KATA KOLOK PHONOLOGY – VARIATION AND ACQUISTION

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The educational component of the doctoral training was provided by the International Max Planck Research School (IMPRS) for Language Sciences. The graduate school is a joint initiative between the Max Planck Institute for Psycholinguistics and two partner institutes at Radboud University – the Centre for Language Studies, and the Donders Institute for Brain, Cognition and Behaviour. The IMPRS curriculum, which is funded by the Max Planck Society for the Advancement of Science, ensures that each member receives interdisciplinary training in the language sciences and develops a well-rounded skill set in preparation for fulfilling careers in academia and beyond. More information can be found at www.mpi.nl/imprs.

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ISBN: 978-94-92910-34-9
Cover design & Layout by Hannah Lutzenberger
Printed and bound by Ipskamp Drukkers, b.v.

 The research reported in this thesis was conducted at the Center for Language Studies of the Radboud University Nijmegen, the Netherlands and was funded by the collaborative grant NWO 326-70-002 from the Dutch Research Council (NWO) and the Flemish Research Council (FWO).

Kata Kolok phonology – variation and acquisition

Proefschrift

ter verkrijging van de graad van doctor

aan de Radboud Universiteit Nijmegen

op gezag van de rector magnificus prof. dr. J.H.J.M. van Krieken,

volgens besluit van het college voor promoties

in het openbaar te verdedigen op dinsdag 22 maart 2022

om 16.30 uur precies

door

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Doctoral Thesis

to obtain the degree of doctor

from Radboud University Nijmegen

on the authority of the Rector Magnificus prof. dr. J.H.J.M van Krieken,

according to the decision of the Council of Deans

to be defended in public on Tuesday, March 22, 2022

at 4.30 pm

by

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CHAPTER ONE

INTRODUCTION

1 INTRODUCTION

> *A young girl, CSA, is born into a Balinese village in 2016. Like both her parents, she is congenitally deaf. Growing up in her maternal grandparents' house, she learns the local sign language Kata Kolok from birth. CSA receives input in the sign language that has evolved in synergy of deaf and hearing villagers of her home village. CSA sees people in her environment sign every day; her parents, her deaf grandparents, her deaf aunts, her hearing cousins and other hearing and deaf members of the same family compound. They all have their own ways of signing Kata Kolok, and CSA quickly develops into a chatterbox in her own way.*

Variation is everywhere in language. The world's 7,000 languages differ as to their sound repertoires, their grammatical structures, and how they encode meaning in their lexicon. For instance, German and Dutch use front rounded vowels like /ø/ but modern English does not; Chinese lexicalises <older brother> into a single form while English uses two words; and Sign Language of the Netherlands uses two separate signs BLUE[1] and GREEN while Kata Kolok includes both colours in a single sign (GRUE-1A). I refer to variation of this type, across different languages, as **crosslinguistic variation**. Moreover, languages can be observed to change over time as a function of how geographical, cultural and social factors influence how individuals use language everyday. For example, German shows regional variation in sound patterns and the lexicon; speakers from the North pronounce syllable-final <ig> in words like

[1] Following the common convention in sign language linguistics, I use small caps to represent glosses as loose translation equivalents of signs.

<König> (king) as palatal fricative ([’kø:niç]) and speakers from the South as velar plosive ([’kønik]), and speakers from the North refer to <chatting> as <schnacken> while speakers from the South would use <ratschen>. I refer to this type of variation, between individual users of the same language, as **within-language variation**.[2]

This dissertation is concerned with the nature of both types of variation and how they are acquired. Specifically, I consolidate the study of language use and language acquisition while investigating the phonology of Kata Kolok, the sign language of a rural enclave in Northern Bali, Indonesia (Hinnant 2000; Marsaja 2008; de Vos 2012b). I draw on methods and findings from linguistic typology, sociolinguistics and language acquisition to shed light on how phonology is used and acquired in the same community. I investigate three research questions, exemplified through the lens of our deaf protagonist CSA:

1) *What varies in the phonology of the language that CSA learns?*
2) *What characterises the phonology of the sign language CSA acquires, compared to other sign languages?*
3) *How does CSA learn the phonological system?*

1.1 VARIATION IN THE WORLD’S LANGUAGES

> “The phenomenon of human language appears in two opposite manifestations: on the one hand, the phenomenon manifests itself in

[2] Note that the distinction between crosslinguistic variation and within-language variation drawn for the purpose of this thesis hinges on the separation between languages and dialects that is ultimately a result of socio-political processes rather than linguistic ones. For a discussion of this issue with respect to sign languages see, for example, Kusters (2021) and Palfreyman and Schembri (in press).

> thousands of individual languages, dialects, and sociolects, and these come with differences that are often so obvious and easy to notice (e.g., different sounds, words, ways of saying things) that people can debate about them and deploy them for marking social or national boundaries. On the other hand, language manifests itself as a universal phenomenon that is shared by our entire species, processed by a brain that is in many fundamental aspects identical for all members of the species, learned efficiently by every infant in the first few years, and used for universally comparable purposes in communication." (Bickel 2014: 102)

Though universal tendencies can be observed across languages (Greenberg 1963; 1966), they exhibit a striking degree of variation (Evans & Levinson 2009). Language and many other human behaviours are founded through social learning, cultural transmission and biological evolution, as well as their interaction (Boyd & Richerson 1985; Thompson, Kirby & K. Smith 2016)[3]. Specifically, being human equips cognition with the skill of learning and using language (Christiansen & Chater 2008), and all humans share the experience of interacting with the world through the body (Aronoff et al. 2008; Sandler 2018). Then, where does all the crosslinguistic variation come from? Variation across languages may arise from differences in the language ecology (Thompson et al. 2016; K. Smith et al. 2017; Hickmann, Veneziano & Jisa 2018; Huisman, Majid & van Hout 2019; K. Smith 2020), for example through cultural evolution. For instance, geographic separation of island communities in

[3] This touches upon one of the most famous debates in language acquisition: nature versus nurture. The question as to whether language is acquired through nurture or nature is still ongoing. The nurture camp suggests that children acquire language through general cognitive mechanisms and statistical learning (e.g., Tomasello 2003; Christiansen & Chater 2008). The nature camp argues for a faculty of language, i.e., that children have a specialised and innate capacity of learning language (e.g., Pinker & Bloom 1990; Hauser, Chomsky & Fitch 2002).

Japan has resulted in various different languages being used on each island; high language contact following colonial occupation gave rise to the Trinidadian Creole in Trinidad and Tobago; co-existence of ethnic minorities such as Swedes living in Finland lead to using different languages.

Different languages may yield different challenges for children. Depending on their language's phoneme inventory size and morphology, for example, some children may need to learn many different sounds but few morphological features, while others may need to learn only few sounds but complex morphology (Stoll 2015). Regardless of the challenges, children become competent users of any language they set out to acquire as (a) first language(s) under the condition that they are provided with sufficient input. Indeed, the cognitive abilities of children appear to be particularly adapted to handle any kind of variation (Evans & Levinson 2009; Levinson 2012), and extract linguistic patterns from distributional probabilities in their input (Tomasello 2003). At the same time, their maturing cognition filters variable input. Patterns that vary unpredictably may not be acquired by children, and thus, may not be sustained on the long term. This generates the following predictions about the role of acquisition in language variation: (i) crosslinguistic variation is acquired by children possibly due to the fact that languages have evolved diachronically to be learnable (Christiansen & Chater 2008), and (ii) within-language variation may be constrained through children's synchronically emerging regularisation (Hudson Kam & Newport 2005; Samara et al. 2017).

Notwithstanding, the cognitive abilities of adult language users also flourish when faced with variation (K. Smith et al. 2017). Adults take into account knowledge about the world and their other language(s) when acquiring new languages (Chenu & Jisa 2009), and navigate culture-mediated biases on the level of the individual and the population to be maximally simple and efficient yet informative to their interlocutors (K. Smith 2020). At the same time, no linguistic interaction is ever exactly the same; any given speaker of a language may create sound categories with different flavours of the "same" sound, memorise various lexical items that refer to the same concept, and can vary their use according to different sociolinguistic contexts. Supported by recent computational modelling, accumulative experience with linguistic interaction provides fertile grounds for linguistic innovation at any given point in a user's life, and thus, stimulates variation (Blythe & Croft 2021).

In the following section, I provide an overview of crosslinguistic variation and within-language variation and how this variation is acquired.

1.1.1 CROSSLINGUISTIC VARIATION

1.1.1.1 UNIVERSAL AND LANGUAGE-SPECIFIC PATTERNS

The languages of the world show widespread variation on all levels of description while at the same time displaying many crosslinguistic similarities (Evans & Levinson 2009; Levinson & Evans 2010; Bickel 2014; Hammarström 2016; Hagoort 2021).

Let us take the example of phonology. Most languages organise their feature inventory around phonemes, i.e., small (meaningless) units that may recombine and create lexical contrast.[4] In German, for example, the sounds /k/ and /t/ distinguish the nouns <Kasse> (cashier) and <Tasse> (cup) and /s/ and /f/ distinguish the noun <Reis> (rice) from the adjective <reif> (ripe). Kenyan Sign Language creates lexical contrast through minimal differences in manual features; the sign BUNGOMA (town name) differs from ROOSTER in 'handshape', from BORROW in 'location' and from BEER in 'orientation' (Figure 1-1). Lexical contrast serves as direct evidence that features are phonemic; the sounds /t/, /k/, /s/, and /f/ are phonemes in German and the handshapes *B* and *5*, the locations *forehead* and *chin* and the orientation *palm-in* and *palm-down* are phonemes in Kenyan Sign Language.

Languages may differ greatly in what is contrastive in a language and how elements may be combined (Hyman 2018). Spoken languages differ in the size of their sound inventories (Maddieson 1984). For instance, Rotokas, a North Bougainville language spoken on an island in Papua New Guinea, uses only 11 phonemes and has among the smallest phoneme inventories attested today (Firchow & Firchow 1969); !Xóõ, a Tuu language spoken in Southern Africa, uses 119 phonemes, including many clicks (sounds are produced while inhaling air through the mouth), which makes it one of the largest phonemic inventories worldwide (Miller 2011). Similarly, the size of the handshape inventory of sign languages ranges from seven phonemes in Adamorobe Sign Language, a sign language used in a Ghananian village (Nyst 2007), to 30 in Sign Language of the Netherlands, the national sign language of the Netherlands (van der Kooij 2002).

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[4] However, see recent work arguing that there are meaningful minimal units in spoken languages (Winter 2021).

Figure 1-1. Minimal pairs of signs in Kenyan Sign Language (H. Morgan 2015: 6). BUNGOMA and ROOSTER differ in handshape; BUNGOMA and BORROW differ in location; BUNGOMA and BEER differ in palm orientation. [Reproduced with permission from H. Morgan]

At the same time, languages exhibit great similarities in their phonologies. All the spoken languages studied by Maddieson (1984) include stops and whenever a language has a single series of stops, they are voiceless. In spoken languages, the smallest vowel inventories include at least /i/, /a/, and /u/ (Crothers 1978; Moran 2013). Similarly, a few handshapes that are easy to articulate and perceptually distinctive account for roughly half the lexicon in unrelated sign languages (Rozelle 2003) and phonological regularities limit the complexity of two-handed signs (Battison 1978; Bellugi & Klima 1990). To date, the only language that has been reported not to have phonological structure is Al-Sayyid Bedouin Sign Language, a sign language used by the third generation of signers in a Bedouin village in Israel (Sandler et al. 2011).

Moreover, languages, spoken or signed, exhibit systematic crosslinguistic form-meaning mappings referred to as iconicity (Perniss, Thompson & Vigliocco 2010; Dingemanse et al. 2015; Blasi et al. 2016; Winter 2021). Vowel quality in spoken languages corresponds to size and intensity, such as *katakata* “clattering” versus *kotokoto* “clattering less noisy” in Japanese, the national language of Japan, or *pimbilii* “small belly” versus *pumbuluu* “enormously round belly” in Siwu, a language used in Ghana (Dingemanse et al. 2015). Locations or handshapes in sign languages are associated with a subset of meanings; signs related to 'hunger' are located at the *stomach* and signs related to 'love' at the *chest* (Börstell & Östling 2017; Börstell 2018; Östling, Börstell & Courtaux 2018) (Figure 1-2), and action signs feature handling and tools instrument handshapes (patterned iconicity) (Padden et al. 2013; 2015; Hwang et al. 2017; Hou 2018). Indeed, researchers have suggested that, due to iconicity, sign languages include many meaningful elements on the phonological level (van der Kooij 2002; Zeshan 2002; Occhino 2017), and that phonological rules are less prominent in sign languages than in spoken languages (van der Hulst & van der Kooij 2021).

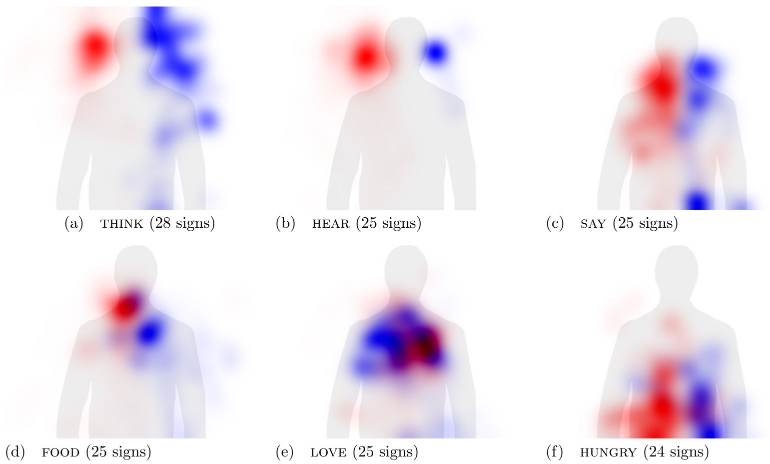

Figure 1-2. Association of locations and concepts across languages as visualised through hand activity (Östling et al. 2018: 12). Activity of the right hand is illustrated in red and activity of the left hand in blue. [Reproduced under the Creative Commons Attribution License (CC BY)]

The discovery that sign languages parallel spoken languages on all levels of description is so powerful because it "alters our very definition of what language is" (Meier, Cormier & Quinto-Pozos 2002: 4). Naturally, sign languages are rife with opportunity for comparisons especially in the field of linguistic typology, revealing an unexplored dimension of diversity. Finding the same structures across many spoken languages and natural sign languages[5] corroborates linguistic universals while at the same time granting linguistic status for sign languages on par with spoken languages.

