overlap.

[4] See Safar (2021) for a detailed discussion of strategies for developing elicitation materials for sign language documentation and the benefits and drawbacks of photo elicitation techniques.

2 Background

Researchers describe the variability found in spoken and signed languages in terms of variation and convergence (Meir & Sandler 2019). Lexical variation is the term typically used to describe the range of forms with the same meaning used by a population of users of the same language. Lexical convergence is the term often used to describe the same phenomenon – the range of forms used by a community of signers – but from a different perspective, in the context of emergent languages. While "variation" establishes convergence and conventionality as a starting point, "convergence" carries a sense that the starting point is variation or disorganization. Variation is a measure of principled diversification away from a standard (if a standard form exists), while convergence implies movement toward conventionalization or standardization. But it is not always transparent how to distinguish meaningful, significant variation from meaningless, unordered variation (Meir et al. 2012; Safar et al. 2018; Safar 2019). The two terms carry markedly different valences. When variation is linked to identity, it does meaningful social work, and this is often presented (implicitly or explicitly) as a more advanced function of language. In contrast, when variation is construed as unordered or unrelated to social roles, it is cast as a proto or preliminary stage in a teleological or evolutionary model of language emergence. As Nyst et al. (2012) and others argue, it is problematic to establish a continuum in which older sign languages are the standard toward which young sign languages evolve (Braithwaite 2020). Because of the associations between the terms variation and convergence, I use the term *lexical overlap* in this study to describe the degree to which signers use the same signs or different signs. In the following sections I describe previous studies of both variation and convergence from the perspective of typological, observational, computational and experimental studies.

2.2 Community characteristics and the lexicon

Studies of lexical variation typically use comparative methods, sampled from different groups of speakers or signers using a recognized language or dialect. The study of lexical convergence, however, has involved a diverse array of methods including naturalistic, experimental, and computational studies. Naturalistic studies of young sign languages, introduced briefly in section 1, involve observational and elicitation methods. Researchers typically spend time in the community and work directly with community members. Simulations of language emergence are either computational or experimental. Computational models use hypothetical agents that are programmed to have certain capacities for memory or learning (Steels 2005). Agents "interact" with each other to establish conventions (names) for a particular set of referents or perceptual domain (Gong et al. 2012; Steels & Belpaeme 2005). In the specifications for the model, researchers can control factors like the size and density of the community of agents. In experimental paradigms, speakers of existing languages are brought together in a lab or online. Participants are placed in situations that constrain their typical strategies for communicating (talking), forcing them to

develop novel systems, often in the visual or manual modality. The diversity of methods allows researchers to explore the relationship between features of communities and lexical convergence, as well as the influence of interaction and transmission. In the following sections, I discuss the predictions and findings from typological, naturalistic, experimental, and computational studies of the relationship between community structure and language structure. There is an extensive literature in each of these areas, and several useful reviews of each.[5] Here, I focus on studies that discuss lexical variation or convergence.

2.2.1 Typological studies of lexical variation

The relationship between social structure and linguistic structure has been explored extensively in work on spoken languages with long histories of language change, language contact, and dialect shift (W. Kusters 2008; Lupyan & Dale 2010; Perkins 1992; Trudgill 2011). Researchers often focus on the following characteristics of communities: community size (Dahl 2011; Wray & Grace 2007), the density of network ties within the community (Milroy & Milroy 1985) and the amount of contact between language users within a network and outsiders (Wray & Grace 2007; Trudgill 1989). Wray & Grace (2007) map these characteristics onto communities that use primarily esoteric (intra-group) communication and communities that engage in primarily exoteric (inter-group) communication. Esoteric communities are described as more homogenous and insular while exoteric communities are more heterogeneous. The primary mechanisms posited to mediate the relations between these community characteristics and linguistic structures include different degrees of familiarity between speakers and characteristics of language learners, specifically whether most language learners are adults or children.

In esoteric communities, language users are more likely to interact with people they know which increases the likelihood that they have shared knowledge, experience, and context that they can draw on in interactions. Researchers have suggested that this familiarity allows language users to be less explicit in conversation. The linguistic consequences of this include preservation of irregular morphology and specific lexical items. A study of the Ballymacarrett community of Belfast, Northern Ireland, Milroy & Milroy (1985), for example, demonstrated that these kinds of communities are able to sustain and enforce linguistic norms, even conservative or complex norms that might be lost in larger, more dispersed communities. In exoteric communities, members are more heterogeneous and are less likely to have shared background and experiences for speakers to use in conversation. Specific or idiosyncratic lexical items that are not widely used across the community are more difficult to maintain because not all language users will recognize them. In terms of characteristics of language

[5] For typological studies see Trudgill (2011); for computational studies, see Baronchelli et al. (2013); for experimental studies, specifically experimental semiotics, see recent overviews by Galantucci & Garrod (2011) and Tamariz (2017). Examples from young natural languages are reviewed in de Vos & Pfau (2015).

learners, adult language learners have been suggested to prompt more transparent, simple, compositional features in language, while child learners are suggested to be more likely to preserve irregularity and increase the "complexity" of the language (Trudgill 2011). In esoteric communities, children constitute the majority of language learners while in exoteric communities, adult learners are more prevalent.

The connection between community characteristics and linguistic structure has also been studied in signing communities including the Al-Sayyid Bedouin community mentioned in the introduction (Meir et al. 2012) and Kata Kolok, a village sign language from Bali (de Vos 2012; Lutzenberger et al. 2021; Mudd et al. 2021). In their 2012 study, Meir et al. compare ABSL and Israeli Sign Language (ISL). Both sign languages are used in Israel and have similar time depths (approximately 100 years) but there are marked differences between the two languages in terms of community size, density, and the amount of contact between signers and other sign languages. ISL has a larger population of users (approximately 10,000, Israel 2009) and is used by signers who immigrated to Israel, often already knowing another sign language from their country of origin. ISL signers typically learn the language in schools for the deaf located in urban centers. The signing community of ISL is thus geographically dispersed and heterogeneous and could be considered an exoteric community. ABSL is used in a smaller community of signers (approximately 150 signers, Israel 2009) who are part of a homogenous community in the Negev desert. Most signers are familiar to each other; thus, the village shares more characteristics with esoteric communities. As an additional comparative sample, the authors included data from American Sign Language (ASL), which is approximately 200 years old with 500,000 signers. They find that ABSL signers show the most lexical variation, followed by ISL and then ASL, which had the least variation (see Israel 2009, Israel & Sandler 2011 for more detailed analysis and discussion). The authors attribute the heightened variation in ABSL to the extensive shared knowledge and familiarity of signers.

In a study of lexicalization of color terms in Kata Kolok, de Vos (2011) finds that there are fewer lexicalized color terms in Kata Kolok than in other urban sign languages like Australian Sign Language (Auslan). She observes that although the young age of some sign languages has been cited as a reason for different levels of variation, two sign languages with variable time depths offer a counterpoint to this relationship – Adamorobe Sign Language, which is approximately 200 years old, has only three signs for color terms, while Israeli Sign Language, estimated to be much younger, has seventeen color signs for fifteen colors (de Vos 2011: 74). de Vos suggests that factors other than language age must be contributing to variable levels of lexicalization and variation in these languages and suggests three characteristics that contribute to the low number of colour terms in Kata Kolok, including: frequent face-to-face conversations, a small, isolated community of users, and the absence of formal deaf education. In two recent studies of variation across the Kata Kolok lexicon, researchers find that rates of variation may

be associated with gender (Mudd et al. 2021) and that a number of sociolinguistic factors (deaf status, age, clan, gender, and deaf relatives) affect variable rates of lexical variation (Mudd et al. 2020). Particularly relevant for this study, Mudd et al. gathered social network data based on sociolinguistic interviews with hearing signers and reported or observational data for deaf signers (see Mudd et al. 2020: 62–64 for discussion of methods). They compared the rates of reported interaction – whether two signers were reported to "spend a substantial amount of time together" (p. 78) – to lexical choices on a photo lexical elicitation task and found a weak correlation – signers who were reported to spend more time together were more likely to use similar lexical items.

2.2.2 Observational and Elicitation Approaches

Studies of lexical convergence in young sign language communities often begin with a list of items to elicit, sometimes based on the Swadesh list (Swadesh 1951), which has been adapted for sign languages (Woodward 2011). Researchers typically elicit signs using photos, drawings, or videos, both because signers may have limited literacy skills, and to avoid interference from the ambient spoken language (Safar 2021). In studies from Japan (Osugi et al. 1999), Papua New Guinea (Reed 2021), Peru (Neveu 2019), Mexico (Hou 2016), and Nicaragua (Richie et al. 2014), researchers have conducted lexical elicitation tasks with signers of young and emerging sign languages. The size and circumstances of these communities, as well as the density of deaf people within them, vary across these sites. The studies sampled both deaf and hearing signers. Hearing signers were close relatives or friends of deaf signers who participated in the same elicitation task. Signers were shown illustrations or photos of items and asked to describe them.[6]

These studies share two methodological concerns that are also at issue for the present study. The first is how to develop appropriate criteria for identifying cognates across dialects or languages, and the second is how to analyze multi-sign responses from participants. The appropriate unit of analysis for sign comparison has been discussed extensively (Morgan 2017; Power 2020; Woodward 2011). Some studies annotate and compare signs at the level of phonological parameters of signs, including handshape, movement, location, and hand orientation. In their study of Al-Sayyid Bedouin Sign Language (ABSL), however, researchers observed that many signs seemed to be produced with significant articulatory variation that violated phonological principles believed to hold for older sign languages (Sandler et al. 2011). Instead of a stable phonological form, researchers noted that signers often seemed to share an "iconic prototype," a common iconic mapping for the referent. In their study, they cite the signs

[6] The number of items elicited ranged from 9 items (Nicaragua) to 66 items (in Papua New Guinea). Most of the elicitation lists included basic vocabulary items, ranging from animals, tools, foods, and people.

that were elicited for ‘dog’ in ABSL, for which most signers provided some iconic version of the mouth of a barking or biting dog. They thus compared signs using both phonological parameters and an iconic or conceptual target.

In addition to the challenge of identifying an appropriate unit of analysis, in almost all cases, researchers observed that signers frequently provided more than one sign for a given photo or elicitation drawing. For example, in response to a photo of a tomato, a signer might produce the signs CUT, EAT and CRUSH (see **Figure 8**). In some studies researchers selected one sign from the set of signs that signers provided based on conversational data or other elicitation sessions (Neveu 2019, Reed 2021). In the current study, signs were compared at the level of the “iconic prototype” (Sandler et al. 2011) or “conceptual component” (Richie et al. 2014). The full set of signs that signers provided in their response was included in pairwise comparisons. This eliminated the need for the researcher to judge which sign was the correct or citation form for that signer.

In each of these studies, researchers calculated convergence scores based on the responses that signers provided. There are a variety of ways to quantify convergence, but many studies compare pairs of signers who have independently completed the description task. The responses from one signer are compared to the responses of another signer to evaluate how frequently they produced the same sign to describe the same photo. For example, two signers who have a convergence score of 0.50 provided the same sign for half of the items that they described. This kind of measure was used for pairs of signers in the studies from Nebilyer/Kaugel Valley in Papua New Guinea (Reed 2021: 77–78) and Toyota/Nueva Vida in Peru (Neveu 2019: 111–153). An alternative strategy for calculating convergence across a group of signers is to report how many signers produced the most common sign for the same elicitation photo. This measure was used in the Amami Island study (Osugi et al. 1999: 98). In their survey of adult signers from Nicaragua who do not know Nicaraguan Sign Language (NSL), Richie et al. (2014) use a weighted-average distance measure to allow for comparisons between signers who produced more than one sign per item.

Researchers have used a range of methods to ask what levels of variation exist in young sign languages and to model or experimentally replicate these conditions. These studies compare mechanisms that might contribute to higher or lower levels of convergence, or to faster or slower rates of convergence. Experimental findings suggest that the quantity of interaction and the configuration of the social network might be key drivers of convergence. Naturalistic observations and comparative studies suggest that these sign communities often have significant shared semiotic resources drawn from local gestures and shared embodied experiences, and that these might contribute to a shared set of sign forms, independent of direct interaction (Safar 2019; 2020). This study adds to this discussion by sampling from diverse micro-ecologies that exist within the same larger speech community.

2.2.3 Experimental and Computational Approaches

The mechanisms identified in typological and observational studies of lexical variation offer starting points in experimental and computational studies that explore the same processes. For example, experimentally manipulating the amount of contact between participants or adjusting characteristics of hypothetical language users in computational models offer controlled studies of variation in these features. These studies attempt to simulate the variation that exists in signers of young sign languages and small communicative ecologies like those documented in the current study.