1.1.1.2 ACQUISITION ACROSS LANGUAGES

Differences in the structure and ecology of a language may affect how children acquire specific features in their target language(s). Zooming into the acquisition of phonology shows crosslinguistic and crossmodal similarities and differences. Nevertheless, research has systematically oversampled WEIRD languages (Western Educated Industrialised Rich Democratic; Henrich, Heine & Norenzayan 2010a), i.e., we still have a poor understanding of how children learn language in diverse non-WEIRD settings (Stoll 2015; Kidd et al. 2020).

Phonological skills are acquired early in life. Preceding first words, children exhibit babbling[6], production of language-like sounds in hearing speech-acquiring children (Vihman et al. 1985) and language-like manual movements in deaf sign-exposed children (Petitto & Marentette 1991; Cheek et al. 2001).By six months of age, children

[5] I do not discuss secondary or alternate sign languages here. Alternate sign languages emerge among hearing communities often without the presence of deaf people and are used as a secondary communication system among hearing people, e.g., Sawmill Sign Language used among hearing employees of a sawmill in British Columbia in Canada (Meissner, Philpott & Philpott 1975). Some alternate sign languages are also used by deaf community members, e.g., Yolngu Sign Language used by an Aboriginal community in North-East Arnhem Land (Northern Territory) in Australia (Kendon 1988; Bauer 2014) or Plains Indian Sign Language used across parts of North America (J. E. Davis 2010).

[6] Note that babbling is not unanimously seen as phonological.

start discriminating between phonemes of spoken and signed languages regardless of whether they are part of their target language and gradually, perception becomes selective to distinguish only those contrasts that are relevant to their target language (Werker & Tees 1984; Baker, Golinkoff & Petitto 2006; Palmer Baker et al. 2012).

Much of the acquisition of phonology appears universal. Speaking children tend to acquire plosives, nasals and clicks earlier than trills, flaps, fricatives or affricatives (McLeod Sharynne & Crowe Kathryn 2018) and early productions typically follow the pattern consonant vowel (CV), preferably (i) labial consonant with central vowel, (ii) coronal consonant with front vowel, and (iii) dorsal consonant with back vowel (Kern & Davis 2009; Kern, Davis & Zink 2009). Signing children first produce handshapes with all or one finger extended or bent, for example *B*, *5*, *1* or *S*, and later handshapes that include extending independent fingers such as *Y* or *ILY* (Boyes-Braem 1990; Pichler 2012; Lillo-Martin & Henner 2021).

Nevertheless, not all aspects of the acquisition of phonology are universal. Dutch children show minor deviations to the commonly attested vowel patterns in early words; instead of labial consonants followed by central vowels, labial consonants co-occur with rounded vowels (Levelt 1994; Fikkert & Levelt 2008). Moreover, Dutch and English children differ in whether or not early words contain dorsal consonant harmony (Pater & Werle 2003; Fikkert & Levelt 2008), and whether they are still recognised when word-initial consonants are manipulated (Tsuji et al. 2015; van der Feest & Fikkert 2015). Similarly, the rate at which speaking children acquire codas (consonant clusters following a vowel) (Zamuner, Gerken & Hammond 2005) and different types of consonants depends on their frequency in the target language (Ingram 2008; Dunbar & Idsardi 2016). For example, codas are more prominent in English than in Spanish which is why children acquiring English produce them earlier than Spanish-learning children (Demuth 2001; Fikkert & Freitas 1997 for Dutch and Portuguese). For signing children, it is yet to be determined whether differences in small case studies (e.g., Boyes-Braem 1990; Marentette & Mayberry 2000; Takkinen 2000; Cheek et al. 2001; Karnopp 2002; 2008; Meier 2006; G. Morgan, Barrett-Jones & Stoneham 2007) should be interpreted as crosslinguistic differences or individual variation.

Some of these differences may be linked to the child's input and culturally entrenched practices. Child-directed speech (and child-directed signing) has long been agreed to be central in language learning, however recent cross-cultural day-long recordings suggest that different child rearing practices influence the amount of child-directed input that is available to children (Cristia et al. 2019; Bunce et al. 2020). Nevertheless, child-directed speech is not required for language development; in communities where child-directed speech is rare, children acquire language mostly from overheard speech (Cristia et al. 2019; Casillas, Brown & Levinson 2020b; 2020a). Indeed, recent work has shown that the amount of child-directed speech varies by community yet remains stable across development within a community (Soderstrom et al. 2019; Bunce et al. 2020).

Joint attention, the focused eye gaze of child and interlocutor on a third referent or object, has long been deemed beneficial to word learning (Akhtar & Gernsbacher 2007). Affordances of different cultures and language modalities shape the specifics of joint attention. In Western middle-class families whose primary mode of communication is speech, dyadic conversation settings are the norm and joint attention is managed between two people and an object. American toddlers tend to focus on one thing at a time rather than multiple ones like children and adults from Guatemala do (Chavajay & Rogoff 1999; Correa-Chávez & Rogoff 2009). Furthermore, American and British caregivers follow the child's attention whereas it is more common in China and Mexico to direct the child's attention (Vigil 2002; Vigil, Tyler & Ross 2006). Lastly, (deaf) families who use a sign language as their primary mode of communication rely on triangulating joint attention through coordinated switches of visual attention between the object and the interlocutor since both deploy the same visuospatial modality (Lieberman, Hatrak & Mayberry 2014).

To sum up, while language acquisition shows both crosslinguistic and crossmodal similarities and particularities, it is crucial to keep in mind that research is heavily biased towards WEIRD languages (Stoll 2015; Kidd et al. 2020). With more and more of the world's languages being documented we broaden our understanding of how diverse acquisition settings may be; this dissertation contributes just that by investigating the acquisition of Kata Kolok. Widening the scope of languages studied provides the chance to revisit and refine (psycho)linguistic theories and update common assumptions.

1.1.2 WITHIN-LANGUAGE VARIATION

All human languages manifest variation. Within-language variation is not accidental but "structured heterogeneity" (Weinrich, Labov & Herzog 1968: 99f.). Users have multiple options to express the same thing and may choose one option over another

depending on their interlocutor and the conversational setting (Bayley 2013). Variation is determined by a complex array of interrelated linguistic and social constraints, in both spoken and signed languages (Lucas et al. 2003; Bayley 2013; Bayley, Schembri & Lucas 2015). Linguistic (or internal) constraints are internal properties of a linguistic unit and the immediate environment in which it occurs, e.g., word class and what words it is preceded and followed by. Social (or external) constraints describe characteristics of the speaker or signer, such as their region of origin, age, gender and socioeconomic background, and details of the conversational setting such as a conversation with family members, or a job interview.

1.1.2.1 VARIATION AS A MARKER OF SOCIOLINGUISTIC VARIABLES

Sociolinguistic variation may concern all levels of linguistic description. Here, I focus on phonology.

Phonological variation in spoken language can be realised through modifying one or more sublexical feature. Final consonant devoicing, vowel nasalisation, or raising and lowering of vowels is common in spoken language and modifying manual features of signs in sign languages. English speakers may modify final coronal stops such as /t/ according to its linguistic environment; when it is followed by a word that starts with a vowel, speakers tend to maintain the coronal stop but delete it when the following word starts with a consonant (Guy 2007). For example, American English speakers prefer to say /east end/ and /eas' side/ rather than /eas' end/ and /east side/. Similarly, Liddell and Johnson (1989) argue that variation in the sign DEAF in American Sign Language, index finger from *chin* to *ear* and index finger from *ear* to *chin*, is influenced by its phonological environment; when preceded by the sign MOTHER, which itself is produced at the *chin*, signers prefer the variant *chin* to *ear*, when preceded by the sign FATHER, which is articulated at the *forehead*, they favour *ear* to *chin* movement.

Social factors shape variation in addition to linguistic factors. Using variants of the sign DEAF is also influenced by the social variables age and region in American Sign Language (Bayley, Lucas & Rose 2000). Similarly, the lowering of signs at the *forehead* has been found to occur as a result of grammatical function and various social variables across cultures; older, male, or a non-native signer in American Sign Language (Lucas, Bayley & Valli 2001), young signers in Black American Sign Language (McCaskill et al. 2011), younger signers from urban centres in Australian Sign Language (Schembri et al. 2009), and signing in a working environment and being young in Hong Kong Sign Language (Siu 2016) have been shown to prompt lowering (Figure 1-3). These observations mirror what has been found for spoken languages. Labov (1963) documented that variation in the sounds /ai/ and /au/ among speakers of Martha's Vineyard, Massachusetts, is organised by age and attitude/identity. Younger speakers centralise the sounds /ai/ and /au/ more often than older speakers, and the degree to which speakers centralised their articulation depends on whether they identify as islanders. A similar but much larger study showed differences in rhoticity among American English speakers in New York City alongside social class (Labov 1966): the pronunciation of /r/ in word-final or pre-consonantal position stratifies residents from the Lower East Side in six (social) groups.

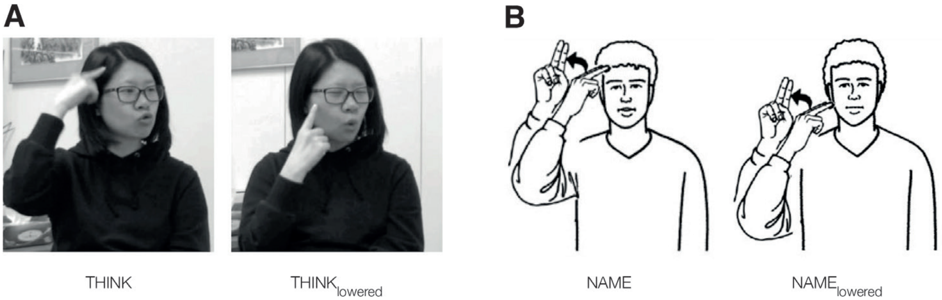

Figure 1-3. Examples of location lowering from (A) Hong Kong Sign Language in the sign THINK (Siu 2016: 6) and (B) from Australian Sign Language in the sign NAME (Schembri et al. 2009: 198). [Reproduced with permission]

The deletion, addition or substitution of a second articulator appears as a modality-specific type of phonological variation in sign languages (Bayley et al. 2015). The choice of whether signers of American Sign Language use a two-handed versus a one-handed variant of a sign is influenced by age, region and ethnicity. Signers who are old(er), from the South, or Black use the two-handed variant more often than other signers (Woodward & De Santis 1977). Lucas and colleagues confirm regional differences; signers from Boston prefer the one-handed and signers from California, Kansas and Louisiana the traditional two-handed variant (Lucas et al. 2007 cf. Bayley et al. 2015). McCaskill and colleagues (2011) confirm differences in ethnicity; older Black signers prefer two-handed variants whereas younger ones use one-handed variants more often (Figure 1-4). A similar observation is made for numerals in New Zealand Sign Language where older signers favour a two-handed system for numerals above five while younger signers prefer a one-handed system (D. McKee, McKee & Major 2011).

Figure 1-4. The sign DON'T-KNOW in American Sign Language in its (A) one-handed and (B) two-handed version. Images reprinted from McCaskill and colleagues (2011: 109). [Reproduced with permission]

Variation in the lexicon is often influenced by social variables, particularly region of origin and age.[7] For example, Grieve and colleagues (2019) find a clear regional dispersion of the synonyms <sofa>, <couch> and <settee> among speakers of British English; speakers from the north prefer <couch>, speakers from the south favour <sofa> and <settee> is used in the midlands. Similarly, there exists considerable regional variation in signs for colours and numbers in British Sign Language (Stamp et al. 2014), including 22 variants for PURPLE, and numerals in Yucatec Maya Sign Languages vary alongside region, age and family membership (Safar et al. 2018). In line with this, variation in the lexicon is commonly influenced by region (e.g., Penn 1992 for South African Sign Language; Campos de Ambreu 1994 for Brazilian Sign Language; Zeshan 2000 for Indo-Pakistani Sign Language; Schermer 2004 for Sign Language of the Netherlands; Vanhecke & Weerdt 2004 for Flemish Sign Language; Stamp et al. 2014; Stamp 2016 for British Sign Language) and by age (e.g., Lucas et al. 2001 for American Sign Language; D. McKee et al. 2011 for New Zealand Sign Language;

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[7] Other social variables that have been studied in sign languages include gender, for example as a result of having gender-separated education systems in Ireland (Leeson & Grehan 2004), ethnicity (R. McKee et al. 2007; McCaskill et al. 2011) and identity (Blau 2017).

Stamp et al. 2014 for British Sign Language; Palfreyman 2016a for BISINDO; Sagara & Palfreyman 2020 for Japanese Sign Language and Taiwanese Sign Language).

Age-related variation often reflects language change (Labov 1994; Bybee 2010). Differences in pronouncing /ai/ and /au/ on Martha's Vineyard reflect a shift in preference; younger and older speakers differ in their pronunciations (Labov 1963). Similarly, younger signers of BISINDO prefer initialised variants for colour signs, i.e., variants that integrate an alphabet handshape corresponding to the first letter of the Indonesian colour term (Palfreyman 2016a), and younger signers prefer more levelled variants of numerals, among other semantic domains, in British Sign Language (Stamp et al. 2014; 2015). More generally, Frishberg (1975) shows that diachronic change occurs from two-handed to one-handed variants in American Sign Language and British Sign Language (also found in Lucas et al. 2001 for American Sign Language; D. McKee et al. 2011 for New Zealand Sign Language), and sign locations at the periphery of the signing space move towards the centre in American Sign Language. Diachronic change is evidenced also by a shift in semantic load from nonmanual to manual features, possibly comparable to lenition in spoken languages (Frishberg 1975; Wilcox & Occhino 2016). For example, the historical form of COMPARE in American Sign Language kept the hands still in front of the face while moving the eyes from side to side; today's version includes no lexical eye movement and instead, moves the hands alternatingly back and forth (Wilcox & Occhino 2016).[8]

Summing up, sociolinguistic variation is common in both spoken and signed languages. Despite the longstanding history of sociolinguistic studies in spoken

[8] Modern American Sign Language sign COMPARE: https://aslsignbank.haskins.yale.edu/dictionary/gloss/2175.html.

languages, a small sample of related languages from the Global North remains oversampled. Studies on sociolinguistic variation in sign languages almost exclusively focus on large sign languages from the Global North (Safar 2021 forming a notable exception). Sign languages from the Global South and sign languages emerging in small-scale settings are severely underrepresented in this area of research.

1.1.2.2 ACQUISITION OF WITHIN-LANGUAGE VARIATION

Variation in a child's input is ubiquitous; interlocutors differ in voice, pronunciation of sounds, accents, regional variation, gender, speed of talking, and sounds vary alongside the physical surroundings such as inside versus outside. This variation is crucial for the child's social development and may thus represent an integral part of acquisition (Roberts 2005).

> "Language is inherently variable, but contrary to the assumptions made by any contemporary approaches to the study of language acquisition, variability does not always equal noise. A key assertion in sociolinguistics is that variability is not simply a problem that language learners must overcome. Rather, it can encode important information about speakers and contexts." (Johnson & White 2020: 2).

This area is still underexplored in spoken languages, and entirely unexplored in sign languages. However, studies increasingly suggest that children acquire within-language variation early but attune to the social variables constraining variation only later (Roberts 2004; Labov 2013; Nardy, Chevrot & Barbu 2013; Johnson & White 2020).

Similar to adults, young children track and use information from their input for language processing (Johnson & White 2020; Choi & Shukla 2021). Taking the example of exposure to many different speakers, speaker-related variability in the input may help children to discriminate between phonotactically possible and impossible units (Seidl, Onishi & Cristia 2014), and may increase the child's flexibility to adapt to phonological detail (White & Aslin 2011; Weatherhead & White 2016; van Heugten et al. 2018). Evidence as to whether speaker-related variability helps or impedes word recognition is debated (Rost & McMurray 2009; van Heugten, Krieger & Johnson 2015; van Heugten & Johnson 2017; Bergmann & Cristia 2018). While exposure to accented speech aids children in accommodating to unknown accents (Potter & Saffran 2017; Schmale, Cristia & Seidl 2012), most children struggle to recognise familiar words in foreign accents (van Heugten et al. 2015). Thus, input-related information about interlocutors sometimes aides and sometimes hinders acquisition.

In spite of producing variable forms that are present in their input, children may become aware of the social variables governing this variation only gradually (Labov 1964; Roberts 2004; Nardy et al. 2013; Johnson & White 2020). For example, it is unclear whether style-shifting in young children is governed by the same factors as in adults: English-speaking children alternate between the progressive suffix /-ing/ and /-in/ by the age of 3 years (Roberts 1994) but their choice is modulated by interlocutor (Roberts 1994) rather than by formality of the context (J. Smith, Durham & Richards 2013). In a Scottish dialect, however, young children vary their vowel in <house> based on formality, with the local pronunciation being most prominent during play sessions (J. Smith, Durham & Fortune 2007). Thus, while children may use different variants in different communicative settings, it is possible that they link variable speech only later to social characteristics of their interlocutor.

In sum, children pick up on the variation in their input early in life. Evidence as to when young children vary their speech production according to social norms is, at this point, inconclusive. The role of variation in the acquisition of sign language phonology remains an open question, also for Kata Kolok. Although a targeted study remains to be conducted, I briefly discuss the implications of variation in the input for children acquiring Kata Kolok in Chapter Eight.

1.2 THIS DISSERTATION

"One cannot study universals without studying particulars."
(Slobin 1985: 4)

The study of linguistic typology, sociolinguistics and language acquisition share the same bias, albeit to different degrees: samples, and hence, findings are biased towards WEIRD languages (Evans & Levinson 2009; Levinson & Evans 2010). The tradition of studying a small set of (related) languages - spoken or signed - that share many sociodemographic characteristics obscures much of the variation that exists across the world's languages.

This is even more pronounced in sign language research. Sociolinguistic studies focus on sign languages from the Global North and variation in signing practices in rural contexts is often studied with a theoretical focus on language

emergence rather than sociolinguistic variation (for an exception, see Safar 2021). Furthermore, studies on individual languages are compared without sharing crucial aspects of their methodology which increases the risk of flawed conclusions. In sign language acquisition, studies on non-WEIRD sign languages are uncommon (Karnopp 2002 for Brazilian Sign Language; Pan & Tang 2017; Wong 2008 for Hong Kong Sign Language) and studies on the acquisition of rural signing practices are extremely rare (Kata Kolok: de Vos 2012c; San Juan Quiahije Chatino Sign Language: Hou 2016).

This dissertation brings together language use and language acquisition by studying phonology in Kata Kolok, the sign language of a rural community in North-Bali (Hinnant 2000; Marsaja 2008; de Vos 2012b). With a focus on variation, I draw on different methods and types of data from linguistic typology, sociolinguistics and language acquisition from the same non-WEIRD language community in order to investigate three central research questions of this dissertation:

1) *What characterises variation in Kata Kolok phonology?*
   [Chapter Three and Chapter Four]
2) *How does Kata Kolok phonology fit into a broader typological landscape? [Chapter Five]*
3) *How is (variation in) the phonological system acquired by children?*
   [Chapter Six and Chapter Seven]

1.2.1 OVERVIEW OF CHAPTERS

This dissertation consists of two main parts: Part I focuses on language variation and Part II on language acquisition. Over the course of my PhD project, I have conducted five studies (Chapter Five through Chapter Seven), each of them tackling a different aspect of variation in language. In addition, each chapter was designed with a particular focus on conducting appropriate comparisons, i.e., the aim to reduce methodological disparities between research on non-WEIRD sign languages and other types of sign languages as well as spoken languages.

Chapter Two briefly introduces Kata Kolok and its language ecology. I provide an update on recent community-level developments that may affect the language ecology and briefly summarise recent research on the linguistic structure of Kata Kolok. Here, I also include an overview of the available data and the newly collected data, and critically reflect on the fieldwork component of this dissertation project.

Chapter Three and **Chapter Four** contribute to answering the first research question as to what characterises form-based variation in Kata Kolok.

Chapter Three charts variation at the level of the lexicon (sign production). In this study, I investigate whether sociolinguistic differences between our participants such as age, gender or whether or not they are deaf, influence the signs they produce in an elicitation task. In order to analyse the data appropriately, I use two variation measures that do not require us to determine one variant as the default and others as a deviation thereof. First, entropy measures variation in a set, i.e., it quantifies differences between participants based on any of the sociolinguistic variables considered. Second, lexical distances measure the overlap between the lexicons of participants such that participants who produced more of the same signs have a shorter distance from each other than participants with little lexical overlap. This is visualised through Multi-Dimensional Scaling (MSD).

Chapter Four charts variation at the level of the form of signs. Here, I am interested in what variation can be attested when considering only the participants whose lexicon appears more similar in Chapter Three, i.e., the deaf participants. Combining methods previously used for sign comparisons, I develop a new measure (variation index) that quantifies variation in sign variants with the same iconic motivation based on the number of variants and their phonetic distance from each other. I apply the measure to the full dataset and use token frequency and signer frequency as a weight to identify how frequent and how widespread different sign variants are across the sample.

Chapter Five examines the second research question by investigating how diverse sign phonologies are when taking a comparative approach in which methodological differences are minimised. I created a dataset of ~1,300 phonologically annotated Kata Kolok signs in the lexical database Global Signbank. Using the same infrastructure, I compare the inventory and regularities of Kata Kolok's phonology to Sign Language of the Netherlands (NGT), a representative example of a large sign language used in a WEIRD context that is maximally different from Kata Kolok in many major typological domains (e.g., sociolinguistic setting, acquisition patterns, etc.). I present two sub-studies: First, I examine the inventory of the Kata Kolok dataset as compared to NGT, and test whether existing claims about the phonology of Kata Kolok are corroborated with the current datasets. Second, I examine phonological regularities (minimal pairs, phonotactic constraints) in both languages to test their suitability. Finally, I evaluate user judgements from Kata Kolok signers to refine the phoneme inventory.

Chapter Six and **Chapter Seven** investigate how (variation in) the phonological system is acquired by children.

In Chapter Six, I study how early productions of signs of four deaf children who acquire Kata Kolok from birth differ from their input. I annotated and analysed ~95 hours of longitudinal data for child productions that deviate from their adult targets. In contrast to previous studies, I apply the same fine-grained feature-level coding as used for adults in the lexical database (Chapter Four and Chapter Five) and used an automatic comparison to categorise modification patterns such as substitutions, omissions, and additions. By comparing the results to the literature, crosslinguistically robust and language-specific patterns emerge.

Chapter Seven explores the challenge of adapting experimental approaches to studying the early acquisition of phonology to (i) a sign language and (ii) a non-WEIRD context. In this study, I report two novel methodologies: I used two established paradigms in spoken language phonology (familiarisation paradigm & habituation paradigm) and conducted two studies with child signers of Kata Kolok and hearing children who do not know any Kata Kolok. In the first study, I adapt a traditional habituation paradigm and complement the traditional looking time analysis with additional behavioural measures to investigate whether group-differences can be detected. In the second study, I pilot a new way of measuring attention; it relies on touch-input instead of looking time which promises modality-neutrality.

Chapter Eight contains a general discussion and conclusion, focusing on the contributions of this dissertation, the relevance of the findings of all chapters in the wider literature and directions for future research.

1.2.2 CLASSIFYING SIGN LANGUAGES: A WORD ON TERMINOLOGY

Since the advent of the field of sign language typology, there is increasing documentation of diverse signing practices among deaf people from the Global South (Zeshan 2000; Palfreyman 2019) and in rural communities (Meir et al. 2010; Zeshan & de Vos 2012). Broadening the geographical and sociolinguistic scope of sign languages under investigation has highlighted a link between structural properties and language ecologies (Zeshan 2004; Vos & Pfau 2015; Zeshan & Palfreyman 2017). Consequently, different classifications of diverse signing practices according to their sociolinguistic ecology emerged (for discussions of classifications see Hou & de Vos 2021; Reed 2019; Hou 2016). This has resulted in binary categorisations that are based on specific characteristics such as demographics (e.g., *rural* versus *urban* (Zeshan & de Vos 2012), *micro-community* versus *macro-community* (Fusellier-Souza 2006; Schembri 2010; Schembri et al. 2018)); time depth (*emerging* versus *established* (Meir et al. 2010), *young* versus *mature* (Brentari & Coppola 2013)); context of use (*shared* versus *Deaf community* (Kisch 2008; Nyst 2012)); sociocultural characteristics and context of use (e.g., 'natural sign' in Green 2014; 'family sign languages' in Hou 2016; and 'CULTURE' in Reed 2019). Unfortunately, the way many of these classifications are used in the literature, particularly time-depth related classifications, evoke dichotomies that imply a "developmental cline" (Hou & Kusters 2020: 565) of languageness and have therefore been challenged (Nyst 2012; Green 2014; Hou 2016; Reed 2019; Hou & de Vos 2021). They position languages that have different ecologies than the average WEIRD sign language, i.e., languages that are used in small, rural communities among mixed deaf-and-hearing groups and that have had less intergenerational transmission, on the side of "not language", potentially stimulating harmful characterisations of those communities and language users.

Generally, large-scale sign languages are characterised by their large size, with mostly horizontal language transmission given the high rate of deaf children with hearing parents and thus, risking language deprivation (Humphries et al. 2014; Hall 2017), and that have a history of standardisation to some degree, e.g., through usage in education. Large-scale sign languages resemble exoteric communities (Wray & Grace 2007); their network structure is loose, interaction patterns are diverse and community members are heterogeneous. Small-scale sign languages are characterised by small community size, a tight-knit network structure with high incidences of (often hereditary) deafness, vertical patterns of language transmission, and a high number of hearing and deaf community members with signing skills. Small-scale sign languages overlap with characteristics of esoteric communities (Wray & Grace 2007); they are a culturally homogeneous group, most members are born within the community and spontaneously arising (relatively high) incidences of deafness leads to the emergence of a sign language which then is used by deaf and hearing community members.

While I agree with the criticism of dichotomous classifications, I consider some of the aforementioned categorisations helpful in the context of this dissertation. I use different classificatory terms according to different foci of the different chapters: in Chapter Three, the focus lies on the distinction between shared sign languages

and Deaf community sign languages; in Chapter Four, I use the terminology micro-community sign languages and macro-community sign languages; in Chapter Five, I differentiate between rural sign languages and urban sign languages; in Chapter Six and Chapter Seven, I zoom in on the typological differences between WEIRD and non-WEIRD sign languages. For the remainder of this dissertation, I adopt the terminology micro-community sign languages and macro-community sign languages (Fusellier-Souza 2006; Schembri 2010; Schembri et al. 2018) since I consider those terms the most ideologically neutral.