Recent experimental studies have manipulated both the size and structure of social networks to consider their effect on rates of conventionalization (Centola & Baronchelli 2015). Findings from an iterated learning experimental paradigm suggest that, *per unit time,* richly connected networks, in which all participants interact with each other, converged more quickly than the sparsely connected networks, in which only one participant, a "central hub" interacted with all members of the network. However, when they controlled for the increased number of interactions in each network, participants in the sparse networks converged faster *per interaction* than participants in richly-connected networks (Richie et al. 2020). That is to say, the relationship between interaction and convergence does not appear to be as straightforward as some of the initial predictions from computationally modeled experiments, e.g., Richie et al 2014. it may be the case that the memory demands of interacting with many people in a richly connected network slows convergence, while a sparsely-connected network with fewer interactions permits a central language user to "set" a standard form on which others can converge (Richie et al. 2020: 282).

Computational models of network structure have produced mixed results in studies of the relationship between network structure and lexical convergence. In a study comparing dynamic (richly connected) networks and static (sparsely connected) networks, researchers found that the dynamic network converged faster (with fewer interactions) on shared lexical items (Richie et al. 2014). In separate studies comparing six types of networks with varying degrees of connectivity between agents and distance between nodes, Gong et al. (2008; 2012) found that star networks conventionalized the fastest, followed by fully connected networks. Star networks had one central node (or agent) closely connected to other nodes, but the other nodes were not connected to each other – similar to the static or sparsely connected networks from the Richie et al. studies. It remains unclear whether networks with greater overall connectivity or networks with particular configurations (e.g., "star" networks) boost simulated lexical convergence. However, the results from both experimental and computational studies indicate that the amount of interaction, relative position in a social network, and the connections between other non-central agents all have the capacity to affect rates of conventionalization in an emergent communication system.

Although experimental and computational studies afford more control over individual variables like quantity of interaction or number of communication partners, it is difficult to assess how well these networks approximate the social experiences of signers and speakers in the world.[7] While it is true that many signers may have difficult or limited interactions with hearing communication partners (Carrigan & Coppola 2017) and may not converge on shared lexicons (Richie et al. 2014), this is not universal, as evidenced in case studies discussed in Nyst et al. (2012) and Reed (2021). Signers who do not know an older sign language or participate in a deaf community are not all equally "isolated" from their communication partners. Meanwhile, signers of an older sign language are not equally embedded in their local ecologies (A. Kusters 2009). Studies of people living within naturally occurring sign ecologies offer an important counterpart to experimental and computational studies. Though variables like frequency of interaction and number of communication partners are impossible to control or manipulate in this line of work, the ecological validity of the data are higher than experiments in the context of a lab or simulated computer models. In the next section I introduce the sign ecologies from Nebaj that are compared in this study.

2.3 Sign communicative ecologies

Three communicative ecology types were introduced in the first section above: individual ecologies, low-frequency ecologies, and high-frequency ecologies. Individual ecologies consist of families with a single deaf signer. Low-frequency ecologies and high-frequency ecologies contain multiple deaf signers who have different rates of social engagement. I use co-residence in the same household or residence in separate households as an indicator of the frequency with which signers interact. The current designation of low-frequency or high-frequency is also based on my conversations with family members. For example, when I asked Nila, José and Juana's mother from the Cobo family, how often they visited their relatives from the Bernal family, she indicated that they see each other approximately once per month. The conclusions that we can draw from this study are limited due to the lack of a quantitative measure of interaction. In future visits, I plan to conduct spot observations to verify the association between co-residence and frequency of interaction.

This classification of sign ecologies emphasizes deaf signers and ecologies with multiple deaf signers, with the assumption that these ecologies may contain a higher number of fluent signers, hearing and deaf. As noted in other studies of young sign languages, deaf-deaf conversations are the only guaranteed sites of sign interactions (Horton et al., under review). Hearing relatives and friends of deaf people in Nebaj will often sign when they are interacting with a deaf person, but

[7] As one reviewer notes, one limitation of many experimental studies of homesign and emerging sign languages is that they do not include detailed qualitative or ethnographically-informed descriptions of signers' social networks and communicative backgrounds.

they will typically switch to speaking if they are talking with another hearing person, even if a deaf person is present (see Safar 2019: 38, for a similar observation about Yucatec Maya Sign Language). The measures of social interaction used here are based on frequency of conversation between fluent signers, hearing and deaf. In particular, hearing siblings of one or more deaf signers are often fluent signers and interlocutors based on my observations of their interactions. As Reed (2021) notes in her study of signers from Papua New Guinea, hearing signers are essential members of signing ecologies.

The ecology types are illustrated in **Figure 1**. As discussed in the introduction, the variability in ecology size and interaction frequency provides an opportunity to analyze the relationship between these characteristics.

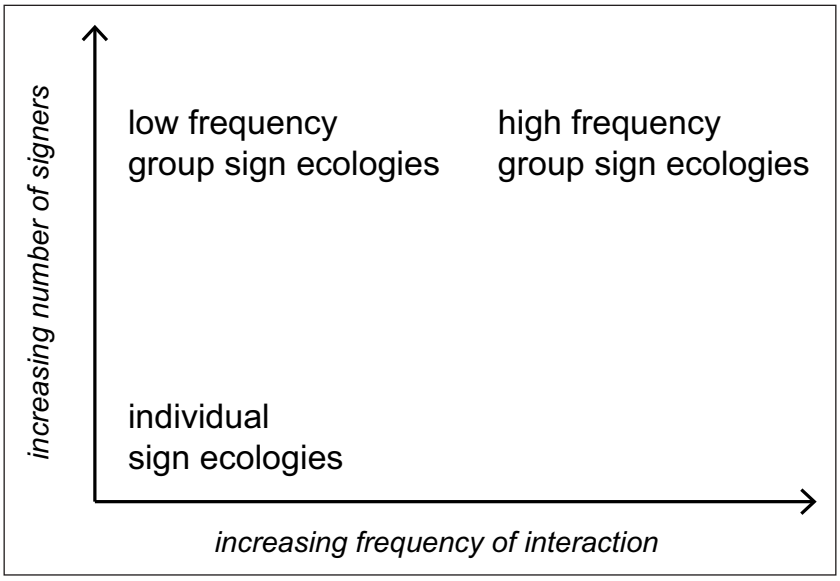

Figure 1: Diagram of the three ecology types compared in the current study based on frequency of interaction and number of deaf signers.

I return to this diagram to show the distribution of the ecologies in this study in section 3.3. In the next section, I introduce the methods used to collect and annotate the data for the study, as well as providing a more detailed introduction to the study participants.

3 Methodology

The data for this study were collected during the course of my fieldwork in Nebaj. I have met 19 deaf people who live in town or nearby, of which 12 are children under the age of 18. I am aware of nine additional deaf people who live in or near the center of town. The deaf people I have interacted with do not appear to use spoken Ixil or Spanish and, to my knowledge, they do

not use Guatemalan Sign Language (LENSEGUA), which is primarily confined to larger cities like Xela and Guatemala City (Parks & Parks 2008). I am a white, hearing woman from the United States and I have traveled to Nebaj each summer for approximately one month since 2013. This study draws on elicited data from 18 participants, described in greater detail in section 3.3 below.

3.1 Data Collection

3.1.1 Fieldsite

Nebaj, population 31,935 (CELADE 2018) is located in the Western region of the Quiche Department of Guatemala. The town is the commercial center for the Ixil region, which shares its name with the local spoken language, a Mayan language in the Mam family. The area was heavily impacted by Guatemala's prolonged civil war from 1960–1996 (García 2014) leading to extensive upheaval and involuntary resettlement. There are several families with intergenerational deafness in town, but there are also deaf people (both children and adults) who are the only deaf person in their immediate family.

Nebaj has a local school for special education which typically enrolls between four and eight deaf students annually. The school's total enrollment is around 40 students. Students have a variety of disabilities and range in age from 4 to 18. Not all deaf children in Nebaj attend this school. Some deaf children attend their local elementary schools and, to my knowledge, do not receive special services or accommodations in the classroom.[8]

As mentioned above, Guatemala's national sign language, LENSEGUA, is used in larger cities and in a subset of ten schools for the deaf across the country. Some of these schools are oral, emphasizing spoken Spanish, and some are reported to use American Sign Language (ASL) (Parks & Parks 2008). None of the schools for the deaf are accessible from Nebaj and none of the deaf people I have met has attended these schools. The school for special education in Nebaj has an illustrated dictionary of LENSEGUA and posts drawings of the manual alphabet, but none of the teachers at the school are fluent signers of LENSEGUA. Some deaf students use some fingerspelled letters from the manual alphabet, but most deaf students do not appear to use the language extensively in casual conversation. In the absence of a standardized, institutionally supported sign language, deaf people from Nebaj create their own sign languages for communicating.

3.2 Method

3.2.1 Stimuli

The data for this study were collected using a photo elicitation task. The elicitation tool was a book of photos taken by the author during a visit to Nebaj in 2013. The photos consist of local

[8] See Horton (2018; 2020a) for more detailed discussion of the sociological and educational circumstances in Nebaj. See also Goico (2019) for a description of the experience of deaf students in regular education schools in Iquitos, Peru and Gagne & Coppola (2021) for a general discussion of literacy in emerging sign communities.

exemplars of food, tools, landmarks, animals, vehicles, furniture, clothing, people, and plants[9] (see appendix 1 for a list of all items). Most of the data in this study (17 sessions) were based on the first book which contains 62 photos. In one session, a participant used an alternative version of the book with 75 pictures. The sets have 56 of the same pictures. Photos were generally simple and focused on one person or object with a blank or plain background. They were intended to be instantly familiar so that the signer could quickly and easily provide a signed label or phrase for the target item.

3.2.2 Elicitation

I was the primary interlocutor for most of the elicitation sessions, though sometimes the participant described the photos to a family member or friend. I usually sat next to the participant and would show them the first few photos and ask them to describe the picture. If the participant was hearing, I would ask them to describe or label the photos with their hands, as if they were talking to their deaf relative. Participants appeared both to comprehend and enjoy the task, particularly when they recognized the items or locations in the photos. If participants did not have a sign or did not want to describe a photo, they would shrug or indicate that they wanted to move to the next page.

It is probable that my role as the interlocutor for these elicitation sessions affected the nature of the interaction and the signs that participants produced. I have gotten to know many participants well during visits to Nebaj since 2013, but I am an outsider to this community and an educated white hearing woman from the United States. Signers certainly would have engaged with the task differently if they had completed it with a family member and I think that my repeated engagement in this task over several years of visiting may have prompted signers to think more consciously about which signs they use and whether they use the same signs as their signing relatives. However, acknowledging the limitations of this task, I am confident that this elicitation provides a snapshot of many of the signs that signers use on a regular basis to talk about familiar topics at home and school.

3.2.3 Responses

As noted in other studies using lexical elicitation (Richie et al. 2020; Lutzenberger et al. 2021; Safar 2021), signers sometimes provided lengthy descriptions of photos or seemed to describe components of the photos that were not intended. For example, one participant, Rosa, age 7, was doing the task and saw a photo of two chickens. She proceeded to describe, in detail, each of the chickens in the yard around us. Lengthy narratives like this were excluded from the analysis,

[9] Safar (2021: 41–47) provides a detailed discussion of the development of a similar set of photos for a lexical elicitation study of Yucatec Mayan Sign Language (YMSL).

as were cases where it was ambiguous whether the signer was describing the target item in the photo or some other feature of the photo. Most signers seemed to comprehend the task quickly, providing deictic signs – pointing to items in the immediate vicinity and farther away – as well as iconic signs and signs that resemble gestural emblems commonly used in the wider speaking community. I discuss the coding system and sign types further in section 3.4. Signers typically provided one or two iconic signs per photo. Signers provided from 1–9 signs per photo, with a mean rate of 1.7 signs per photo across all participants. I discuss individual signer rate in section 4 below, providing each signer's rate in **Table 3**.

3.3 Participants

All participants completed the lexical elicitation task between 2013 and 2016.[10] Characteristics including age, hearing status, and communicative ecology are presented in **Table 1**. Twelve participants are deaf signers while the remaining participants are hearing relatives of deaf signers, either siblings or parents.

	Ecology	***Name***	***Age***	***Deaf or Hearing***
	Peer Group	Tomás	10;6	Deaf
		Alejandro	10;11	Deaf
		Diego	13;7	Deaf
Cobo Family & Peer Group*		José	10;5	Deaf
		Juana	14;1	Deaf
	Cobo Family	Andres	7;9	Hearing
		Nila	Adult	Hearing
	Bernal Family	Sara	8;4	Deaf
		Lucia	Adult	Deaf
		Ramon	12	Hearing
		Abel	Adult	Hearing

(Contd.)