CHAPTER TWO

THE LANGUAGE ECOLOGY OF KATA KOLOK – AN UPDATE ON LANGUAGE AND COMMUNITY

Chapter adapted from: *Lutzenberger, H. (in press). Threat or natural fluctuation? Revisiting language vitality of Kata Kolok, the sign language of a village in Bali. In State of the art of indigenous languages in research: A collection of selected research papers. UNESCO.*

2 THE LANGUAGE ECOLOGY OF KATA KOLOK – AN UPDATE ON LANGUAGE AND COMMUNITY

This dissertation is dedicated to studying Kata Kolok. Kata Kolok is the indigenous sign language of the village Bengkala in Bali, Indonesia. In the following section, I first describe the village community and the language ecology of Kata Kolok and discuss recent changes to the language ecology, including increased mobility, language contact, and the state of language documentation. Then I provide a brief overview of recent research on the structure of the language. I conclude this chapter by critically reflecting on the fieldwork carried out in this dissertation project.

2.1 DEMOGRAPHIC UPDATE OF THE COMMUNITY

Bengkala is a traditional village of approximately 3,000 inhabitants (Desa Bengkala 2017) in the rural region of Kubutambahan, Buleleng in the North of Bali, Indonesia (Figure 2-4). Most villagers earn their living through day-labour on surrounding fields growing crops like turmeric, peanuts, rice, root vegetables and fruits, by raising or guarding livestock, or by running small local businesses (Marsaja 2008). As mobility and tourism increase in North-Bali, careers in urban centres as well as in tourism have become available, in particular for young people. While job opportunities in hotels in the different parts of Bali are a popular and sustainable option for many, temporary jobs in the cruise ship business may represent an attractive prospective, especially for young men. Like most places across Bali, Hinduism is the practiced religion in Bengkala. This shapes the geographical layout and social organisation of the village:

the village entrance faces South (*kelod*) and the exit West (*kauh*) and houses centre around four big temples in each of the cardinal directions (Covarrubias 1937).

On a macro-level, the community is organised in ten village clans (*dadya*), each of which is located at a different area of the village. Clan membership shapes the duties and privileges of individual villagers, for instance, during events such as praying routines, religious ceremonies, death or marriage. Clan membership is generally determined by birth. According to patrilineal lineage (Covarrubias 1937; Marsaja 2008), men remain in their birth clan throughout their lifetime whereas clan membership changes for women upon marrying a spouse from a different clan. Marriage patterns are endogamous and while traditionally, villagers married other villagers (Marsaja 2008) from the same or different clans, villagers increasingly find spouses from elsewhere as the contact with the wider Balinese community continues to increase. Clearly, clans influence the broad social network of villagers.

On a micro-level, the community is organised through family compounds. Within each clan, kin live in complexes of multiple houses that are arranged around a common courtyard and share a small temple (Covarrubias 1937). Each house comprises a multigenerational household, mostly with large numbers of members. According to patrilineal tradition, male offspring remains in the family compound they were born in and female offspring relocates to the husband's family compound upon marriage. The courtyard accommodates large parts of everyday life, especially communal tasks such as religious preparations or social gathering. Moreover, members of a family compound share religious duties in the family compound temple; female members of each household carry out small daily rituals and additional duties tied to larger ceremonies on the clan-level. In short, family compounds shape the nuclear network of villagers.

A genetic mutation of the recessive gene DFNB3 has resulted in high incidences of hereditary and nonsyndromal autosomal deafness among the villagers of Bengkala (Friedman et al. 1995; Winata et al. 1995). In 1998, Liang and colleagues (1998) estimated the birth of the first deaf individual affected by the mutation approximately eight to twelve generations ago (see de Vos 2012b for a discussion of Kata Kolok's time depth). Subsequently, a growing number of deaf individuals were born over several generations. Winata and colleagues (1995) and Marsaja (2008) counted 47 deaf villagers in a village population of 2,185 and 2,186 respectively (~2.15%). In 2012, de Vos (2012b) reported 38 deaf individuals (1.4% of 2,740 population) who resided permanently in Bengkala. By 2018, this had further decreased to 31 deaf people (1.02% of 3,032 population; fieldwork, 2018). Figure 2-1 provides an updated family tree, based on the genealogical tree created by Liang and colleagues (1998) and heavily informed by our hearing research assistant I Ketut Kanta. This decrease in deafness may be caused by a combination of different factors including death of deaf villagers, fewer births of deaf individuals, relocation of deaf villagers to other parts of Bali, and a general increase of the population. Nevertheless, Bengkala still preserves ten times higher incidences of deafness than Western countries; deafness affects around 0.1% of the population in countries in the Global North (CDC 2020).

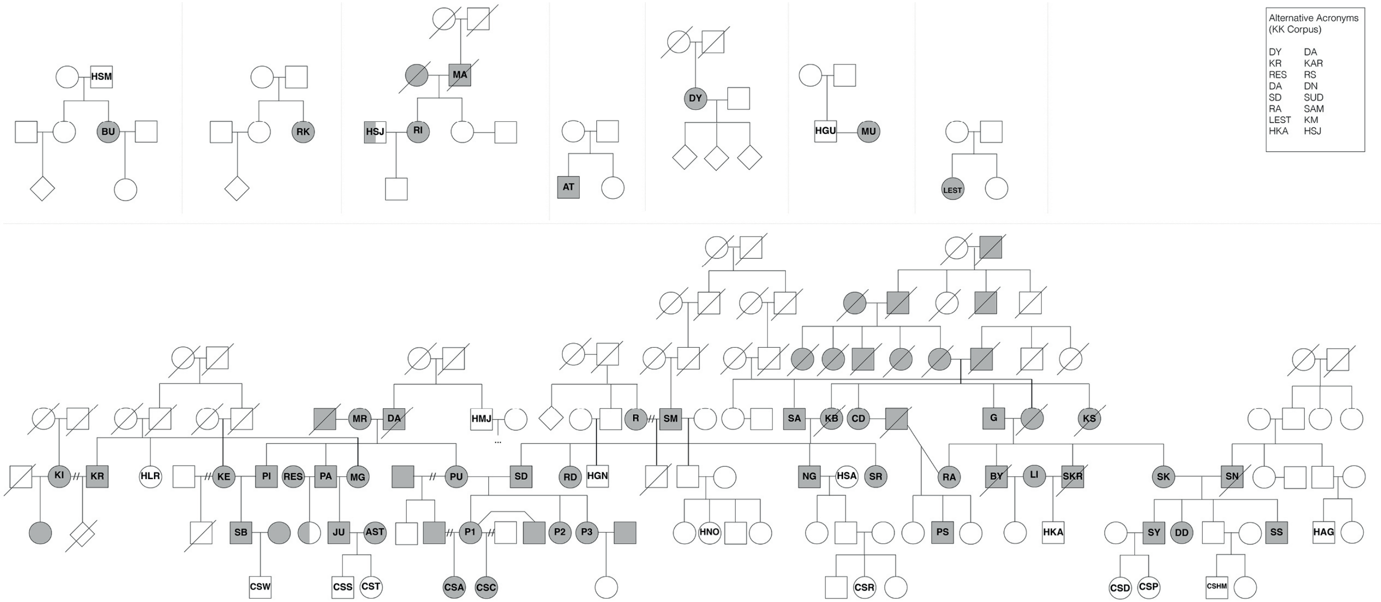

Figure 2-1. Family tree of deaf villagers in Bengkala, recreated based on personal consultation with research assistant Ketut Kanta and Connie de Vos. Circles stand for female individuals, squares for male individuals and diamond shapes for unknown sex. Filled symbols stand for deaf individuals and empty symbols for hearing individuals. Slashes through a symbol indicate that an individual is deceased. Horizontal lines indicate same-level kinship, vertical lines represent offspring.

Since the first occurrence of deafness in the village, deaf people were born in all ten village clans (Marsaja 2008). Figure 2-2 provides an overview of the number of deaf villagers in each clan based on reports from 2012 (de Vos 2012b). Clans of the southern half of the village have more deaf members than clans in the northern half. In 2012, the clans Ceblong/Gelgel counted nine deaf members and the clan Tihing/Pulsari eleven members. Today, there are ten deaf members in Ceblong/Gelgel and 14 in Tihing/Pulsari. This is probably linked to the intermarriage of two families with many deaf people that lead to much deaf offspring (Figure 2-1).

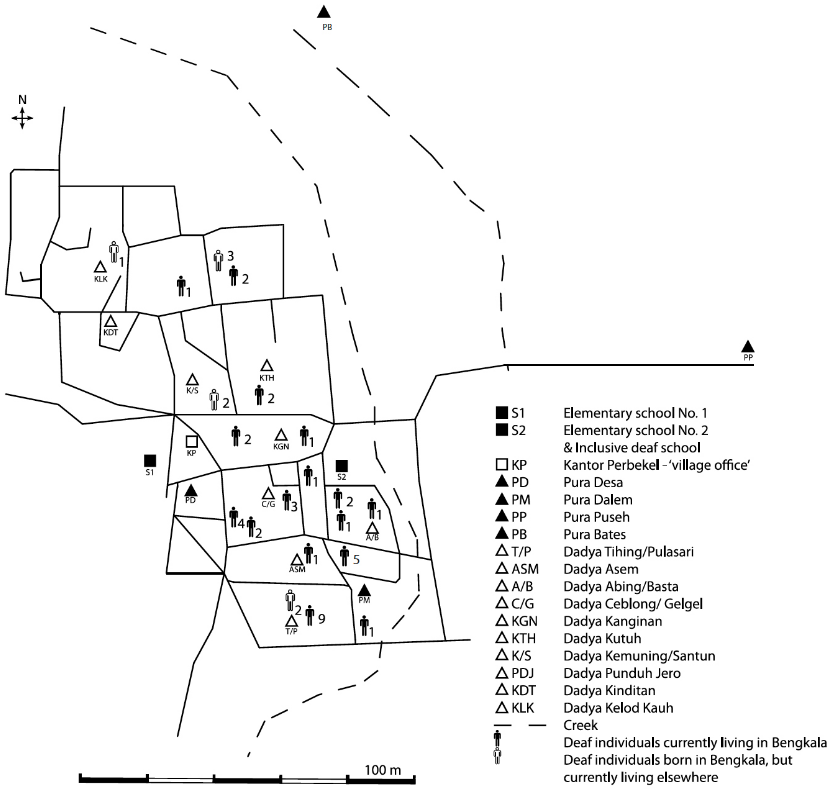

Figure 2-2. Geographical distribution of deaf people in the village. Figure from de Vos (2012b: 27). [Reproduced with permission from Connie de Vos]

2.2 LANGUAGE ECOLOGY OF KATA KOLOK

The prevailing deafness caused the village community to evolve linguistically, socially, and culturally around deafness. Unlike elsewhere, deafness is not stigmatised in Bengkala but deeply rooted in the culture of the village (Hinnant 2000; Marsaja 2008). Religious beliefs and folktales include myths about a deaf ghost, the deaf have created their own version of the traditional dance *janger*, the deaf execute specific duties such as preparing graves for the deceased, and the sign language Kata Kolok has emerged and is used by deaf and hearing villagers to communicate in all situations of daily life.

Kata Kolok is estimated to have emerged at least six generations of deaf signers ago (de Vos 2012b). Following de Vos (2012b), I consider the first generation of Kata Kolok signers to be a group of five deaf siblings with an older deaf uncle, the first deaf individual affected by the genetic mutation of DFNB3. This determines Kata Kolok's time depth to six generations (Figure 2-3). Note, however, that de Vos' (2012b) estimation is conservative; given that congenital deafness is overall high in Bali, it is possible that the deaf uncle had other deaf peers or even older deaf language models who we have no records of. Nevertheless, the field of sign language emergence lacks consensus as to how language age is counted and reported and the delineation of a generation is not commonly discussed in detail (Kisch 2012). Some researchers report time depth in biological generations (e.g., Ergin 2017 for Central Taurus Sign Language), and others in cohorts of signers (e.g., A. Senghas 1995 for Nicaraguan Sign Language) which makes direct comparisons difficult.

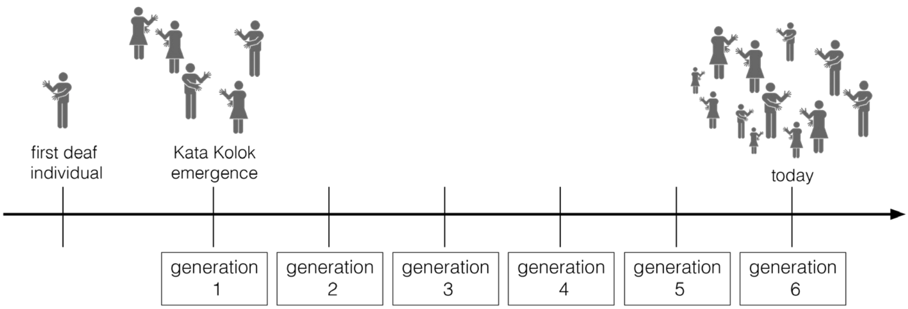

Figure 2-3. Timeline of Kata Kolok from its emergence until today, based on de Vos (2012b: 47).

The sustained high incidence of deafness and emergence of Kata Kolok has diversified the linguistic landscape in the village. With Balinese, Bahasa Indonesia, and Kata Kolok, multilingualism is widespread across the villagers. Based on a survey from 2000 (Marsaja, 2008; de Vos, 2012b), approximately 57–69% of the villagers have signing skills in Kata Kolok. Although likely that deaf Kata Kolok signers have some degree of multilingual knowledge of Bahasa Indonesia and Balinese, mouthings or articulations of spoken words alongside signing are uncommon. Many hearing villagers sign to various degrees of proficiency, and speak Balinese and Bahasa Indonesia. Whether or not hearing villagers acquire Kata Kolok is often determined by external factors; hearing villagers with deaf family members may learn Kata Kolok early in life or even as a first language while for hearing villagers without a deaf family member, the acquisition of signing may (or may not) start later when their life routines intersect regularly with the deaf villagers. Marsaja (2008: 115f.) observes a difference in Kata Kolok fluency among hearing villagers alongside gender; men are likely to be more fluent signers than women which he explains by differences in cultural practices and the division of labour among men and women:

female tasks have a smaller radius around the house while men spend most of their day outside the house, hence interacting with more different people.

At least six generations of deaf signers have acquired Kata Kolok natively from their deaf parents (de Vos 2012b) and a substantial number of hearing children with deaf parents, caregivers or close family members within the same compound learn Kata Kolok as a first language. These children receive diverse signing input from birth: they are exposed to child-directed signing and observe overseen signing, that is signing that is not directly addressed to them, from multiple interlocutors including family members, peers, neighbours, teachers, and shopkeepers on a daily basis and in a variety of situations.

This rich acquisition setting resembles many aspects of how hearing children acquire speech and contrasts starkly with more dispersed urban deaf communities, e.g., the US where 90–95% of deaf children have hearing, non-signing parents (Mitchell & Karchmer 2004) and experience language deprivation (Humphries et al. 2014; Hall 2017; Hall, Levin & Anderson 2017). The input Kata Kolok signing children receive may differ from both the input for deaf children with deaf parents in the Global North and for hearing children who acquire a spoken language: (i) input for children learning Kata Kolok likely stems from many second language users with various degrees of proficiency which has been shown to impact language learning in other contexts (for signing children: Lu, Jones & Morgan 2016; for bilingual children: Place & Hoff 2016; Unsworth et al. 2019; Hoff, Core & Shanks 2020); (ii) input from deaf signers is likely to vary alongside individual signer profiles (see Chapter Three and Chapter Four). Nevertheless, child-directed signing as well as the quantity and quality of input children acquiring Kata Kolok receive has not yet been studied. This is necessary to evaluate how modality-driven and cultural differences may affect what the children are exposed to (Soderstrom et al. 2019; Casillas et al. 2020a; 2020b).

2.3 RECENT DEVELOPMENTS IN THE COMMUNITY

Since last description of the socio-demographic profile of Bengkala in 2012 (de Vos 2012a; 2012b), the community has undergone considerable changes that affect the language ecology of Kata Kolok. First, community-level changes include an increase in mobility of villagers, local and international tourism, and a shift in deaf education, leading to reshaping the community of Kata Kolok signers by affecting social network ties (Section 2.3.1). Second, the resulting increase in contact with the wider Balinese and international (deaf) community increases language contact between Kata Kolok and other sign languages (Section 2.3.2). Third, language documentation since 2007 is ongoing to preserve the structure, use, and acquisition of Kata Kolok (Section 2.3.3). While together, these factors affect the vitality of Kata Kolok (Section 2.3.4), Kata Kolok currently continues to thrive.

2.3.1 COMMUNITY-LEVEL CHANGES

Advancements in technology such as electricity, gas stoves, scooters, and mobile phones have changed the daily routines of all villagers. Young villagers, now owning mobile phones, spend an increasing amount of their free time on social media. For deaf villagers, video chat and mobile internet allow staying in touch with signing friends from outside the village and foreigners who visit regularly, e.g., researchers such as myself. Moreover, with scooter transportation becoming more common, the villagers' sphere of movement has increased. Together, this has led to increased contact with the wider Balinese and international (deaf) community.

Since 2000, the media attention in the village has been growing steadily (Hinnant 2000). The national oil company Pertamina functions as an official supporter of Bengkala's deaf community. Financial as well as material support in the form of seeds, livestock, and small-scale food donations are regularly provided specifically to deaf families. In return, the deaf community has become a symbol of Pertamina's social engagement, featuring in some of their commercials. Recently, Pertamina has financed the construction of facilities to receive tourists and also subsidised the production of small goods for purchase, such as a turmeric-based drink.

More and more media products such as short inspiring videos on social media, documentaries produced by organizations like the BBC or National Geographic, interviews on national TV, and articles in newspapers or travel journals appear (e.g., Eveleigh 2019; Valo 2020). This has contributed to increasing popularity of the deaf people and a steadily growing number of national and international tourists. Where tourists used to stay for a few hours or occasionally organised an overnight stay at the house of a deaf villager, the new demand led to the construction of two homestays in the village for short- and long-term residency. Deaf villagers are compensated through donations for performing the traditional dance *janger*, weaving sarongs, or other traditional activities. Thus, the professional focus of deaf, and (some) hearing villagers may gradually shift towards tourism.

Another big change in the educational environment is likely to redefine the community of language users. Since 2007, one of the village's primary schools provides inclusive education using Kata Kolok (de Vos 2012b). Today, Bengkala's deaf youth have either outgrown primary education or have not yet entered school, leaving a gap of native Kata Kolok signers in the inclusive unit. At the moment, a small number of deaf children growing up in hearing families in surrounding villages, i.e.,previously homesigners, attend the inclusive unit. Naturally, these deaf children do not know Kata Kolok when they first arrive. They acquire Kata Kolok in a formal school setting instead of through intergenerational transmission. Supported by the local government and the oil company Pertamina, inclusive education in the village is planned to be extended through a secondary school, targeting all deaf child homesigners in the area, of which there are thought to be many (Winata et al., 1995). Deaf homesigners will be late learners of Kata Kolok and form part of a growing satellite community of Kata Kolok signers, residing outside the village, yet using Kata Kolok at school and in Bengkala.

Illiteracy prevailed among the deaf villagers until the inclusive unit was established (de Vos 2012b). The institutionalisation of Kata Kolok alongside increased mobility have created opportunities for further education among Bengkala's deaf youth.[9] Some signers of the fourth and fifth generation have attended deaf schools in other parts of Bali, e.g., Singaraja, Jimbaran, or Denpasar (Figure 2-4) where other forms of signed communication and oralist methods are used (Marsaja, 2008). In one case,

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[9] Note that the institutionalisation of Kata Kolok does not affect acquisition patterns among children who are native to Bengkala; these children continue to learn Kata Kolok early in life from signers in their environment. This contrasts with the situation of other signing communities where many deaf children are exposed to sign language for the first time when entering a deaf school (Zeshan & de Vos 2012).

this has created the opportunity to employ a deaf generation five signer as externally funded[10] teacher in the deaf unit where they serve as a role model for the new generation of Kata Kolok signers as well as incoming homesigners. Despite these opportunities, not all deaf villagers pursue further education due to the considerable financial expenses to cover commuting by scooter or a boarding school.

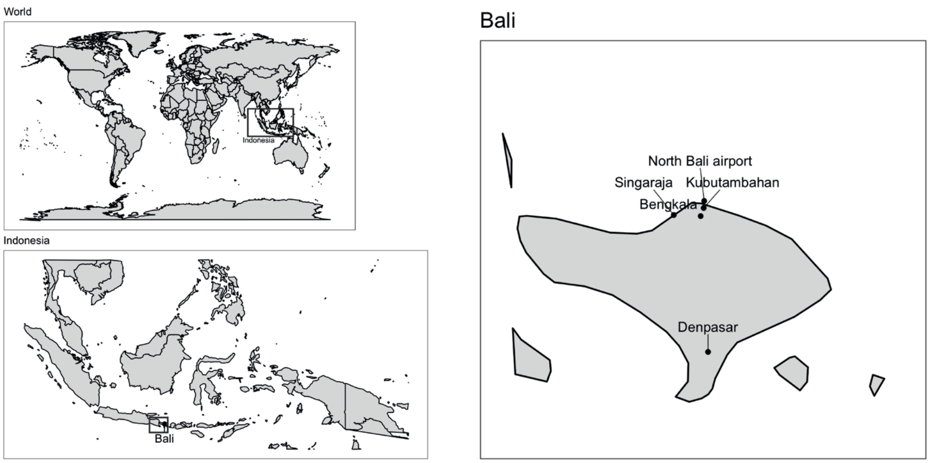

Figure 2-4. Map of Bali, including the geographical locations of cities mentioned in this chapter.

Summing up, Kata Kolok has thrived due to the geographic proximity and symbiotic relationship among hearing and deaf users in the past. As social network structures are being redefined through changes in the community, the language community becomes more dispersed and may change the patterns of language use and transmission to resemble the majority of signing communities across the world.

[10] While hearing teachers are approved and employed by the government, deaf candidates still face several structural barriers related to official employment conditions to be officially employed through the government. The deaf teacher is funded externally through the ERC Starting Grant *Emergence of Language in Social Interaction* (ELISA - 852352) awarded to Dr. Connie de Vos.

2.3.2 LANGUAGE CONTACT

Until recently, Kata Kolok has developed with virtually no contact to other sign languages and has therefore been considered an isolate (Perniss & Zeshan 2008; de Vos 2012b). Neither spoken Balinese nor spoken Bahasa Indonesia have had any major influence on the language (de Vos 2011; 2012b). In the recent years, contact with other sign languages has increased (Moriarty 2020).

Fingerspelling was introduced in the inclusive school in 2007 as an educational tool to teach deaf children basic literacy skills in Bahasa Indonesia. Note that this manual alphabet differs from a two-handed alphabet used by some signers of Indonesian signing varieties (Palfreyman 2019) . Today, fingerspelling is used by young literate Kata Kolok signers in educational contexts and special circumstances, e.g., introducing themselves to foreigners or when conversing with acquaintances from outside the village. However, fingerspelling remains foreign to older, illiterate deaf signers, as well as to most hearing signers. Villagers generally rely on Kata Kolok to communicate and do not employ borrowings from spoken or written language such as fingerspelling, mouthing, lip-reading, or writing in their conversations.

The language contact with BISINDO used by the wider deaf community in Bali has increased considerably since 2007 (Moriarty 2020). With the boost in mobility and literacy among the deaf youth, the interaction with other Balinese deaf individuals has grown. As a result, young Kata Kolok signers now have deaf friends from outside the village and some generation five signers have even found deaf spouses from other villages. For deaf spouses from outside the village, Kata Kolok commonly becomes their primary language. Most of Bengkala's deaf youngsters

– even the ones who never attended secondary education outside the village themselves – have quickly achieved some degree of sign bilingualism in Kata Kolok and BISINDO and code-switch frequently. For example, Chapter Four includes examples of borrowings of signs that may not have a conventionalised variant in Kata Kolok (Figure 2-5); for example, for the colour yellow, we observed a non-initialised variant (YELLOW-BISINDO-1A with *1* handshape; Figure 2-5A) and two initialised variants (Bahasa Indonesia 'kuning', YELLOW-BISINDO-2A and YELLOW-BISINDO-3*a* with *K* handshape; Figure 2-5B), or signs that have similar meaning as existing signs, e.g., the negator NEG-BISINDO differs from the conventional Kata Kolok negator NEG in handshape and nonmanuals (Figure 2-5C). Code-switching and lexical borrowing have been observed among young deaf signers (generation five). Some older deaf people (generation four and generation three) occasionally use selected lexical signs from BISINDO, albeit unsystematically. Hearing signers who do not usually mingle with deaf friends from outside the village do not appear to know or use BISINDO signs.

Figure 2-5. Examples of lexical borrowings from BISINDO: three variants for yellow (YELLOW-BISINDO-1A, YELLOW-BISINDO-3A and YELLOW-BISINDO-1A) and a negation marker (NEG-BISINDO).

Related to the increased language contact is the occurrence of mouthing. Mouthings are commonly understood as a language contact phenomenon between a signed and spoken language, i.e., code-blending (Crasborn et al. 2008; Bank 2015). This type of mouth actions is rare in Kata Kolok since they are attested only for a few selected lexical items such as COFFEE that sometimes is co-articulated with the Indonesian <kopi> or WHAT-1 that may be produced alongside the Indonesian <apa> (Marsaja 2008; fieldwork 2017-2019; de Vos 2012b). However, signs borrowed from BISINDO are often, yet not always, accompanied with the corresponding mouthing (see Figure 2-5), regardless of the level of literacy of the signer. It is, however, unclear whether this mouthing is identical to the mouthing commonly used by BISINDO signers or modulated, for example in terms of quantity (i.e., how regularly a manual borrowing occurs with mouthing) or quality (i.e., whether this mouthing can be linked to a spoken word or not).

Yet another source of increased language contact with other sign languages is the flourishing tourism. The increasing encounters with signing tourists from different parts of the world feed into the linguistic knowledge of Kata Kolok signers, and thus crosslinguistic borrowings. For instance, Kata Kolok signers of different ages may use the signs DEAF, FAMILY or NAME that are borrowed from other sign languages (Figure 2-6 for those signs in ASL). Although likely, it is at this moment unclear whether signers use these signs exclusively in situations with foreigners or whether they have been adopted into the Kata Kolok lexicon more systematically. Some evidence for a higher degree of integration exists for NAME; this sign is taught explicitly at school and deaf parents have been observed to teach their children to spell their name or sign their name sign when prompted with this sign. This, however, has not been observed for signs like FAMILY or DEAF. Thus, lexical borrowings like these provide evidence for language contact, as stimulated by tourism as well as increasing institutionalisation, i.e., the new importance of literacy, acting on the grammar of Kata Kolok.