[10] All names are pseudonyms. Some participants have completed this task multiple times as part of a longitudinal study. This analysis only considers data from the first time that each participant completed the task. Age data was obtained for all child participants under the age of 18. Adults often did not report their age. Child participants' ages were verified with their birth certificate.

	Ecology	*Name*	*Age*	*Deaf or Hearing*
	Marcos Family	Jorge	6;5	Deaf
		Rosa	7;4	Deaf
		Pedro	Adult	Deaf
		Luisa	Adult	Hearing
	Individuals	Antonio	5;11	Deaf
		María	Adult	Hearing
		Jacinto	8;7	Deaf

Table 1: Participant characteristics.
*José and Juana are part of both the Cobo family and the peer group that attends school together, see section 3.3.2 for more detail.

There are several configurations of deaf and hearing signers, or sign communicative ecologies in Nebaj, as introduced in section 2.2 above. I introduce the participants below within their communicative ecology types.

3.3.1 Individual sign ecologies

Two deaf participants (Antonio and Jacinto) are members of individual sign ecologies. Antonio and Jacinto are the only deaf person in their immediate family. Antonio's mother, María, who is hearing, is also included in the sample. Like many deaf signers from individual ecologies, Antonio and Jacinto have one or two family members who sign with them. Antonio's brother and Jacinto's sister have both participated with them during sessions and appeared to sign with them proficiently. To my knowledge, however, Antonio and Jacinto do not interact with any other deaf signers.

3.3.2 Low-frequency sign ecologies

The Marcos family and the Cobo-Bernal extended family each have several deaf signers but the signers live in multiple households and do not interact as frequently as families residing in the same household or the children who regularly attend the school. The Marcos family is a large extended family that includes Pedro, a deaf man with several adult hearing children. Pedro had a brother who was deaf who is now deceased. His daughter, Luisa, who is hearing, has five children; two of these children, Rosa and Jorge, are deaf. Like the Bernal family, the Marcos family includes both deaf adults and deaf children. Unlike the Bernal family, the deaf adult and

deaf children reside in different households. Pedro lives with another of his daughters, a short walk away from Luisa and her family. According to Luisa, Pedro and his deaf grandchildren see each other several times per week, but they do not interact daily. The Marcos family relationships are illustrated in **Figure 2**.

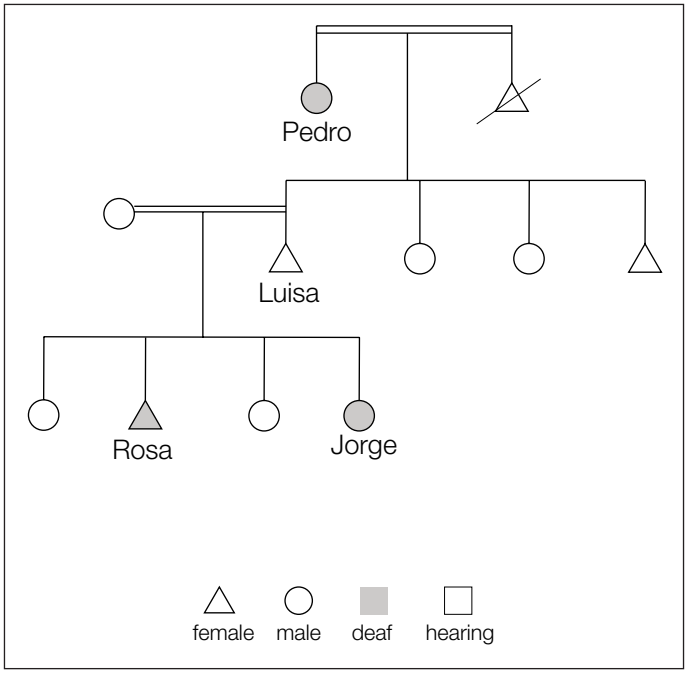

Figure 2: The Marcos family sign ecology includes three deaf signers, children Rosa and Jorge, their grandfather Pedro, and one hearing adult signer, Luisa, who is Rosa and Jorge's mother (and Pedro's daughter). Pedro's brother, who was also deaf, is deceased.

The Cobo-Bernal extended family consists of two single-household families who are related to each other. The extended family is illustrated in **Figure 3** and includes children Sara, Ramon, Juana, José, and Andres who are cousins, as well as adults Abel, Lucia, and Nila.

3.3.2 High-frequency sign ecologies

The set of high-frequency sign ecologies includes two families (the Cobo and Bernal families) and the peer group of students who attend the local special education school. The Cobo family consists of Nila and her three children – Juana and José are both deaf and Andres, their younger brother, is hearing. As mentioned above, Juana and José attend the local school for special education. Thus the primary contact that Juana and José have with other deaf signers outside of their family are interactions with same-aged peer signers. The Cobo family relationships are illustrated in **Figure 4**.

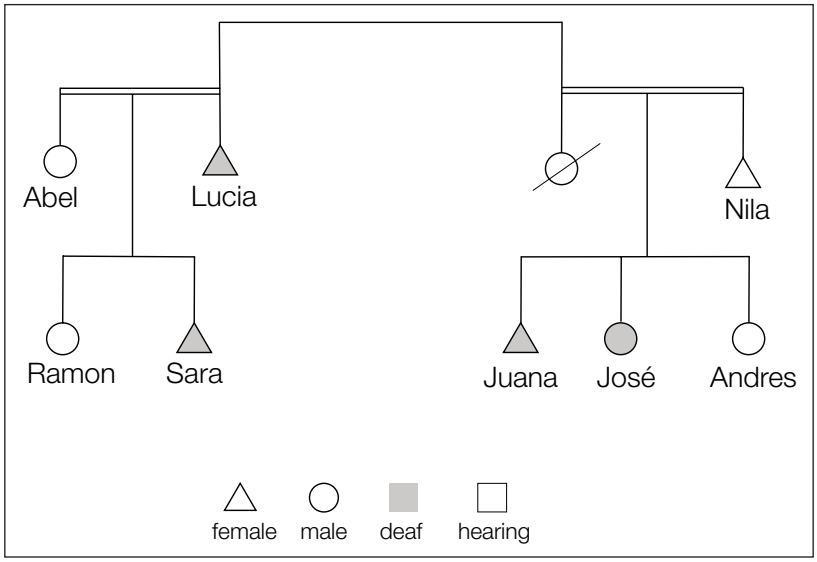

Figure 3: The Cobo-Bernal family sign ecology which includes with four deaf signers, children Sara, Juana, and José and one deaf adult, Lucia, Sara's mother. There are also four hearing signers, Ramon, Abel, Nila, and Andres. They live in two households that are located in separate parts of town.

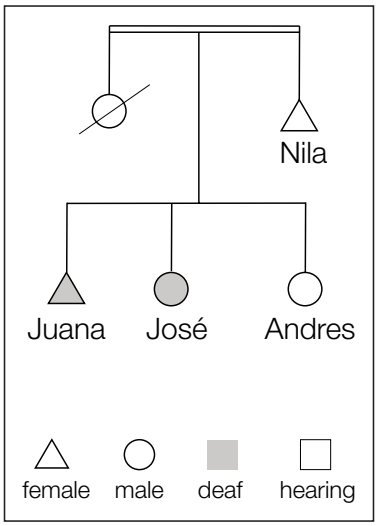

Figure 4: The Cobo family sign ecology includes two deaf signers, Juana and José, and two hearing signers, Nila, their mother, and Andres, their brother.

The Bernal family includes Lucia, a deaf woman who is married to Abel, a hearing man. They have two children, Sara, who is deaf, and Ramon, who is hearing, but has been exposed to his mother's signing since birth and is a fluent signer (see **Figure 5**). In this family, there is both a deaf adult signer and a deaf child signer, and half of the family members are deaf. Based on the time that I have spent with this family, many interactions in the household occur in sign.

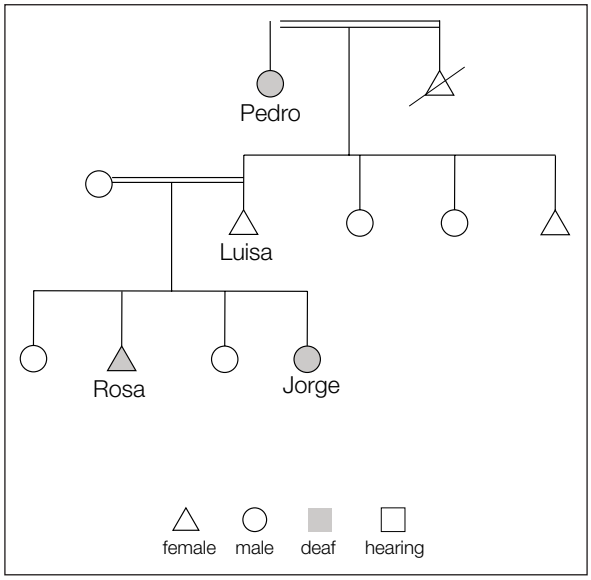

Figure 5: The Bernal family sign ecology includes two deaf signers, Sara and her mother Lucia, and two hearing signers, Ramon and Abel.

The Cobo and Bernal families have multiple deaf signers and the families within a single household are quite small. With only four people in each home, a significant proportion of family members in each household are deaf. As a consequence of this density of deaf signers, there are likely to be instances in which deaf and hearing child signers are able to see other sign conversations not directed to them. This may provide valuable opportunities to learn through "overhearing" (though in this case, it is "over-seeing"). The high proportion of deaf signers also increases the frequency of interactions that occur using signs. For example, if a vendor comes to the Bernal home selling fruit, Sara is able to observe her mother, Lucia, sign with the seller to negotiate her purchase. In contrast, in the Marcos family, described above, Rosa, who is deaf, is not likely to observe her mother, who is hearing, sign with a vendor because her mother and the seller would speak Ixil in that interaction. Rosa does, however, see her mother signing with her father (Rosa's grandfather), who is deaf.

There are five participants in the study who attend the local school for special education. These include José and Juana, siblings from the Cobo family, as well as Tomás, Diego, and Alejandro. Tomás and Diego are cousins who lived in close proximity to each other for some time, but now live across town and see each other primarily at school. Alejandro lives in an *aldea*[11] outside Nebaj, and attended the school two to three days per week during the years that he participated in the study. The familial and social connections between the five students are illustrated in **Figure 6**.

[11] Aldeas are small communities adjacent to larger towns in Guatemala. They are usually within walking distance or a short bus ride from the center of town.

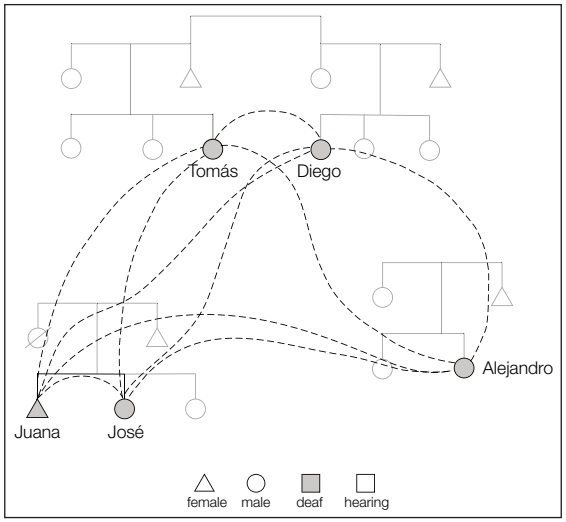

Figure 6: Peer sign ecology. A *group ecology* with five deaf signers, all children and students at the local school for special education.

3.3.3 Comparing sign ecologies

In **Figure 7**, all of the ecologies are represented on the chart from **Figure 1**, showing the gradient nature of ecology size and frequency of interaction. The Cobo-Bernal family, for example, has a larger concentration of deaf signers (four) but less frequent interaction, while the Bernal and Cobo families have fewer deaf signers (two) but more frequent contact due to co-residence in small households.

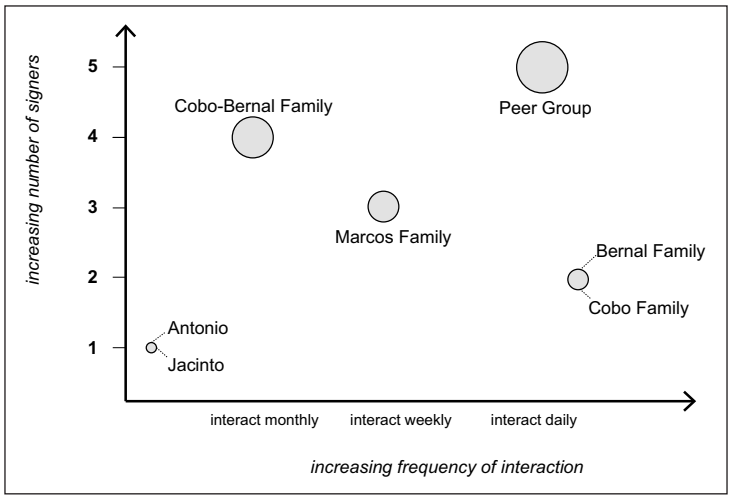

Figure 7: Ecologies shown relative to each other based on the size of the ecology, the number of deaf signers, and the frequency of interaction. Some ecologies are smaller, with more frequent interaction (Bernal, Cobo families), while some ecologies are larger but with less frequent interaction (Cobo-Bernal extended family). The signers from individual ecologies have no other deaf signers in their local ecology and thus also have limited social interaction with other deaf signers.

3.4 Data coding and annotation

Sign forms produced by the participants were annotated using ELAN, a video annotation software (Sloetjes & Wittenburg 2008). Each sign was isolated based on motoric criteria. Signs began when the handshape was formed and movement of the hand (or other body part) began. Non-manual signs on the face or body were also annotated. Signs were coded for the following categories: sign type, handshape type, handshape, and place of articulation. All signs were given a gloss based on the iconic mapping between the referent and its representation in the sign.

When a signer produced multiple signs for a single photo, each sign was coded for all categories. For this analysis, I focus on the categories of *sign type* and *gloss*. The primary *sign types* included: deictic, iconic, emblem, conventional, and other. Signs were considered *deictic* if the signer pointed to something in the immediate physical context, to the photo itself, or to a location or direction. *Deictic* signs were produced with the hand, in a variety of handshapes, and also with the chin and lips. *Iconic* signs visually resembled some aspect of referent or an action associated with the referent. Signs were coded as *emblems* if they resembled a limited set of conventional gestural forms observed and documented in the hearing community of Nebaj and across Mesoamerica (Meo-Zilio & Mejía 1980; 1983; Fox Tree 2009; Hou 2016; Le Guen 2019). Some emblems were also iconic. For example, the emblem used to indicate drinking in Nebaj is produced by forming a fist with the thumb extended and raising the hand up to the person's mouth, resembling the act of drinking. If a sign resembled an emblem, even an iconic emblem, it was given the code emblem. The sign type *conventional* was assigned to signs that had a conventional meaning within a specific ecology, usually a name to refer to an individual person. The meanings of these signs were often explained to me by hearing signers when I asked about them. For example, in the Marcos family, Rosa uses a sign that iconically represents sheep, which her grandfather owns, to refer to her grandfather. Sign type was exclusively used to determine which signs to include or exclude in the analysis. Only *iconic* signs, *emblems*, and *conventional* signs were included in the dataset. Signs were then distinguished on the basis of their gloss rather than their type, so the overlap between *iconic* and *emblem/conventional* signs does not pose a problem for the current analysis. Signs were given the code *other* if they were signs for quantities, signs that were ambiguous, or from a limited inventory of signs from LENSEGUA that students learned at the school. One research assistant coded the dataset. The first author also coded a subset of the data (531 signs). Intercoder reliability for sign type was 93% (Cohen's kappa = .89).

As mentioned above, signs were given a *gloss* based on the iconic mapping between sign and referent. If a sign was a pantomimed action or activity associated with the referent, then the sign was glossed with a generic English verb describing the action. For example, if a signer described a photo of chilies with a sign that looked like cutting or slicing, then the sign was assigned a gloss of CUT. If a sign represented the size or shape of the referent, rather than an activity associated

with the referent, then the sign was glossed with an English word for the shape or size dimension represented. If a signer described the same photo of chilies and produced a sign that showed a small space between two fingers, the sign was given a assigned a gloss of EXIST_SMALL,[12] since the "action" in this sign primarily concerns the existence of a particular shape or size characteristic. If a sign represented a person's reaction to the sensory experience of a referent, this was glossed with an English word that described the characteristic the signer represented. If the signer described the photo of chilies with a sign in which they puffed their cheeks and blow air out of their mouth, then this was glossed as REACT_SPICY. Examples of signs and their glosses are provided in **Figure 8**. As mentioned above, one research assistant coded the dataset and the first author coded a subset of the data (508 signs[13]) for sign gloss. Intercoder reliability for sign gloss was 90.5%.

Figure 8: Illustration of signs and their glosses.

Signs that were of the types *emblem* or *conventional* were assigned a gloss based on an inventory of forms that were developed as the coding progressed and based on an inventory of conventional local gestures (Meo-Zilio & Mejía 1980; 1983). The number of unique glosses for each type of sign are presented in **Table 2**.

[12] The glossing convention "EXIST" was used for signs that iconically represented a size dimension of an item using the distance between two hands or fingers while signs that iconically represented the shape characteristics of an item were glossed with a label for that shape, e.g., ROUND_SHAPE. Both of these types of signs would be considered Size and Shape Specifiers (SASS) in other systems. The sign type, however, was not used as part of this analysis.

[13] When coding, we did not provide a sign gloss when the signer pointed to the book of photos. 23 signs in the reliability set for sign-type (N = 531) were points to the book, these were omitted in the second reliability set (N = 508) because they did not have a gloss.

Sign Type	Unique Form Glosses	Total Signs	Most frequent form gloss
Iconic – Pantomime	124	1,115	EAT (N = 98)
Iconic – Size or Shape	42	388	EXIST_SMALL (N = 66)
Iconic – Reaction	6	25	REACT_SPICY (N = 16)
Emblem	8	187	ANIMAL (N = 69)
Conventional	8	58	OLD (N = 24)

Table 2: Number of unique glosses and signs for each sign type.

Signs were compared at the level of their sign gloss, similar to previous studies, including Hou (2018), Richie et al. (2014), and Mudd et al. (2020; 2021). Many of these studies use a gloss, "conceptual component" (Richie et al. 2014) or "iconic prototype" (Meir et al. 2012) to compare signs because there seems to be significant tolerance for variation in the articulation of signs. One of the first studies to observe high levels of phonological variation was Sandler et al. (2011). They noted that many signers of ABSL produced signs for the same concept with a similar iconic representation, but variation in how that iconicity was realized. In this analysis, signs were considered the same if they received the same gloss. This means that two signs that were produced with slightly different handshapes but shared an iconic relationship with the referent were considered to be overlapping. In future work, I plan to compare signs based on formational parameters like handshape and movement, similar to recent work by Lutzenberger et al. (2021) which provides a detailed analysis of variation based on both iconic and formal properties of signs in Kata Kolok.

In the next section, I describe the pairwise method used to compare the signs produced by each signer. I then present the results of two analyses that use the pairwise calculations to analyze the relationship between ecology type and community-level lexical overlap (analysis 1) and the relationship between interaction frequency and ecology-level lexical overlap (analysis 2).

3.5 Measuring lexical overlap: the Jaccard index

As described in section 1, lexical overlap is the rate at which two signers use the same sign form(s) to describe the same referent. To measure lexical overlap, I use the Jaccard index – a similarity measure for comparing sets (Fletcher & Islam 2018; Jaccard 1912). The Jaccard index is a ratio of the number of unique sign forms that both signers produced divided by the total number of unique signs. The calculation is thus a ratio of the sign forms that were the same

(the intersection of the sets of sign forms produced by each signer), relative to all of the unique sign forms that were produced by each signer (the union of the sets of sign forms produced by each signer).

This index is useful for this analysis because signers frequently produced multi-sign responses. This has been a challenge for estimating lexical convergence in prior studies of young sign languages, such as ABSL (Sandler et al. 2011). The Jaccard index can capture the similarity of the set of signs produced by two signers in a gradient fashion, whether they produce a single sign or multiple signs. Additionally, when signers are producing multi-sign responses for an item, they may produce some of the same signs and some different signs. Rather than restricting the set of signs considered "the same" to responses that are identical, the Jaccard index quantifies how much a pair of signers overlap in their descriptions of the same item. The calculation is illustrated in **Figure 9**.

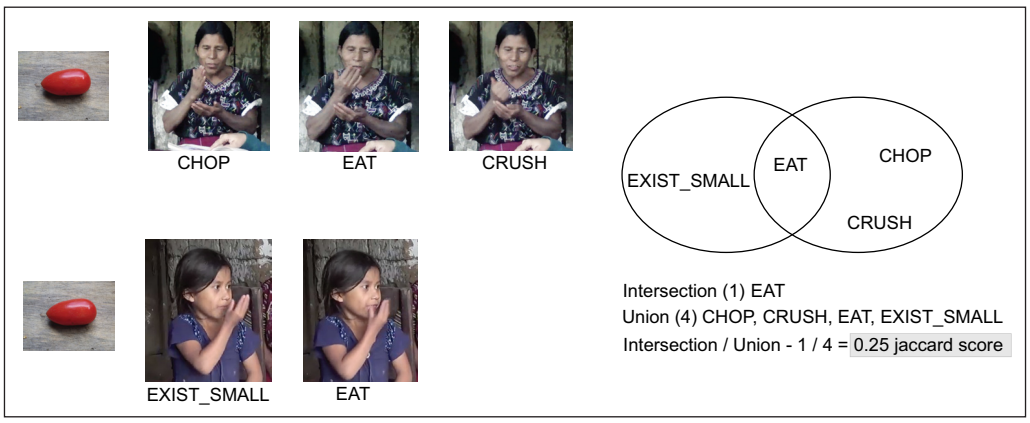

Figure 9: sample of Jaccard similarity calculations for a pairwise comparisons of the set of sign forms produced for *tomato* by two participants.

In this sample calculation, two signers from the Bernal family, Lucia (a deaf woman) and Sara (Lucia's daughter, who is also deaf), describe a photo of a tomato. The adult participant, Lucia, produced a set of three signs CUT, EAT and CRUSH. The child participant, Sara, used the signs EXIST-SMALL and EAT to describe the photo. The Jaccard similarity score for the tomato photo for Lucia and Sara (illustrated in the overlapping circles in **Figure 9**) is thus 1/4 (.25), because there is one sign that they both produced in their descriptions, EAT, and there were four unique signs (CUT, EAT, CRUSH, and EXIST-SMALL) produced by both signers. A higher Jaccard score indicates more similarity, or higher overlap between two signers for a given photo. A Jaccard score was calculated for the sets of signs that any two participants produced for each photo in the stimuli set (N = 6,109 Jaccard scores). A sample mean Jaccard score is presented in appendix 2.

Figures 10 and **11** illustrate some of the signs that were provided by signers from the Bernal and Cobo families. In both examples the signers provided labels for a photo of a pineapple. The Jaccard scores for pairs of signers are also included in the Figures.

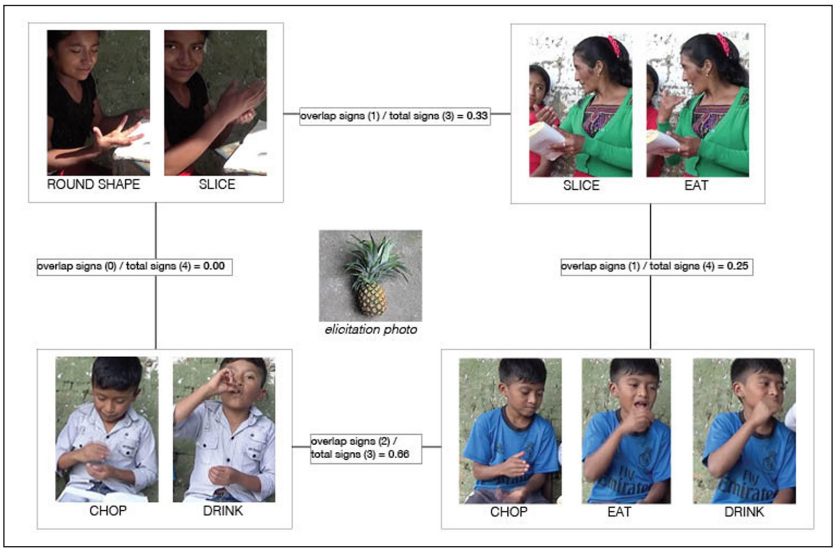

Figure 10: Signers from the Cobo family describe a photo of a pineapple. Signers are compared using the Jaccard score. We can see that there are many combinations of overlapping and non-overlapping signs and the scores range from 0 to .66.