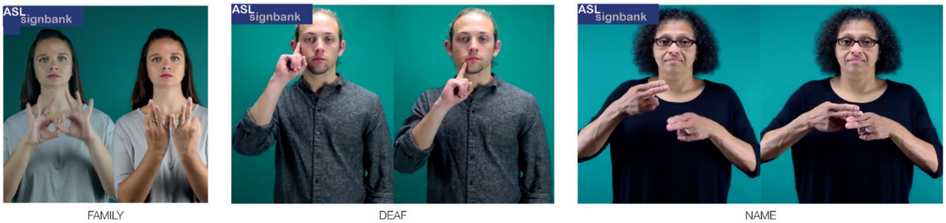

Figure 2-6. Examples of borrowed signs from ASL (or another sign language where these signs are used) that are now used by Kata Kolok signers. Images retrieved from ASL Signbank (Hochgesang, Crasborn & Lillo-Martin 2021). [Reproduced from ASL Signbank under the CC BY-NC-SA 4.0 License]

Moreover, tourism may also stimulate sign creation. Balinese society has encompassed tourism as one major source of income, and thus, the incentive to please visitors is high (Howe 2005). Hearing signers who interpret conversations among deaf villagers and tourists or deaf villagers themselves may feel a need for signs that did not exist in Kata Kolok before, stimulating the invention of new signs; the sign THANK-YOU has emerged due to newly arising expectations of politeness (Figure 2-7). Financial benefits of local tourism in the form of donations to individuals or the entire village, where most inhabitants still live in poverty, may intensify both lexical borrowing and sign creation (Marsaja 2008).

Figure 2-7. Example of sign creation in Kata Kolok: THANK-YOU.

2.3.3 LANGUAGE DOCUMENTATION

Kata Kolok has been documented for over a decade, each documentation effort with a different aim. Marsaja's (2008) data yielded an initial description of Kata Kolok but is not accessible, de Vos' (de Vos 2016) data targeted language documentation and typology and access can be requested via The Language Archive hosted by the Max Planck Institute for Psycholinguistics in Nijmegen (NL) (König 2011), and Putri and colleagues' (Putri et al. 2017; Putri 2018; Putri & Sutjaja 2019) data is aimed at producing a dictionary.

The documentation efforts linked to this dissertation have been archived as contributions to the Kata Kolok Corpus (*Kata Kolok Corpus* 2021) and the Kata Kolok Child Signing Corpus (*Kata Kolok Child Signing Corpus* 2021) (de Vos 2016). Find the Data Management Plan associated with this dissertation in the Appendix. The collected data capture video footage from deaf and hearing signers from generation three through generation five in the Kata Kolok Corpus and from generation five and generation six in the Kata Kolok Child Signing Corpus (Figure 2-8). The type and scope of data collected between 2007-2009 are described in de Vos (2016). For data collected since 2017, we used a Canon Legria HF G 26 camera at 25 fps and converted the Advanced Video Coding High Definition (AVCHD with H.264/MPEG-4 AVC) output file to high quality MPEG files (H.264/MPEG-4 AVC). Raw video files were converted videos using a script provided by Jeroen Geerts from the Technical Support Team at the Max Planck Institute for Psycholinguistics in Nijmegen (NL) that was later adapted by Katie Mudd at Free University of Brussels.

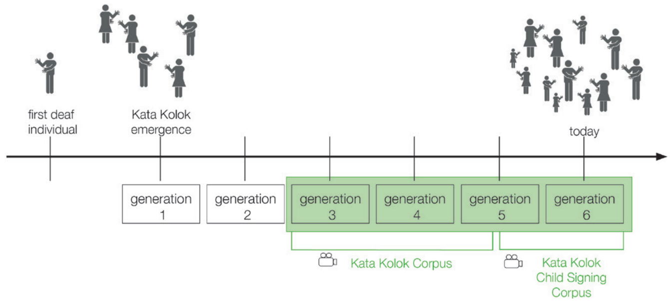

Figure 2-8. Timeline of Kata Kolok emergence, detailling language documentation efforts.

The Kata Kolok Corpus comprises video recordings of hearing and deaf signing adults in different genres (de Vos 2016). Data collection has been ongoing since 2007, initiated and facilitated by Connie de Vos and myself together with local research team I Ketut Kanta, Ni Made Dadi Astini and Ni Made Sumarni. The Kata Kolok Corpus contains both naturalistic and elicited data, including different conversational constellations as well as linguistic elicitation of sensory, video- and picture-prompted data with a large range of deaf and some hearing signers. In 2015, the Kata Kolok Corpus has been placed UNESCO Memory of the World Register. Table 2-1 provides an overview of data collected in the Kata Kolok Corpus. Of the original ca. 63.5 hours of data, roughly 3:52 hours are translated, 3:44 hours are glossed and about 1:45 hours are translated and glossed.

Table 2-1. Overview of data in the Kata Kolok Corpus, based on de Vos (2016).

genre	type	# of signers
semi-spontaneous	monologues	9 signers (23 narratives)
	dialogues	18 signers (deaf) (13 dialogues)
	multi-party	10 recordings (informal gathering & religious ceremonies)
	deaf-hearing	12 recordings (multiparty interactions) 3 one-hour recordings (dialogues between adult deaf and hearing siblings) 3 one-hour interaction among hearing community members for Balinese (w/ co-speech gesture)
	Balinese gesture	
stimulus-based elicitations	canary row	12 signers (deaf)
	Sendung mit der Maus	13 signers (deaf)
	Language of perception	13 signers (deaf)
	Man-tree	5 pairs of signers (deaf)
	reciprocals	4 signers (deaf)
	space/number	7 pairs of signers (deaf)
	still images	activities (line drawings): 16 signers (deaf) animals: 12 signers (8 deaf; 4 hearing) emotions (line drawings): 10 signers (deaf) flora: 6 signers (4 deaf; 2 hearing) food: 7 signers (5 deaf; 2 hearing) misc: 20 signers (deaf) praying: 8 signers (6 deaf; 2 hearing) school: 6 signers (3 deaf; 3 hearing) tools: 16 signers (deaf) variation project: mixed elicitation with 46 signers (20 deaf; 26 hearing)
	real objects	rruits & vegetables: 20 signers (deaf) Materials: 18 signers (deaf) School: 4 signers (2 deaf; 2 hearing)
other	memory	3 triads 7 dyads
	Sentence Repetition Task (pilot)	38 signers (13 deaf; 25 hearing)
	expert Interviews	3 expert interviews

The Kata Kolok Child Signing Corpus (KKCSC) comprises longitudinal video footage of hearing and deaf signing children who acquire Kata Kolok as their first language. Data collection has been initiated in 2007 by Connie de Vos and facilitated by I Ketut Kanta. Since 2015, I have managed and extended further data collection together with local research assistants Ni Made Dadi Astini and Ni Made Sumarni. Both deaf research assistants are responsible for data collection. Find an overview of recording sessions in Table 2-2.

Table 2-2. Overview of Kata Kolok Child Signing Corpus as of July 2021.

Focus child	Corpus code	Gender	Hearing status	Hearing status parents (mother; father)	Siblings	initial recording	Age range covered
P3	Child2	female	deaf	deaf; deaf	deaf; older (P1, P2)	1;11	1;11-7;11
SS	Child1	male	deaf	deaf; deaf	deaf; older (SY) + deaf; older (DD) + hearing; older	2;0	2;0-8;4
KM	Child5	female	deaf	hearing; hearing	N/A	5;6	5;6-5;11
CSA	Child6	female	deaf	deaf; deaf	deaf; younger (half-sibling; CSC)	0;5	0;5-6;9
CSC	Child11	female	deaf	deaf; hearing	deaf; older (half-sibling; CSA)	0;9	0;9-3;1
	Child3	male	hearing	hearing; deaf	hearing; older	0;2	0;2-1;10
	Child4	male	hearing	deaf; deaf	deaf; older	0;0	0;0-0;9
CSN	Child7	male	hearing	hearing; hearing	hearing; younger	2;1	2;1-2;6
CSHM	Child8	male	hearing	hearing; hearing	N/A	0;4	0;4-5;3
CSD	Child9	female	hearing	hearing; deaf	hearing; younger (CSP)	1;1	1;1-4;5
CSS	Child10	male	hearing	deaf; deaf	hearing; younger (CST)	0;9	0;9-4;1
CSW	Child12	male	hearing	deaf; deaf	N/A	0;9	0;9-4;0
CST	Child13	female	hearing	deaf; deaf	hearing; older (CSS)	0;5	0;5-2;10

For all data collected for this dissertation, I collaborated with the local research team. Since this dissertation focuses on the lexicon and phonology, the data that was newly collected from adult signers represent predominately lexical elicitation using picture stimuli (photographs taken in the field and some line drawings/cartoons) and real objects. Two additional types of data were collected: expert knowledge, and a minimal pair memory game. Expert knowledge was elicited either through informal interviews of a mixed group of experts (possibly alongside picture prompts or objects) or through themed conversations where two experts were prompted with a topic. For example, we recorded a hearing priest who is a fluent signer together with a deaf relative, a hearing research assistant and myself to discuss religious vocabulary, videotaped two befriended deaf ladies whose profession at the time was weaving sarongs (traditional religious clothing) while discussing their work in their working environment, and documented a prompted conversation between two generations of deaf women, both of which are mothers, about child care, childhood diseases and their experiences of their respective weddings. The minimal pair memory game consisted of pairs of pictured objects that were thought to be minimal pairs and was played in groups of minimally three participants. In addition, I have collected free conversation particularly among older signers, a pilot of a Sentence Repetition Task aimed at measuring signing fluency with hearing and deaf participants related to the project in Chapter Six, as well as perception and acceptability data related to Chapter Five and Chapter Seven. Data of the minimal pair game and spontaneous data from older signers were archived but not analysed for this dissertation. Data from children participating in the studies for this dissertation stem from the regular recordings within the Kata Kolok Child Signing as well as experimental data from hearing and deaf local children in Chapter Seven.

2.3.4 VITALITY & ENDANGERMENT

Kata Kolok has previously been rated as ‘definitely endangered’, based on a range of different criteria (Webster & Safar 2019). In the past ten years, however, there have been many changes in the community. In this section, I will briefly discuss how recent developments in some of these criteria may affect the language ecology: (i) decreasing number of deaf villagers, (ii) different community-level changes, (iii) decreased seclusion, and, iv) positive attitudes towards Kata Kolok (summarised in Figure 2-9).

The number of deaf children growing up in the village has decreased. After a notable paucity of ten years, two deaf babies were born in 2014 and 2017. Natural fluctuations of this type are known from other communities (Kusters 2010). Nevertheless, both children are female, and due to Bengkala’s paternal lineage, it is unclear whether they will remain in the village throughout their childhood or settle in Bengkala. Indeed, both deaf children have grown up with a strong signing peer group of hearing children from other deaf families since their birth until early 2020 when the COVID-19 pandemic caused financial hardship that led to the relocation of the children to their fathers’ family compounds in different villages. It is, at this point, unclear how this affects their language development and the future of those two deaf children. More deaf-deaf relationships have resulted in multiple hearing children, mostly due to the fact that one of the deaf spouses stems from outside Bengkala and therefore does not carrying Bengkala’s recessive deaf gene. More deaf children from the same deaf families are, at this point, unexpected and the few hearing families with deaf children have moved to other parts of Bali or even left the island. In short, we simply do not know whether the genetic transmission and occurrence of deafness in the community as measured by Winata and colleagues (1995) are still representative today, and whether the number of deaf children will start to increase again or continue to decrease in the future. As a consequence, the implications for the number of new fluent hearing signers are unclear as well.

Rapid demographic, economic, and social changes may affect both the internal balance of the community and the language ecology. First, the economic benefit from the thriving tourism seems to encourage a shift away from traditional economic models and towards tourism or employment in a new airport project in the North of Bali. Both of these aspects are also likely to bring along migrant labour. While deaf-oriented tourism increases language contact with other sign languages and may encourage code-switching to accommodate to visitors, work migrants are unlikely to acquire Kata Kolok because they will not be working with the deaf. Nevertheless, the global pandemic has put a hold to these developments with a rapid drop-off of tourism, leading to financial shortages among certain (deaf) villagers and demonstrating the fragility of the ecology.

Another significant change is the increased mobility of villagers, which has led to intensified contact with the wider Indonesian deaf community and growing sign bilingualism. Crucially, this concerns exclusively the deaf, not the hearing signers. As pointed out by Nonaka (2012) for a signing community in Thailand, and by Lanesman and Meir (2012) for a minority of deaf Jewish Algerians in Israel, there is little motivation for hearing signers to learn a national sign language. Hearing signers may become the guardians of the local sign language as the linguistic repertoires of hearing and deaf villagers gradually diverge. With the current developments, a similar scenario is at least possible for the case of Kata Kolok as well.

Nevertheless, some factors act positively on Kata Kolok's vitality. Firstly, villagers have always had positive attitudes towards Kata Kolok (Hinnant 2000; Marsaja 2008; de Vos 2012b). This is reflected in the diverse social, cultural, and linguistic adaptations the community has undergone since the first occurrence of deafness in the village (Marsaja 2008). Media attention facilitated the popularity of the deaf community across Indonesia, which might even enhance the prestige of Kata Kolok. Secondly, Kata Kolok has been relatively well documented in the past; the two sizeable corpora that were created in close collaboration with deaf and hearing community members document the language use among adult signers (Kata Kolok Corpus) and first language acquisition (Kata Kolok Child Signing Corpus). Thirdly, although Kata Kolok is not recognised by the government, it serves as language of instruction in the local primary school and soon in a hub for inclusive secondary education. In addition, the village administration has taken deliberate action to increase the number of hearing signers in the village: Kata Kolok classes are planned for Bengkala's elementary school that does not include any deaf pupils. Both actions will increase the number of Kata Kolok signers, yet all of them are hearing or deaf second language learners.