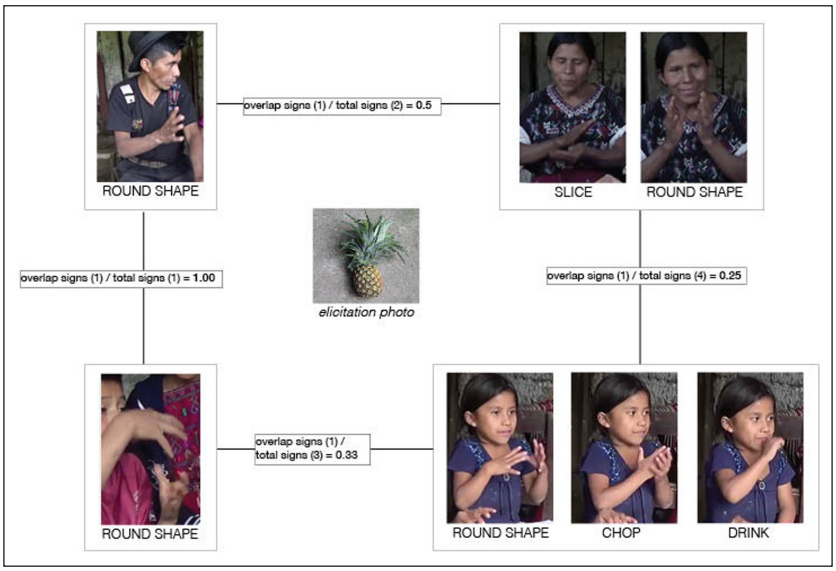

Figure 11: Signers from the Bernal family describe a photo of a pineapple. Signers are compared using the Jaccard score. We can see that there are many combinations of overlapping and non-overlapping signs and the scores range from .25 to 1.00.

Note that this score does not account for the order in which signs were produced and signs are not weighted according to their frequency. So, for example, Sara, from **Figure 11**, lower right images, produced the sign ROUND_SHAPE[14] first in her response, while her mother, Lucia, from **Figure 11**, upper right images, first produced SLICE, followed by ROUND_SHAPE. These were counted equally in the comparison, even though they appear in different orders for the two signers.

To analyze the relationship between social interaction and lexical convergence, I calculated the Jaccard similarity scores for all possible pairs of signers. Every signer in the sample was compared with every other signer. Each pairwise comparison (N = 153 pairs) is the mean of the Jaccard indices for all of the items described by both signers (see sample calculation in appendix 2).

4 Results

This analysis is based on 1,773 signs produced by participants in 18 sessions. Participants produced several types of signs, described in detail in section 3.4 above. This analysis uses only iconic signs, signs that resemble gestural emblems (which are also sometimes iconic), and signs that are conventional within ecologies of signers (some of these are iconic as well). Signers produced variable amounts of each sign type, with some signers using more deictic signs than others. The rates of included signs (iconic, emblem, conventional) and excluded signs (deictic, LENGSEGUA, numbers) are reported in **Table 3**.

Ecology	*Name*	*Signs Included**	*Total Signs*	*Photos Described*	*Sign Rate*[15]
Peers	Tomás	89 (0.77)	115	57	1.56
	Alejandro	92 (0.84)	109	60	1.53
	Diego	70 (0.65)	108	64	1.09
Cobo Family, Peers	José	89 (0.53)	167	65	1.37
	Juana	73 (0.81)	90	62	1.18

(Contd.)

[14] See footnote 12, above, for discussion of glosses EXIST_SMALL versus ROUND_SHAPE

[15] Sign rate was calculated based on the number of signs included in the analysis (deictics and non-iconic signs were excluded) divided by the number photos described.

Ecology	*Name*	*Signs Included**	*Total Signs*	*Photos Described*	*Sign Rate*[15]
Cobo Family	Andres	100 (0.61)	165	59	1.69
	Nila	88 (0.53)	167	64	1.38
Bernal Family	Sara	75 (0.60)	126	39	1.92
	Lucia	133 (0.77)	172	63	2.11
	Ramon	47 (0.44)	107	48	0.98
	Abel	66 (0.34)	195	60	1.10
Marcos Family	Jorge	84 (0.40)	212	41	2.05
	Rosa	253 (0.33)	760	62	4.08
	Pedro	189 (0.62)	304	63	3.00
	Luisa	97 (0.80)	121	58	1.67
Individual	Antonio	46 (0.26)	179	62	0.74
	Maria	82 (0.78)	105	62	1.32
	Jacinto	100 (0.36)	279	63	1.59

Table 3: Signs included in the analysis and individual sign rate.
*The number in parentheses is the proportion of signs included in the analysis.

Signers produced between 90 and 304 signs to describe between 39–64 photos per session. Though they were given the opportunity to describe all photos, signers sometimes skipped photos that they did not have a sign for or did not want to describe. Of the total number of signs produced, the proportion of those signs that were iconic, emblems, or conventional (and included in the analysis) ranged from .26 to .84 (46 signs–189 signs).

4.1 Community Overlap

I start by describing the general trends in the lexical overlap comparisons and reporting the community overlap. As mentioned above, community overlap is measured as the median of the Jaccard comparison scores from all participants (N = 153 comparisons). **Figure 12** illustrates their distribution in a histogram. The range of scores was 0.12 –0.45, with a median of 0.279 (sd = 0.07).

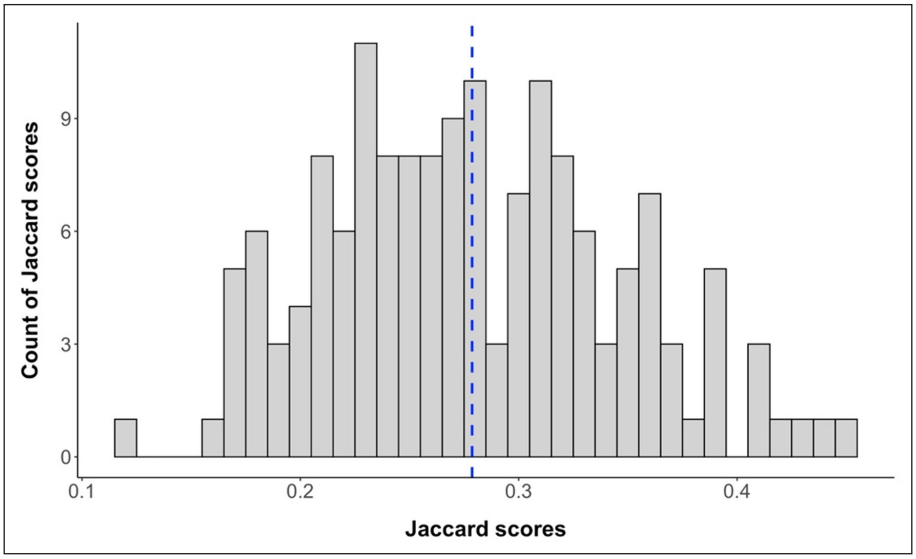

Figure 12: Histogram showing the distribution of mean Jaccard scores for all pairs of participants.

4.2 Individual Ecologies

The first analysis explores the relationship between interaction and lexical overlap by considering signers from individual ecologies. This analysis addresses the question: is the ecology overlap of signers from individual ecologies higher or lower than community overlap? The ecology overlap for each signer from an individual ecology is presented in **Table 4**.

Individual	***Median Lexical Overlap (standard deviation)***
Antonio	.252 (.06)
Jacinto	.218 (.05)
Maria	.206 (.03)

Table 4: Median Jaccard scores for signers from individual ecologies.

I use a Wilcoxon ranked sum test with continuity correction to compare the median Jaccard scores for each individual signer with the median community overlap (0.279). The ecology overlap for Antonio was not significantly different from the community overlap ($W = 1105.5$, p–.31, $r = –.07$). The ecology overlap for Jacinto was significantly lower than the community overlap ($W = 2042$, $p < .001$, $r = –.30$). The ecology overlap for María was also significantly lower than the community overlap ($W = 2157$, $p < .001$, $r = –.34$). The distributions of ecology overlap and community overlap are illustrated in **Figure 13** where each dot is the mean Jaccard index for one pair of signers.

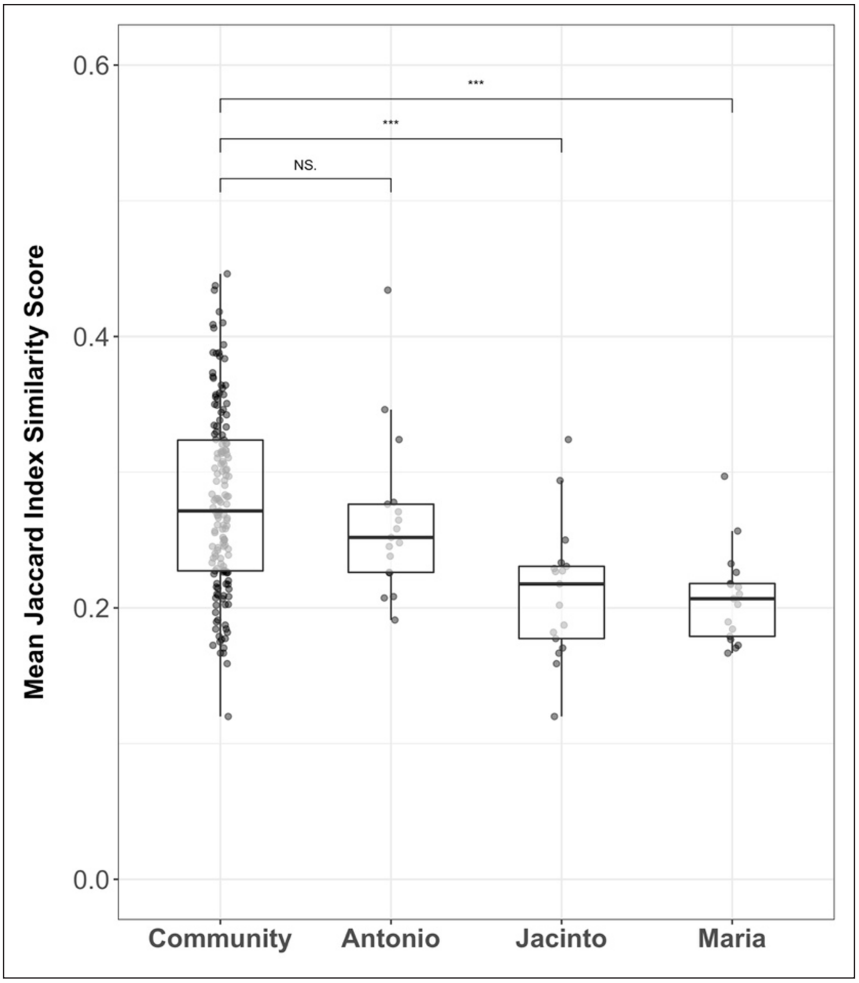

Figure 13: Jaccard similarity scores for signers from individual ecologies who do not interact with other deaf signers compared with community overlap. Each point is the mean jaccard score for two signers. All comparison pairs that include Antonio, Jacinto, or Maria are shown in the right three box plots. Community overlap (all comparison pairs) are shown in the left box plot. Box plots show the median Jaccard score (center line) as well as the interquartile range (box). Whiskers show one and a half times the quartile range. The median Jaccard scores for Jacinto and Maria are significantly lower than the median Jaccard score of the community ($p < .001$).

Signers from individual ecologies, in which they are the only deaf signer in their immediate social network, have equivalent or significantly lower levels of lexical overlap than the community. In the discussion section, I consider explanations for this finding, which could be related to the quantity of signed interactions individual signers experience or are able to observe during daily conversations. In the next section, I analyze the Jaccard scores from group ecologies with multiple deaf signers, comparing rates of ecology overlap from low frequency and high frequency ecologies to community overlap.

4.3 Low-frequency and high-frequency group ecologies

The second analysis explores the relationship between frequency of interaction and lexical overlap by considering signers from high and low frequency ecologies. This analysis addresses the question: are the rates of the ecology overlap of high and low frequency ecologies higher or lower than community overlap? The median jaccard scores for each ecology are presented in **Table 5**.

Ecology Type	*Ecology*	*Signers*	*Median Lexical Overlap (standard deviation)*
high frequency	Peers	5	.378 (.02)
	Bernal family	4	.397 (.06)
	Cobo family	4	.354 (.04)
low frequency	Cobo-Bernal family	8	.275 (.04)
	Marcos family	4	.257 (.06)

Table 5: Median Jaccard scores for signers from co-residence and multi-residence group ecologies.

I use a Wilcoxon ranked sum test with continuity correction to compare the rates of ecology overlap with community overlap. The peer ecology ($W = 126$, $p < .001$, $r = –.35$), the Bernal family ($W = 787.5$, $p < .01$, $r = –.23$), and the Cobo family ($W = 755$, $p < .01$, $r = –.21$) have significantly higher rates of ecology overlap than community overlap. The ecology overlap of the Marcos family ($W = 475$, $p = .88$, $r = –.01$) and the Cobo-Bernal extended family ($W = 1322$, $p = .60$, $r = –.04$) are not significantly different from the community overlap. The distribution of jaccard scores for each ecology are presented in **Figure 14**.