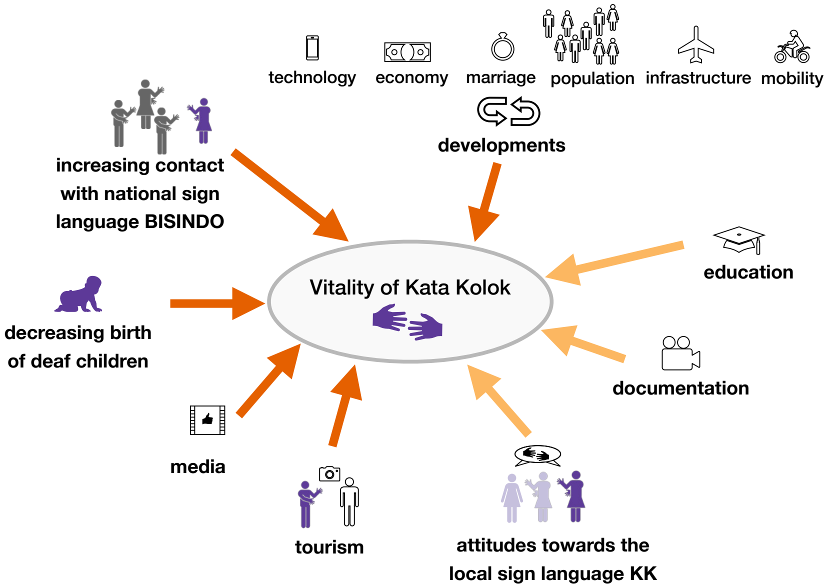

Figure 2-9. Recent developments affecting the language vitality of Kata Kolok. Created using Apple software Keynote; sign language symbol by J. Vogel. Purple figures represent villagers, light shade mark hearing signers, dark shade deaf signers; arrows in dark orange represent predominately negative influences, light orange positive ones (in this context).

2.4 LINGUISTIC STRUCTURE: RECAP OF RECENT STUDIES

With two sizeable corpora, Kata Kolok is one of the most extensively documented and studied micro-community sign languages. In the following section, I briefly summarise different aspects of the linguistic structure of Kata Kolok, focusing on recent studies. Note that the community is experiencing growing interest also from other disciplines, in particular anthropology (e.g., Breau 2020; Moriarty 2020).

One of the most well-known characteristics of Kata Kolok is the use of an absolute frame of reference (Levinson 2003; de Vos 2012b). In spoken Balinese, speakers may use the cardinal directions West, East, South, or North to refer to locations for example on the body (Mead & Bateson 1942). Similarly, Kata Kolok signers deploy real world locations in their signing (de Vos 2012b). Specifically, pointing may be directed towards the actual or habitual location of the referent and specific signs may be anchored to the real location so that their form changes according to where the signer is located and what direction they are facing. For example, de Vos (2012b: 280ff) asked a participant to retell the story of an accident between a person on a motorbike and a dog twice, once facing West and once facing North (Figure 2-10). Notably, the signer modifies her signing of how the motorbike and the dog were positioned and moved toward each other according to real world locations.

Figure 2-10. Illustration of retelling an accident between a motorbike and a dog. Signer faces West in Recording 1 and North in Recording 2. Images adapted from de Vos (2012b: 273–274). [Reproduced with permission from Connie de Vos]

Related to the use of space are classifier predicates (Marsaja 2008: 172ff; Kimmelman et al. 2019). While Marsaja's analysis remains on the level of showing that different types of classifiers commonly attested in other sign languages are used in Kata Kolok as well (namely size and shape classifiers, whole entity classifiers, handling classifiers), Kimmelman and colleagues (2019) find that, like in NGT, German Sign Language and Russian Sign Language, Kata Kolok exhibits canonical mappings of classifier types and argument structure; whole-entity classifier predicates occur most commonly in intransitive contexts and handling classifier predicates are used only in transitive contexts. Thus, besides some language-specific differences, classifier systems show great crosslinguistic similarities.

Negation has previously been described as typologically unique in Kata Kolok; Marsaja (2008) claims that signers exclusively rely on a manual negator to express negation. In a small sample of conversational study from three generations of signers, Lutzenberger (2017) finds that no single default negator becomes obvious; the manual negator NEG and the negative headshake are both used frequently. Most often, signers combine the two markers whereas a substantial portion of the data included either the manual negator only or the negative headshake only. While there is some indication that the negative headshake grammaticalizes among younger generations of signers, recent studies on negation in other sign languages revealed more variation in the results when using spontaneous data. For both NGT (Oomen & Pfau 2017) and for Australian Sign Language (Auslan; Johnston 2018), more variation than previously reported has been found. While this may indicate leaps in the established typology of sign language negation, it suggests that increased ecological validity of the data (i.e., naturalistic language data) co-occurs with higher degrees of variation.

Putri (2019) investigates a novel aspect of Kata Kolok morphology, namely reduplication of movement. The data in Putri's study stem from three deaf signers but the method of data collection remains unclear. Putri finds five types of contexts in which reduplication is used: (i) phonological repetition of movement in lexical signs such as in TALK, (ii) aspectual repetition of movement such as in the signs DRINK or COUGH, (iii) plurality (in nouns), iv) intensification (in verbs), v) pace of repetition to distinguish temporal signs as in A-LONG-TIME-AGO versus GRADUALLY. More studies and more data in this domain are needed to extend this line of research.

In the lexicon, Kata Kolok shows low lexicalisation in basic vocabulary such as colour terms and kinship signs (de Vos 2011; 2012b). Specifically, Kata Kolok signers rely on four conventionalised colour signs namely BLACK-1, WHITE-1, RED-1 and GRUE-1A (GREEN-BLUE). For other colours, signers tend to name prototypical objects, e.g., banana to refer to the colour yellow, or use a conventionalised searching behaviour followed by pointing to an object of the colour that is available in the environment, e.g., a yellow slogan on someone's t-shirt (de Vos 2011). Kin relations are expressed with a similarly small paradigm. Kata Kolok signers use signs for GRANDPARENT, FATHER, MOTHER-1, and OFFSPRING-1. The signs GRANDPARENT and OFFPSRING may be combined with the sign for FEMALE or MALE to further specify the gender of the referent. In addition, a general sign, RELATIVE, is used to indicate some degree of relatedness between referents. The data collected in the Kata Kolok dataset within the lexical database Global Signbank (Crasborn et al. 2020) may suggest a few more specific terms for offspring; children may be referred to with different signs alongside their age, e.g., BABY-A for a newborn, BABY-C for an infant, or BABY-D for a toddler (see Figure 2-11).

BABY-A BABY-C BABY-D

Figure 2-11. Kata Kolok variants to refer to a small child: BABY-A, BABY-C, and BABY-D.

Further, the Kata Kolok lexicon has been reported to exhibit considerable polysemy (Putri et al. 2015; 2017; Putri 2018; Putri & Sutjaja 2019). Putri and colleagues (2015; 2019) conduct several qualitative analyses of the meaning of signs related to religious ceremonies that they elicited from a small sample of signers. They find variation in the lexicon as well examples of polysemy and evidence of homonyms across their sample. For example, according to Putri (2015: 44), two variants are used to express the cultural tradition of *ngaben* (cremation ceremony), one related to fire and one with the hands next to the head; signs for 'must/have to', 'should' and 'remember' appear as homophones (THINK); the polysemous sign NOT-YET is used to express both 'not-yet' and 'later'. The precise pressures driving these ambiguities remain at this point unclear.

Among other aspects of Kata Kolok grammar that remain undiscussed in this dissertation, Marsaja (2008) provides an initial investigation of basic building blocks, i.e., sublexical components, of Kata Kolok signs. Marsaja's (2008: 125–157) analysis centres around the four parameters 'handshape', 'location', 'movement' and 'orientation'. The analysis is based on 1,171 sign utterances collected from semi-spontaneous signing, elicited as prompted by cameos or topic-guided narratives. It remains not entirely clear which signers contributed the data.

Marsaja (2008) identifies 28 distinct handshape primes and classifies them "according to the roles they play in the phonological system" (Marsaja 2008: 131) as basic, regular and restricted. More specifically, Marsaja opts to combine formational properties (ease of articulation), frequency in the lexicon, and ease of perception (perceptual distinctiveness) to determine the status of handshapes in his study. Based on these criteria, six handshapes (*B*, *5*, *curved B*, *curved 5*, *A* and *G*) are classified as basic, sixteen handshapes (*loose fist*, *tight fist*, *thumb hand*, *X*, *U*, *V*, *curved V*, *W*, *4*, *I*, *L*, *pinched hand*, *Bo/F*, *O*, *bC*, *C*) as regular, and six handshapes (*bunched hand*, *Y*, *T*, *R*, *E*, *extended middle finger*) as restricted. Note that in addition to these handshapes, Marsaja identifies a few handshapes as "derivatives" of basic handshapes (e.g., *bent B*), and therefore excludes them from his study.

Kata Kolok signs include 28 location primes that are predominately on the body (Marsaja 2008). Location primes are characterised by an extended signing space and uncommon locations. Specifically, Kata Kolok signs are produced in locations ranging from the above the *head*, e.g., RAIN, to the *hip*, e.g., INJECTION, and to both sides of the *torso*, e.g., JANGER-KOLOK. Sign languages used in the Global North primarily use locations in the rectangle between *forehead* and *chest* at shoulder width (Battison 1978; Klima & Bellugi 1979). Moreover, some of the locations attested in Kata Kolok signs are claimed to be rare in macro-community sign languages. Specifically, Marsaja (2008: 141) claims that locations such as the *hip*, the *tongue*, the *nail* and the *teeth* are unique to Kata Kolok (and other village sign languages). In Kata Kolok, the sign SALT-1 is produced at the protruded *tongue*, the sign WHITE-1 at the exposed front *teeth* and the sign GARLIC-1 on the thumb *nail* (Marsaja 2008: 143–144).

Orientation primes describe the palm of the hand and the orientation of the fingers and/or the thumb may become relevant in some Kata Kolok signs such as COW and GUN (Marsaja 2008: 148). He reports six palm orientations that are commonly attested in other sign languages as well: *palm up*, *palm down*, *palm in*, *palm out*, *palm contralateral*, and *palm ipsilateral*.

Twenty-nine movement primes, describing the direction and/or the path of movement, are classified into four types: path movement, path movement with internal movement, internal movement, and a mixed category (Marsaja 2008). While internal hand movement includes changes in handshape and orientation such as *opening* and *closing* or *flexions* of the wrist, path movement describes a displacement of the hand between two locations. The miscellaneous category includes different types of contact, such as repeated or stationary touch.

Lastly, Marsaja (2008) stresses the fundamental role of nonmanuals in Kata Kolok phonology. He identifies four types: facial expressions, body posture, oral noise or mouthing, and other parts of the body. While facial expressions can function as independent signs, i.e., as a distinctive or obligatory element of a sign (Marsaja 2008: 153ff), body posture is often used affectively or as grammatical marker (Marsaja 2008: 156f.). Although Kata Kolok does not use mouthing, mouth actions appear frequently but details about frequency, distribution, and optionality remains to be explored (Marsaja 2008: 157).

To summarise this section, I have presented an overview of recent research on the structure and grammar of Kata Kolok. While Marsaja (2008) presents the publication with the largest breadth of topics, other research has contributed more in-depth studies of focused areas such as morphosyntax, morphology, the lexicon and phonology.

2.5 FIELDWORK

Fieldwork is an essential means of data building in linguistics, especially in language documentation. This dissertation is heavily based on fieldwork. Throughout my PhD, I aimed to conduct fieldwork in a respectful manner. In the following section, I reflect on and position myself in the context of my research, explain details about the community involvement, and the procedure for obtaining informed consent in this dissertation project.

2.5.1 CRITICAL REFLECTION

In this section, I take the opportunity to position myself in the context of my research. I am a white hearing woman who started acquiring her first sign language (German Sign Language, DGS) at the age of 19 at University of Hamburg. Driven by curiosity, I have engaged actively in the deaf community in Hamburg, made deaf friends, and quickly improved my signing skills. Then, I pursued several study or work occasions abroad, learning different sign languages and getting to know and befriending different deaf communities and researchers from different countries.

I was first introduced to the Kata Kolok community during an internship with Connie de Vos. Accompanying her on a fieldtrip to Bengkala in 2014, I was immediately welcomed with open arms. Everyone was eager to include me in activities, village traditions, religious ceremonies and clan festivities. I enthusiastically participated in many events and preparations – to the joy and amusement of the entire village – which created strong personal bonds between me and the villagers. Quickly, hearing and deaf villagers would guide me naturally through the appropriate behaviour, e.g., during a ceremony ritual, and, under laughter, integrated me in their preparations. The introduction to the community through Connie certainly helped me to gain the villager's trust and open-heartedness quickly and paved the way for all subsequent fieldtrips I undertook independently. At the same time, it meant that I was at times met with expectations that I had yet to fulfil – or demonstrate that different people may handle things differently. Eventually, the villagers never missed a chance to point out to me similarities and differences in our behaviour or paint out my future to me, at times as a mirror-image of Connie's path.

Although having been introduced to the community through Connie has softened my path, I believe that my dedication to learning the villagers' languages and my willingness to build lasting friendships has considerably contributed to making my fieldwork a success on both sides. Developing and improving communication skills has always been one of my main goals during the fieldtrips. With the help from deaf and hearing villagers, I quickly picked up Kata Kolok to the degree of being able to participate in narratives and jokes and I received compliments from both hearing and deaf signers. I did my best to also acquire basics in Balinese and Bahasa Indonesia to be able to do small talk with hearing villagers with lower or without signing fluency. These efforts to share the villagers' languages were always highly appreciated – despite the limited success in Balinese and Bahasa Indonesia – and helped us to build lasting positive relationships. I am grateful that this path was patterned with curiosity and joyful experiences on both sides.