In ecologies with high frequency interaction – families who reside in the same home, and students who attend school together every day – signers have higher rates of ecology overlap, when compared to the rate of overlap in the wider community. For these groups, regular social interaction is associated with using more of the same signs. However, direct interaction does not guarantee that signers are more likely to use the same signs. In group ecologies that are spread across multiple households, signers have similar rates of lexical overlap to the wider community. In these ecologies, sporadic or infrequent interaction does not seem to be associated with using more of the same signs.

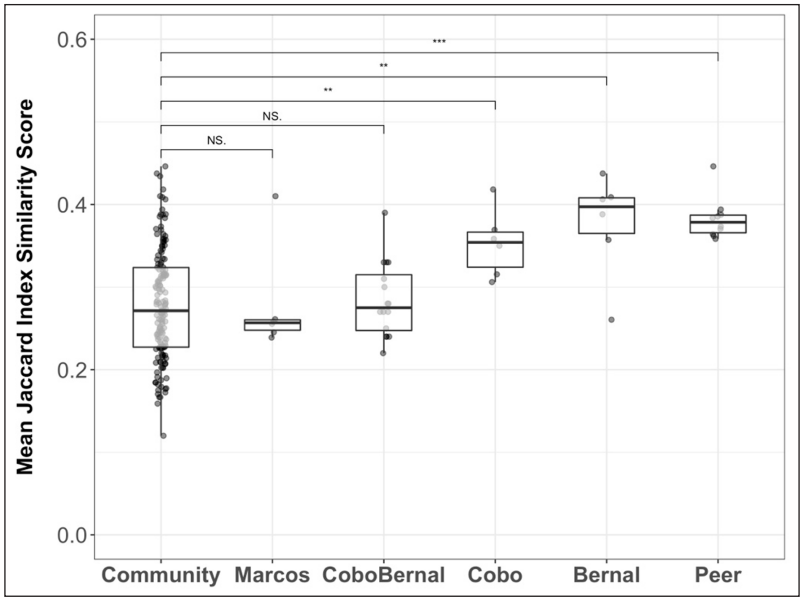

Figure 14: Jaccard similarity scores for signers from single-household group ecologies and multi-household group ecologies. Each point is the mean jaccard score for two signers. All comparison pairs from the Marcos, Cobo-Bernal, Cobo, and Bernal families are shown in the middle four box plots. All comparison pairs from the Peer ecology are shown in the right box plot. Community overlap (all comparison pairs) are shown in the left box plot. The median Jaccard scores for the Cobo and Bernal families are significantly higher than the median Jaccard score of the community ($p < .01$). The median Jaccard score for the Peer ecology is significantly higher than the median Jaccard score of the Community ($p < .001$).

5 Discussion

Saussure asserts that language is always an inheritance of the past, but there are young languages whose users do not inherit their language from others in the typical process of language acquisition. In this study I find that properties of these young languages are related to more than just their age. Instead, they are shaped by the daily communicative interactions of their users, which contribute to unique characteristics that may not wholly align with our experience of older languages.

As noted in the introduction to this paper, there are limitations to the methods used in this study. The elicitation task was conducted using photos that signers described. The set of photos was developed to capture many semantic domains and to be familiar to participants, but it is likely not representative of all of the signs that signers use in daily conversation, so any conclusions from these data should be verified with naturalistic conversational data where possible. The use of photos may have implicitly prompted signers to produce more iconic signs than they would

in other circumstances, this should also be acknowledged as a limitation of this methodological choice. In the analysis, co-residence in the same household, attendance at a shared school setting, as well as interviews and observations of participant interactions, were used as proxies for how much different signers converse with each other on a regular basis. Lastly, in terms of the coding and analysis, signs were compared based on their iconic representation of target items, not on formational properties like handshape, movement, or location. If signs were analyzed and compared at the level of formational parameters, i.e., if signs with different handshapes, but the same iconic relationship to the referent, were counted as different signs, then this would likely result in lower rates of overlap than those reported here. In spite of these limitations, there are clear patterns in these data that suggest an association between interaction and lexical overlap. In this section, I discuss possible sources of the different rates of lexical overlap as well as other factors that could be contributing to variability in lexical overlap.

5.1 Interaction and lexical overlap

Despite the common-sense notion that social interaction will contribute to lexical change and convergence, evidence from naturalistic and experimental studies, introduced in section 2.2.3, complicates the relationship between social interaction and lexical variation. In a longitudinal study of adult homesigners from Nicaragua who were the only deaf person in their immediate social network, Richie et al. (2014) found that these signers were less likely to converge with their hearing communication partners than signers of Nicaraguan Sign Language (NSL), even after lengthy periods of contact and interaction. NSL signers converged on shared sign forms relatively quickly, compared to the same homesigners (Richie et al. 2014). In a subsequent laboratory experiment, described briefly in section 2.1.1, researchers simulated the social networks of homesigners versus NSL signers. Participants interacted in networks that were structured to resemble either the homesigners' ecologies or the NSL signers' ecologies. The networks that simulated homesigners' ecologies were characterized as sparsely connected, with one central participant, "the hub," representing the homesigner who is the primary user of the sign system. The networks that simulated the NSL signers were richly connected, with all participants connected to each other. Participants in the richly connected networks did not converge faster on shared gestural forms, per interaction, than participants in the sparsely connected network. This finding suggests that rather than particular configurations of interlocutors, the quantity of interaction overall is what leads to eventual convergence in these scenarios. In terms of ecology overlap, it is possible that the group ecologies who interact less frequently have not had enough interactions to reach the same levels of overlap as the group ecologies with high frequency interaction. With additional time, however, these ecologies might show a similar distinction between ecology overlap and community overlap.

In a study of the relationship between multiple demographic factors and lexical variation in Kata Kolok, Mudd et al. (2020) analyze the effect of deaf status, age, clan, gender, and having a deaf family member on lexical distance. They do not find a significant relationship between any of the demographic factors, but they do report a significant yet weak relationship between interaction and lexical choice. I plan to explore additional demographic factors further in future work, in addition to obtaining quantitative measures of interaction. The next section discusses shared cultural context as an alternative source of lexical overlap.

5.2 Shared cultural context and lexical overlap

This study quantifies lexical overlap, the frequency with which signers use the same signs for the same referent. Although this study attempts to isolate social interaction as one contributor to variable rates of lexical overlap, there are many factors that contribute to rates of overlap and variation. In this section, I discuss one potential contributor in sign communities: shared cultural context.

In a study of translanguaging in Yucatec Maya communities with a high incidence of deafness, Safar (2019) observes that sign languages that span the region share lexical forms, even when signers are not in direct contact. Safar does not attribute these similarities to a historically related regional sign language (p. 34), but instead to a large inventory of conventional gestural emblems used by the hearing community and homogeneous communities with shared cultural knowledge (p. 32). Unexpected similarities of sign forms used across broad geographic regions have also been described in Nepal (Green 2014, who describes the phenomenon as “natural sign”) and in ABSL (Kisch 2008). In each of these settings, the researchers note that signers share culturally grounded embodied experiences, what Kisch (2008) describes as “local experiential knowledge” (p.284–5). This shared experience, or collective corporeal memory, contributes to signs that are legible to other people from the community, whether hearing or deaf, signers or not, because the sign form iconically resembles an activity or object that someone with the same embodied experiences can recognize. An example from this study would be the sign for tortilla. Signers often produced a sign that pantomimically represented making tortillas from masa by clapping their hands together lightly back and forth (see **Figure 15**, see also Safar 2021: 49–50 for illustrations of two variant signs for tortilla used in Yucatec Mayan Sign Language, YMSL). Someone unfamiliar with the process would be unlikely to recognize this as a sign for tortillas, but it would be familiar to most people from Nebaj, whether or not they had experience with signers and signing (Safar makes a similar point in her discussion of YMSL, Safar 2019; 2021, as does Reed, in her discussion of signs from Papua New Guinea, Reed 2021).

Figure 15: Three signers describe a photo of tortillas.

In the example from **Figure 15**, signers all produced a similar sign for the same referent, though none of these signers know each other. Signers' shared context for the items in the photo elicitation book varies and some photos elicited more similar signs from all participants than others. The jaccard scores for all photos are presented in appendix 3, where it is possible to observe variation in the overlap scores for different photos. In a recent study of lexical variation in Kata Kolok, Lutzenberger et al. (2021) include a token-weighted variation index, which weights sign responses based on their frequency. This weighting proved useful in their analysis of lexical variation and would be useful to implement in future studies of this data.

It is currently not clear whether community-level lexical overlap in Nebaj is driven by use of shared gestural emblems from the wider speaking community or if it can be attributed to common iconic representations that draw on shared embodied experiences, similar to the processes described for other sign communities above. One strategy for assessing this would be to gather similar data from a community near Nebaj. This would provide a comparison sample that shares a similar cultural context but likely does not have contact with any of the participants in this study.

5.3 Social histories and lexical overlap

Descriptive studies of signers from communities around the world offer an essential window into the day-to-day conversations that contribute to phenomena like the variable rates of lexical overlap. Researchers have highlighted the considerable skill and communicative resources that deaf signers marshal in service of daily communication with those who make less of an effort to understand them than they must make to be understood (Friedner 2014; Graif 2018; Green 2014; A. Kusters et al. 2017b). The signers from Nebaj in this study are not spared these experiences. They interact with hearing people within their own families and outside of their homes who may or may not expend social effort to engage with them as competent communicators. In this context, maintenance of a fixed lexicon of signs may not contribute to communicative efficiency nor to mutual understanding. Instead, flexibility and creativity might be the most effective strategies for signers across diverse contexts of interaction. Signers' communicative experiences

may contribute to a diverse and flexible lexicon of signs tuned to their individual communicative history. Consequently, this lexicon might not be calibrated or convergent with other signers in their communicative ecology. In addition to these unique socio-communicative pressures, it is not clear how degree of convergence or conventionalization between a pair of signers relates to their mutual comprehension. It is possible that signers maintain an inventory of their signs as well as an alternate set of signs that other signers in their network use, a possibility discussed in Mudd et al. (2021) and Raviv et al. (2019).

In the current study, rates of community-level lexical overlap are substantial for signers from both group and individual ecologies, but they are significantly higher for pairs of signers from high frequency group ecologies (see section 4.3). Interacting with other deaf signers in one's local ecology impacts the degree to which they share a common set of sign forms with other signers in the wider linguistic community. It is possible that this set of forms derives from the negotiation that occurs between multiple deaf signers in regular contact, and does not arise when a signer is the only one in their immediate social ecology who uses the manual sign system as their exclusive means to communicate. Absent other deaf fluent signers, signers from individual ecologies might generate relatively strict, idiosyncratic systems that have less overlap with a community-level shared set of signs. This result is similar to findings from an earlier study of an individual "homesigner," a deaf child raised in an oral environment, from the United States. Researchers found that the child developed standards of well-formedness for his individual homesign system in a fairly short span of developmental time and with minimal input and buy-in from his most frequent interlocutors (Singleton et al. 1993). Singleton et al. (1993) and Goldin-Meadow (2004) note that the absence of collaborators in its creation may have constrained the homesign system, but it also gave the signing child control and ownership. Thus the child signer was able to be more rigid about standards of form than if he had been negotiating the system with another committed, fluent signer.

It is also important to emphasize the role of individual variation in rates of lexical overlap. In a study of Rural Indian Sign Language (RISL), Jepson (1991) documents significant variation in two sign languages used by deaf individuals from the same village. She attributes much of this variation to the respective signers' social status in the community. While one signer enjoys close social relationships with a small group of family and friends, the other signer appeared to be more isolated and lack many fluent hearing communication partners. Individual variation might also be extended to small family units. Hou (2016) introduces the concept of a *family sign language* and Tano (2016: 154–160) as well as Sandler et al. (2011) use the term *familylect*.

In a study of dispersed individual deaf signers from Papua New Guinea mentioned above, Reed (2021) introduces the concept of a nucleated sign network. In this model deaf signers are distantly connected but do not interact frequently. Reed analyzes rates of lexical convergence in one nucleated sign network and reports slightly higher overlap than might be expected,

considering that the deaf signers do not interact with each other directly very often. She emphasizes the significant role of fluent hearing signers in these networks, similar to Jepson, as well as shared cultural context. The nucleated sign network model is most similar to the individual sign ecologies from this study. In the other ecologies of signers in this study, there is a higher density of deaf signers than the community surveyed by Reed and this may be associated with different patterns in signers' lexicons. For example, the presence of multiple deaf signers in a household or local ecology significantly increases the likelihood that conversations will occur in sign, and that it will be possible for deaf signers to observe signed conversations between two other signers in which they are not direct participants.

A central concern for some theorists might be that lower rates of convergence suggest an unstable, or unpredictable, lexicon, and that this, in turn, indicates that signers are using an ad-hoc system that is underdeveloped or less advanced than other languages. Nyst (2012) and Braithwaite (2020) discuss the consequences of conceptualizing diversity in sign language types along developmental lines. Nyst (2012) notes that this conception presupposes an "ultimate" stage of sign language development which seems to be characterized by a large, monolingual signing community, few hearing or speaking signers, and accessible adult sign language models. This model implicitly suggests that all sign languages are moving toward this ultimate stage, and that some languages have advanced more along this "developmental cline" (p. 566). With respect to the lexicon, an assumption might be that an "ultimate" or "advanced" language, whether signed or spoken, would have an entirely converged, conventionalized lexicon with only "functional" variation – principled variation that maps onto or indexes social categories. But it is possible that deploying lexical variation effectively – lexical "flexibility" – is an essential skill for signers of young sign languages. Across young and emerging sign languages, it remains an open question how best to interpret and understand the variation that is documented, both within a single signer and between signers. It is important to recognize the diversity in the structure and function of the lexicon in these languages, and to remain open to the possibility that these characteristics are a functional adaptation to the unique social circumstances in which these languages emerge.

6 Conclusion

This study analyzes lexical overlap in sign communicative ecologies distinguished by frequency of interaction. Rates of lexical overlap within ecologies were compared with a baseline level of community overlap. Individual ecologies, with a single deaf signer had the same or significantly lower levels of lexical overlap than the community. Low frequency sign ecologies with multiple deaf signers who interact sporadically had equivalent levels of overlap as the community. High frequency sign ecologies, with multiple deaf signers who interact regularly, had significantly higher levels of lexical overlap than the baseline rate of the community.

These results are significant because they show that interaction does not automatically lead to increased use of the same signs. Only ecologies with frequent interaction showed significantly higher rates of lexical overlap than the community. Undoubtedly there are other factors contributing to these patterns of overlap, but in this community regular interaction does appear to be associated with increased use of the same signs. As mentioned in the discussion, it remains an open question whether higher levels of lexical overlap contribute to mutual comprehension or should be considered an adaptive communicative strategy for signers who share the social circumstances of those in this study.

Additional file

The additional files for this article can be found here: DOI: https://doi.org/10.16995/glossa.5829.s1

They include:

- **Appendix 1.** Stimuli Photos in Lexical Elicitation Task.
- **Appendix 2.** Sample mean Jaccard calculation comparing Sara (age 8;4) and her mother, Luisa.
- **Appendix 3.** Mean Jaccard score and standard deviation for each elicitation photo.

Acknowledgements

I am grateful to all of the participants from Nebaj who made this work possible, as well as María Luz García who introduced me to Nebaj and the Grupo. Thank you to Jason Riggle, who was instrumental in helping me figure out how to analyze this data. Thank you also to Jenny Singleton, Ryan Lepic, and four anonymous reviewers who read earlier versions of this paper and provided feedback. I received helpful comments on this work from the Goldin-Meadow Lab at the University of Chicago and the Sign Language group at the University of Texas.

Funding information

Data collection for this work was supported by an award from the Society for Psychological Anthropology/Lemelson Pre-dissertation Award, made possible by a generous donation from The Robert Lemelson Foundation, pre-dissertation Field Research Grants from the Center for Latin American Studies (CLAS) at the University of Chicago and the Tinker foundation. This research was also supported by NSF Award #1627520, "Doctoral Disseration Research: Conventionalization of Homesign Systems in Guatemala: Lexical and Morpho-phonological Dimensions" to Laura Horton and Diane Brentari and NSF Award #1654154, "Language Emergence in the Manual Modality" to Susan Goldin-Meadow.

Competing interests

The author has no competing interests to declare.

References

Aronoff, Mark & Meir, Irit & Padden, Carol & Sandler, Wendy. 2008. The Roots of Linguistic Organization in a New Language. *Interaction Studies* 9(1). 133–53. DOI: https://doi.org/10.1075/is.9.1.10aro

Baronchelli, Andrea & Ferrer-i-Cancho, Ramon & Pastor-Satorras, Romualdo & Chater, Nick & Christiansen, Morten. 2013. Networks in cognitive science. *Trends in Cognitive Sciences* 17(7). 348–360. DOI: https://doi.org/10.1016/j.tics.2013.04.010

Braithwaite, Ben. 2020. Ideologies of Linguistic Research on Small Sign Languages in the Global South: A Caribbean Perspective. *Language and Communication* 7. 182–94. DOI: https://doi.org/10.1016/j.langcom.2020.06.009

Carrigan, Emily & Coppola, Marie. 2017. Successful Communication Does Not Drive Language Development: Evidence from Adult Homesign. *Cognition* 158. 10–27. DOI: https://doi.org/10.1016/j.cognition.2016.09.012

CELADE. 2018. XII *Censo Nacional de Población*. Resultados Del Censo. http://redatam.censopoblacion.gt/.

Centola, Damon & Baronchelli, Andrea. 2015. The Spontaneous Emergence of Conventions: An Experimental Study of Cultural Evolution. *Proceedings of the National Academy of Sciences* 112(7): 1989–94. DOI: https://doi.org/10.1073/pnas.1418838112

Coppola, Marie & Brentari, Diane. 2014. From Iconic Handshapes to Grammatical Contrasts: Longitudinal Evidence from a Child Homesigner. *Frontiers in Psychology* 5. 1–23. DOI: https://doi.org/10.3389/fpsyg.2014.00830

Dahl, Östen. 2011. Are Small Languages More or Less Complex than Big Ones? *Linguistic Typology* 15(2): 171–75. DOI: https://doi.org/10.1515/lity.2011.012

de Saussure, Ferdinand. 1983. *Course in General Linguistics*. Bally, Charles & Sechehaye, Albert (eds.). trans. By Roy Harris, Open Court Classics, Chicago, IL. (Original work published 1916).

de Vos, Connie. 2011. Kata Kolok color terms and the emergence of lexical signs in rural signing communities. *The Senses and Society* 6(1). 68–76. DOI: https://doi.org/10.2752/174589311X12893982233795

de Vos, Connie. 2012. *Sign-spatiality in Kata Kolok: How a village sign language of Bali inscribes its signing space*. Nijmegen: Radboud University dissertation. DOI: https://doi.org/10.1075/sll.16.2.08vos

de Vos, Connie & Pfau, Roland. 2015. Sign Language Typology: The Contribution of Rural Sign Languages. *Annual Review of Linguistics* 1(1). 265–88. DOI: https://doi.org/10.1146/annurev-linguist-030514-124958

Fletcher, Sam & Islam, Md Zahidul. 2018. Comparing Sets of Patterns with the Jaccard Index. *Australasian Journal of Information Systems* 22. 1–17. DOI: https://doi.org/10.3127/ajis.v22i0.1538

Fox Tree, Erich. 2009. Meemul Tziij: An Indigenous Sign Language Complex of Mesoamerica. *Sign Language Studies* 9(3). 326–66. DOI: https://doi.org/10.1353/sls.0.0016

Friedner, Michele. 2014. The church of deaf sociality: Deaf churchgoing practices and "Sign Bread and Butter" in Bangalore, India. *Anthropology and Education Quarterly* 45(1). 39–53. DOI: https://doi.org/10.1111/aeq.12046

Gagne, Deanna & Coppola, Marie. 2021. Literacy in Emerging Sign Language Communities. *The Oxford Handbook of Deaf Studies in Literacy*, 353–369. DOI: https://doi.org/10.1093/oxfordhb/9780197508268.013.25

Galantucci, Bruno & Garrod, Simon. 2011. Experimental semiotics: a review. *Frontiers in Human Neuroscience* 5(11). 1–15. DOI: https://doi.org/10.3389/fnhum.2011.00011

García, María Luz. 2014. The Long Count of Historical Memory: Ixhil Maya Ceremonial Speech in Guatemala. *American Ethnologist* 41(4). 664–80. DOI: https://doi.org/10.1111/amet.12104

Goico, Sara. 2019. The impact of "inclusive" education on the language of deaf youth in Iquitos, Peru. *Sign Language Studies* 19(3). 348–374. DOI: https://doi.org/10.1353/sls.2019.0001

Goldin-Meadow, Susan. 2004. Lexical development without a language model. In Hall, D. Geoffrey & Waxman, Sandra (eds.), *Weaving a Lexicon*, 225–256. Boston: MIT Press.

Goldin-Meadow, Susan & Brentari, Diane & Coppola, Marie & Horton, Laura & Senghas, Ann. 2015. Watching language grow in the manual modality: Nominals, predicates, and handshapes. *Cognition* 136. 381–395. DOI: https://doi.org/10.1016/j.cognition.2014.11.029

Gong, Tao & Baronchelli, Andrea & Puglisi, Andrea & Loreto, Vittorio. 2012. Exploring the Roles of Complex Networks in Linguistic Categorization. *Artificial Life* 18(1). 107–21. DOI: https://doi.org/10.1162/artl_a_00051

Gong, Tao & Puglisi, Andrea & Loreto, Vittorio & William, S.-Y. 2008. Conventionalization of Linguistic Knowledge under Communicative Constraints. *Biological Theory* 3. 154–63. DOI: https://doi.org/10.1162/biot.2008.3.2.154

Graif, Peter. 2018. *Being and Hearing: Making Intelligible Worlds in Deaf Kathmandu*. Hau Books.

Green, E. Mara. 2014. *Natural Signs: Nepal's Deaf Society, Local Sign, and the Production of Communicative Sociality*. Berkeley: University of California dissertation.

Haviland, John B. 2020. Zinacantec family homesign (or "Z"). In Le Guen, Olivier & Safar, Josefina & Coppola, Marie (eds.), *Emerging Sign Languages of the Americas*, 35–96. Boston: De Gruyter Mouton. DOI: https://doi.org/10.1515/9781501504884-002

Horton, Laura. 2018. *Conventionalization of shared homesign systems in Guatemala: Social, lexical, and morphophonological dimensions*. Chicago: University of Chicago dissertation. DOI: https://doi.org/10.6082/uchicago.1321

Horton, Laura. 2020a. A sociolinguistic sketch of deaf individuals and families from Nebaj, Guatemala. In Le Guen, Olivier & Safar, Josefina & Coppola, Marie (eds.), *Emerging Sign Languages of the Americas*, 401–412. Boston: De Gruyter Mouton. DOI: https://doi.org/10.1515/9781501504884-010

Horton, Laura. 2020b. Representational strategies in shared homesign systems from Nebaj, Guatemala. In Le Guen, Olivier & Safar, Josefina & Coppola, Marie (eds.), *Emerging Sign Languages of the Americas*, 97–154. Boston: De Gruyter Mouton. DOI: https://doi.org/10.1515/9781501504884-003

Horton, Laura & Hou, Lynn & German, Austin & Singleton, Jenny. under review. Sign Language Socialization and Participant Frameworks in Three Indigenous Mesoamerican Communities.

Hou, Lynn. 2016. *'Making hands': Family sign languages in the San Juan Quiahije communi*ty. Texas: University of Texas at Austin dissertation.

Hou, Lynn. 2018. Iconic patterns in San Juan Quiahije Chatino Sign Language. *Sign Language Studies* 18(4). 570–611. DOI: https://doi.org/10.1353/sls.2018.0017

Israel, Assaf. 2009. Sublexical variation in three sign languages. Haifa: University of Haifa dissertation.

Israel, Assaf & Sandler, Wendy. 2009. Phonological category resolution: A study of handshapes in younger and older sign languages. *Cadernos de Saude* 2. 13–28.

Jaccard, Paul. 1912. The Distribution of the Flora in the Alpine Zone. *New Phytologist* 11(2). 37–50. DOI: https://doi.org/10.1111/j.1469-8137.1912.tb05611.x

Jepson, Jill. 1991. Two sign languages in a single village in India. *Sign Language Studies* 70(1). 47–59. DOI: https://doi.org/10.1353/sls.1991.0016

Johnson, Allen. 1973. Time Allocation in a Machiguenga Community. *Ethnology* 14. 301–310. DOI: https://doi.org/10.2307/3773258

Kisch, Shifra. 2008. 'Deaf Discourse': The Social Construction of Deafness in a Bedouin Community. *Medical Anthropology: Cross Cultural Studies in Health and Illness* 27(3). 283–313. DOI: https://doi.org/10.1080/01459740802222807

Kisch, Shifra. 2012. Demarcating generations of signers in the dynamic sociolinguistic landscape of a shared sign-language: The case of the Al-Sayyid Bedouin. In Zeshan, Ulrike & de Vos, Connie (eds.), *Sign Languages in Village Communities: Anthropological and Linguistic Insights*. 87–126. Berlin: De Gruyter Mouton. DOI: https://doi.org/10.1515/9781614511496.87

Kusters, Annelies. 2009. Deaf Utopias? Reviewing the Sociocultural Literature on the World's 'Martha's Vineyard Situations'. *Journal of Deaf Studies and Deaf Education* 15(1). 3–16. DOI: https://doi.org/10.1093/deafed/enp026

Kusters, Annelies & O'Brien, Dai & de Meulder, Maartje. 2017a. Innovations in Deaf Studies: Critically Mapping the Field. In Kusters, Annelies & de Meulder, Maartje & O'Brien, Dai (eds.), *Innovations in Deaf Studies: The Role of Deaf Scholars*, 1–53. Oxford: Oxford University Press.

Kusters, Annelies & Spotti, Massimiliano & Swanwick, Ruth & Tapio, Elina. 2017b. Beyond languages, beyond modalities: transforming the study of semiotic repertoires. *International Journal of Multilingualism* 14(3). 219–232. DOI: https://doi.org/10.1080/14790718.2017.1321651

Kusters, Wouter. 2008. Complexity in Linguistic Theory, Language Learning and Language Change. Language Complexity. *Typology, Contact, Change*, 3–22. DOI: https://doi.org/10.1075/slcs.94.03kus

Le Guen, Olivier. 2019. Emerging Sign Languages of Mesoamerica. *Sign Language Studies* 19(3). 375–409. DOI: https://doi.org/10.1353/sls.2019.0002

Lupyan, Gary & Dale, Rick. 2010. Language Structure Is Partly Determined by Social Structure. *PloS ONE* 5(1). DOI: https://doi.org/10.1371/journal.pone.0008559

Lutzenberger, Hannah & de Vos, Connie & Crasborn, Onno & Fikkert, Paula. 2021. Formal variation in the Kata Kolok lexicon. *Glossa: a journal of general linguistics* 6(1). 119. 1–28. DOI: https://doi.org/10.16995/glossa.5880

Marsaja, I. Gede. 2008. Desa Kolok: A deaf village and its sign language in Bali, Indonesia. Lancaster: Ishara Press.

Meir, Irit & Israel, Assaf & Sandler, Wendy & Padden, Carol & Aronoff, Mark. 2012. The Influence of Community on Language Structure. *Linguistic Variation* 12(2). 247–91. DOI: https://doi.org/10.1075/lv.12.2.04mei

Meir, Irit & Sandler, Wendy. 2019. Variation and conventionalization in language emergence: The case of two young sign language of Israel. In Doron, Edit & Rappaport Hovav, Malka & Reshef, Yael & Taube, Moshe (eds.), *Linguistik Aktuell/Linguistics Today* 256. 337–363. Amsterdam: John Benjamins Publishing Company. DOI: https://doi.org/10.1075/la.256.13mei

Meo-Zilio, Giovanni & Mejía, Silvia. 1980. Diccionario de Gestos: España e Hispanoamérica, Volume 1. Bogotá: Instituto Caro y Cuervo.

Meo-Zilio, Giovanni, & Mejía, Silvia. 1983. Diccionario de Gestos: España e Hispanoamérica, Volume 2. Bogotá: Instituto Caro y Cuervo.

Milroy, James & Milroy, Lesley. 1985. Linguistic Change, Social Network, and Speaker Innovation. *Journal of Linguistics* 21. 339–84. DOI: https://doi.org/10.1017/S0022226700010306

Morgan, Hope. 2017. *The Phonology of Kenyan Sign Language (Southwestern Dialect)*. California: The University of California, San Diego dissertation.

Mudd, Katie & Hannah Lutzenberger, Hannah & de Vos, Connie & Fikkert, Paula & Crasborn, Onno & de Boer, Bart. 2020. The effect of sociolinguistic factors on variation in the Kata Kolok lexicon. *Asia-Pacific Language Variation* 6(1). 53–88. DOI: https://doi.org/10.1075/aplv.19009.mud

Mudd, Katie & Lutzenberger, Hannah & de Vos, Connie & de Boer, Bart. 2021. Social structure and lexical uniformity: a case study of gender differences in the Kata Kolok community. *Proceedings of the Annual Meeting of the Cognitive Science Society* 43. 2692–2698.

Munroe, Ruth & Munroe, Robert. 1971. Household Density and Infant Care in an East African Society. *Journal of Social Psychology* 83. 9–13. DOI: https://doi.org/10.1080/00224545.1971.9919967

Neveu, Grace Kathleen. 2019. *Lexical conventionalization and the emergence of grammatical devices in a second generation homesign system in Peru*. Austin: University of Texas at Austin dissertation. DOI: https://doi.org/10.26153/tsw/3230

Nonaka, Angela. 2009. Estimating Size, Scope, and Membership of the Speech/Sign Communities of Undocumented Indigenous/Village Sign Languages: The Ban Khor Case Study. *Language and Communication* 29(3). 210–29. DOI: https://doi.org/10.1016/j.langcom.2009.02.004

Nonaka, Angela. 2012. Language Ecological Change in Ban Khor, Thailand: An Ethnographic Case Study of Village Sign Language Endangerment. In Zeshan, Ulrike & de Vos, Connie (eds.), *Sign Languages in Village Communities: Anthropological and Linguistic Insights*, 277–312. Boston/Berlin; Nijmegen: Mouton de Gruyter, Ishara Press. DOI: https://doi.org/10.1515/9781614511496.277

Nyst, Victoria. 2012. Shared Sign Languages. In Woll, Bencie & Steinbach, Markus & Pfau, Roland (eds.), *Sign Language: An International Handbook*, 552–74. De Gruyter Mouton. DOI: https://doi.org/10.1515/9783110261325.552

Nyst, Victoria & Sylla, Kara & Magassouba, Moustapha. 2012. Deaf Signers in Douentza, a Rural Area in Mali. In Zeshan, Ulrike & de Vos, Connie (eds.), *Sign Languages in Village Communities: Anthropological and Linguistic Insights*, 251–76. Boston/Berlin; Nijmegen: Mouton de Gruyter, Ishara Press. DOI: https://doi.org/10.1515/9781614511496.251

Osugi, Yutaka & Supalla, Ted & Webb, Rebecca. 1999. The Use of Word Elicitation to Identify Distinctive Gestural Systems on Amami Island. *Sign Language & Linguistics* 2(1). 87–112. DOI: https://doi.org/10.1075/sll.2.1.12osu

Parks, Elizabeth & Parks, Jason. 2008. *Sociolinguistic Survey Report of the Deaf Community of Guatemala*. SIL International: SIL Electronic Survey Report.

Perkins, Revere. 1992. *Deixis, Grammar, and Culture*. Amsterdam; Philadelphia: John Benjamins Pub. Co. DOI: https://doi.org/10.1075/tsl.24

Polich, Laura. 2005. *The Emergence of the Deaf Community in Nicaragua: With Sign Language You Can Learn So Much*. Washington, DC: Gallaudet University Press.

Power, Justin. 2020. *The Origins of Russian-Tajik Sign Language: Investigating the Historical Sources and Transmission of a Signed Language in Tajikistan*. Texas: The University of Texas at Austin dissertation.

Raviv, Limor & Meyer, Antje & Lev-Ari, Shiri. 2019. Larger communities create more systematic languages. *Proceedings of the Royal Society B* 286(1907). 20191262. DOI: https://doi.org/10.1098/rspb.2019.1262

Reed, Lauren. 2021. Sign networks: Nucleated network sign languages and rural homesign in Papua New Guinea. *Language in Society*, 1–25. DOI: https://doi.org/10.1017/S0047404521000798

Richie, Russell & Yang, Charles & Coppola, Marie. 2014. Modeling the Emergence of Lexicons in Homesign Systems. *Topics in Cognitive Science* 6. 183–95. DOI: https://doi.org/10.1111/tops.12076

Richie, Russell & Hall, Matthew L. & Whan Cho, Pyeong & Coppola, Marie. 2020. Converging Evidence. *Language Dynamics and Change* 10(2). 259–90. DOI: https://doi.org/10.1163/22105832-bja10008

Rogoff, Barbara. 1981. Adults and Peers as Agents of Socialization: A Highland Guatemalan Profile. *Ethos* 9(1). 18–36. DOI: https://doi.org/10.1525/eth.1981.9.1.02a00030

Safar, Josefina. 2019. Translanguaging in Yucatec Maya Signing Communities. *Applied Linguistics Review* 10(1). 31–53. DOI: https://doi.org/10.1515/applirev-2017-0082

Safar, Josefina. 2020. *A comparative study of Yucatec Maya Sign Languages*. Stockholm: Stockholm University dissertation. Retrieved from: http://urn.kb.se/resolve?urn=urn:nbn:se:su:diva-185092.

Safar, Josefina. 2021. What's your sign for TORTILLA? Documenting lexical variation in Yucatec Maya Sign Languages. *Language Documentation & Conservation* 15. 30–74. (http://hdl.handle.net/10125/24970)

Safar, Josefina & Le Guen, Olivier & Collí Collí, Geli & Collí Hau, Merli. 2018. Numeral Variation in Yucatec Maya Sign Languages. *Sign Language Studies* 18(4). 488–516. DOI: https://doi.org/10.1353/sls.2018.0014

Sandler, Wendy & Aronoff, Mark & Meir, Irit & Padden, Carol. 2011. The Gradual Emergence of Phonological Form in a New Language. *Natural Language & Linguistic Theory* 29(2). 503–43. DOI: https://doi.org/10.1007/s11049-011-9128-2

Senghas, Ann. 2011. The Emergence of Two Functions for Spatial Devices in Nicaraguan Sign Language. *Human Development* 53(5). 287–302. DOI: https://doi.org/10.1159/000321455

Senghas, Ann & Coppola, Marie. 2001. Children Creating Language: How Nicaraguan Sign Language Acquired a Spatial Grammar. *Psychological Science* 12(4). 323–28. DOI: https://doi.org/10.1111/1467-9280.00359

Singleton, Jenny & Morford, Jill & Goldin-Meadow, Susan. 1993. Once is Not Enough: Standards of Well-Formedness in Manual Communication Created over Three Different Timespans. *Language* 69(4). 683–71. DOI: https://doi.org/10.2307/416883

Sloetjes, Han & Wittenburg, Peter. 2008. Annotation by Category – ELAN and ISO DCR. Proceedings of the 6th International Conference on Language Resources and Evaluation.

Steels, Luc. 2005. The Emergence and Evolution of Linguistic Structure: From Lexical to Grammatical Communication Systems. *Connection Science* 17(3–4). 213–30. DOI: https://doi.org/10.1080/09540090500269088

Steels, Luc & Belpaeme, Tony. 2005. Coordinating Perceptually Grounded Categories through Language: A Case Study for Colour. *Behavioral and Brain Sciences* 28(4). 469–89. DOI: https://doi.org/10.1017/S0140525X05000087

Swadesh, Morris. 1951. Diffusional Cumulation and Archaic Residue as Historical Explanations. *Southwestern Journal of Anthropology* 7(1). 1–21. DOI: https://doi.org/10.1086/soutjanth.7.1.3628647

Tamariz, Monica. 2017. Experimental studies on the cultural evolution of language. *Annual Review of Linguistics* 3. 389–407. DOI: https://doi.org/10.1146/annurev-linguistics-011516-033807

Tano, Angoua. 2016. *Etude d'une langue des signes émergente de Côte d'Ivoire: l'example de la langue des signes de Bouakako (LaSiBo)*. Leiden: Leiden University dissertation. DOI: https://doi.org/10.1075/sll.20.1.07tan

Trudgill, Peter. 1989. Contact and isolation in linguistic change. In Leiv Breivik & Ernst Jahr (eds.), *Language Change: Contributions to the Study of its Causes*, 227–237. Berlin: Walter de Gruyter.

Trudgill, Peter. 2011. *Sociolinguistic Typology*. Oxford: Oxford University Press.

Woodward, James. 2011. Some Observations on Research Methodology in Lexicostatistical Studies of Sign Languages. In Mathur, Gaurav & Napoli, Donna Jo (eds.), *Deaf around the World: The Impact of Language*, 38–53. DOI: https://doi.org/10.1093/acprof:oso/9780199732548.003.0002

Wray, Alison & Grace, George. 2007. The Consequences of Talking to Strangers: Evolutionary Corollaries of Socio-Cultural Influences on Linguistic Form. *Lingua* 117(3). 543–78. DOI: https://doi.org/10.1016/j.lingua.2005.05.005

Zeshan, Ulrike. 2011. Village Sign Languages: A Commentary. In Mathur, Gaurav & Napoli, Donna Jo (eds.), *Deaf around the World: The Impact of Language*, 221–30. Oxford: Oxford University Press. DOI: https://doi.org/10.1093/acprof:oso/9780199732548.003.0012