My status as a hearing person appeared to be of less importance to the deaf people than to the hearing villagers but was never a major topic of discussion. For the deaf villagers, all that counts is my fluency in Kata Kolok. Often, they even bragged with how well I sign and find joy in telling visitors that I belong to them. Hearing villagers may at times be confused about whether or not I am deaf or hearing due to the fact that I mostly sign, and are delighted and encouraged when they find out that I also speak – which they immediately and joyfully follow up on by making me attempt some words in Balinese or Bahasa Indonesia.

I have worked together very closely with three research assistants since my first fieldtrip in 2014. Both professionally and personally, I Ketut Kanta, Ni Made Dadi Astini and Ni Made Sumarni have become dear friends and in many ways crucial to my fieldwork and my research in general. Beyond the interpersonal connection established with all three of them in their own ways, we have always enjoyed the exchange of knowledge and skills both ways. This may be through discussions about what signs are used by which signers and the meaning of different child productions that I failed to identify and interpret, through increasingly gaining computer literacy and being in charge of managing data collection, or discussion of cultural differences. In short, the team of research assistants have been one of the most important things of, about, during, and after fieldwork, both professionally and personally.

Throughout all the fieldtrips I conducted independently, I have resided in the village. While I spent the first stay in the family compound of our deaf research assistant Ni Made Dadi Astini, I lived within the family compound of our hearing research assistant I Ketut Kanta for all three stays during my PhD. There are several reasons for this decision: first, living in the village allows to be integrated in daily life and easily accessible; second, I aimed not to disrupt the social balance between deaf villagers by choosing one family over another. Given that I was planning on spending the majority of my time in the village with deaf community members, staying with a hearing family without any deaf family member in the village was a chance to engage with and pay my respect to hearing villagers beyond the deaf families and to gain different insights; third, Connie de Vos as well as John Hinnant, another researcher, had stayed in this family compound at a previous occasion and the room was not currently used. With the decision to stay in a hearing family compound with low(er) signing skills, I agreed to being exposed yet available to the village community 24/7, i.e., my doing or not-doing was being surveyed, observed and discussed at all times. Nevertheless, it also meant inclusion and belonging; I was part of the family compound and thus did what they did (e.g., for ceremonies), was involved in duties and became part of their family.

Last but not least, I am a white foreigner. While adults are fairly familiar with white people by now, this fact persisted to be discussed extensively with – and probably without – me. This was expressed in the comparison and judgment of skin tone, medical explanations of my vegetarianism, or the examination and classification of pimples, scratches and mosquito bites – much of it is attributed to my whiteness. However, these conversations have always occurred on a very familiar, physical level and I am convinced that my engagement in every aspect of life, e.g., helping to mind children, do dishes and washing, assist to prepare offerings or cook my own meals, was so well received because it diminished some presupposed differences.

Although I would like to think that I am treated as an equal, the foreigner-mark occurs most strikingly during visits of important people, e.g., the boss of the oil company Pertamina, or other foreigners, and with children. In the strongly hierarchical traditions of Balinese culture, guests have a high rank and thus, may serve themselves to food first. During important events, I was often expected to serve myself with the visitors instead of with the locals. Children, on the other hand, made the foreigner-effect even more explicit; I experienced reactions ranging from fear to curiosity and joy. Luckily, persistence and patience as well as a great amount of soap bubbles helped to build up trust and confidence that I was trustworthy.

To sum up, the young and old villagers and I have created and curated wonderful and strong relationships that cause a feeling of belonging (for me) despite the fact that I am and always will be the white foreigner who walks everywhere, signs but does not speak much and waves every time when someone calls out her name.

2.5.2 COMMUNITY INVOLVEMENT

This research has been conducted with the utter respect and devotion to the community of deaf and hearing villagers of Bengkala. I have always aimed to involve community members in as many stages of my research as possible and connect with the deaf and hearing villagers on a personal level.

Both on a personal and an academic level, I tried to balance attention and personal connections with individual villagers. For this reason, I decided to stay in the village during all my field visits and established personal bonds with hearing and deaf community members individually as well as on a group-level. The different projects included in this dissertation allowed me to expand the personal connections to a wider range of villagers and especially the ones who are hearing. For the data collected for Chapter Three and Chapter Four, I worked together with hearing research assistants and hearing signers and for the project in Chapter Seven, I got the chance to network more with non-signing villagers, that is parents of the non-signing children who participated in the study. Since both, deaf and hearing individuals have expressed their appreciation of spending time together, particularly in their respective homes, I have made sure to pay visits and distribute time with individual families in a balanced way. During the periods that I was not in the field, I stayed in touch with many villagers using video chats and pictures as managed by the research assistants. The regular visits over the past five years allowed to create and strengthen personal relationships with large parts of the village community.

For data collection, the focus on the diversity of the lexicon (Part I) allowed me to involve a great number of deaf (and hearing) people in the project as informants. Although the main focus remained on deaf signers for most projects, except Chapter Three and Chapter Seven, balanced and justified sampling of deaf signers always had high priority. Since inviting all deaf people for all projects is not feasible, I made sure to discuss with my research assistants to invite a subset of deaf members from the same generation who live in the same household, and to do this across all households for which this applies. The involvement of hearing people as informants in this dissertation is most evident in Chapter Three and Chapter Seven. Luckily, we were also able to engage two young hearing villagers as part-time research assistants for those projects. In short, I tried to distribute time and attention spent with particular individuals beyond our research assistants equally in order to pay my respect to them and to be a friend.

Since my first fieldtrip in 2014, I have worked in close collaboration with three research assistants. I Ketut Kanta is a fluent signer in his 60s who is hearing and has been working with and as an advocate for the deaf community members for a long time. He also worked as main research assistant during previous projects with Connie de Vos and Ulrike Zeshan. My communication with I Ketut Kanta is mostly in English and Kata Kolok. Ni Made Dadi Astini, a deaf native Kata Kolok signer in her 20s, has been involved in projects of Connie de Vos in previous years and was my first field-site buddy of a similar age to myself. At the time of my PhD, Ni Made Dadi Astini was working in Denpasar which restricted her availability to join me for research related tasks to some extent. Nevertheless, upon her return to the village, we recruited and employed her as a teacher at the local deaf unit. Ni Made Sumarni, also a deaf native Kata Kolok signer in her late teens, has joined the team of research assistants with the beginning of my PhD project. I trained her in data collection and transcription and she has worked with me intensively throughout my PhD project for data collection, data processing, data transcription and cross-checking obtained data. Both Ni Made Dadi Astini and Ni Made Sumarni are responsible for collection data within the Kata Kolok Child Signing Corpus. I communicate with both of them in Kata Kolok. Over the course of my PhD, we have transferred a large range of skills and successfully collected a range of different data together: spontaneous conversation, longitudinal child data, lexical elicitation with picture prompts and real objects, experimental paradigm with children.

Last but not least, I was able to make a small contribution to the empowerment of the community through participating in festivities and ceremonies, attending important meetings, supporting the local village government and the educational infrastructure in the village. In this vein, I have delivered multiple small-scale workshops on sign language, language contact, and Kata Kolok to employees of the village head office and the second primary school in the village that does not have any deaf pupils. Moreover, I was able to successfully lobby for our research assistant Ni Made Dadi Astini to join the local deaf unit as a deaf teacher at the end of my last fieldtrip in late 2019. Since then, she has been flourishing in teaching the deaf students in her native language and growing into her new role.

2.5.3 INFORMED CONSENT

For all studies, informed consent was obtained. Consent forms were translated into Bahasa Indonesia and contained information about the specific project, information about storage and usage of data as well as conditions of publishing the data. Signatures were done through writing or thumb print according to the participants' preferences. Each participant was reminded that they may revert their consent at any time and received a copy of the consent form. The procedure of obtaining informed consent was repeated each fieldtrip and videotaped in case of (illiterate) deaf participants. Informed consent was obtained either right before the data session (e.g., in the case of deaf participants who are familiar with the procedure) or several days in advance (e.g., for parents of child participant of Chapter Seven).

In all cases, data collection was preceded by a visit at the participants' home. Following the procedure introduced by Connie de Vos, adult participants and parents of participating children were compensated monetarily for their participation in this research project with the equivalent of a day's salary. Child participants of the longitudinal data collection within the Kata Kolok Child Signing Corpus were compensated with a symbolic monetary gift on their birthday and child participants of the experiment in Chapter Seven received a small toy.

Deaf adult participants were fairly familiar with the form and the procedure from previous research activities with Connie de Vos. Nevertheless, we discussed and explained how this research may differ from previous research while filling the consent form. All discussions with deaf participants were held in Kata Kolok, mostly in company of Ni Made Sumarni and at times also I Ketut Kanta.

Hearing adult participants received the written consent form in Bahasa Indonesia. Due to the various degrees of literacy skills especially across older participants, our team included two young villagers (Putu Someli Pardani and Kadek Anggri Subagia) with command of English who triangulated between written Indonesian, Balinese and English in case of questions or clarifications.

For children participating in Kata Kolok Child Signing Corpus, informed consent was obtained from the parents through a visit to the family's house where I explained the aim and conditions of the long-term recordings in Kata Kolok. In most cases, I Ketut Kanta and the deaf research assistant who was going to conduct the recordings were present during this session as well. For longitudinal recordings, the deaf research assistant who made the recordings was a relative of the focus child.

For children participating in the experiment of Chapter Seven, we followed two different protocols depending on whether or not the child already participated in data collection for the Kata Kolok Child Signing Corpus. For children who already take part in Kata Kolok Child Signing Corpus, we followed the same procedure as with deaf adult participants. Other participants were identified using the medical record for matching birth dates. The selected families were then visited by myself and I Ketut Kanta to explain and demonstrate the task and ask for permission of the parents for their child to participate. In case parents agreed to participate, they received a consent form in Bahasa Indonesia and filled it while we were still present in order to answer all potential questions.

2.6 CONCLUDING REMARKS

Kata Kolok may be one of the most well-studied micro-community sign languages to date. The longstanding history of research on different aspects of Kata Kolok grammar make this language an excellent candidate for further typological studies, for example, an in-depth study of phonology and its acquisition as provided in this dissertation.

Micro-community sign languages exist in a fragile language ecology and rapid changes in the language environment may have great impact on the vitality and persistence of the language (Nonaka 2012; 2014; Mudd, de Vos & Boer 2020). While I have suggested that recent changes and developments are likely to redefine the community of Kata Kolok signers, including a growing satellite community of signers and increasing sign bilingualism among deaf villagers, the long-term effect of these changes are yet to be seen. Up until today, Kata Kolok remains in use on a daily basis among deaf and hearing villagers and continued interest from different academic disciplines ensure documentation of the cultural heritage of the community.

PART ONE

VARIATION

CHAPTER THREE

THE EFFECT OF SOCIOLINGUISTIC FACTORS ON VARIATION IN THE KATA KOLOK LEXICON

Chapter adapted from: *Mudd, K., Lutzenberger, H., de Vos, C., Fikkert, P., Crasborn, O., & de Boer, B. (2020). The effect of sociolinguistic factors on variation in the Kata Kolok lexicon. Asia-Pacific Language Variation, 6(1), 53–88. https://doi.org/10.1075/aplv.19009.mud.*

AUTHOR'S NOTE

This paper was designed, carried out and written as a collaborative project with Katie Mudd from Free University of Brussels, with Katie Mudd and Hannah Lutzenberger as leading authors. The idea for the study as well as the study design was done by Katie Mudd and Hannah Lutzenberger, with feedback from Connie de Vos. Data collection was carried out by Hannah Lutzenberger together with local research assistants. Data processing was done by Hannah Lutzenberger and Katie Mudd. Transcriptions were done by Katie Mudd in close collaboration between Hannah Lutzenberger. Analyses were conceptualised by Katie Mudd and Hannah Lutzenberger, with advice from Bart de Boer, and carried out by Katie Mudd. Katie Mudd wrote large parts of the first draft, except the sections on Kata Kolok and data collection which were written by Hannah Lutzenberger. All co-authors gave feedback on the first and on the final draft. Hannah Lutzenberger was greatly engaged in editing and revising the manuscript at several stages before publication.

3 THE EFFECT OF SOCIOLINGUISTIC FACTORS ON VARIATION IN THE KATA KOLOK LEXICON

ABSTRACT

Sign languages can be categorised as shared sign languages or deaf community sign languages, depending on the context in which they emerge. It has been suggested that shared sign languages exhibit more variation in the expression of everyday concepts than deaf community sign languages (Meir et al. 2012). For deaf community sign languages, it has been shown that various sociolinguistic factors condition this variation. This study presents one of the first in-depth investigations of how sociolinguistic factors (deaf status, age, clan, gender and having a deaf family member) affect lexical variation in a shared sign language, using a picture description task in Kata Kolok. To study lexical variation in Kata Kolok, two methodologies are devised: the identification of signs by underlying iconic motivation and mapping, and a way to compare individual repertoires of signs by calculating the lexical distances between participants. Alongside presenting novel methodologies to study this type of sign language, we present preliminary evidence of sociolinguistic factors that may influence variation in the Kata Kolok lexicon.

KEYWORDS

Kata Kolok; lexical variation; shared sign language; sign language; sociolinguistics

3.1 INTRODUCTION

Linguistic variation occurs in spoken and sign languages (Valli & Lucas 2000). In sign language research, a prominent topic of study has been variation at the lexical level, specifically how signers of various sociolinguistic groups systematically use different lexical variants. Yet unanswered is how the sociolinguistic setting and use of a sign language may affect lexical variation.

Sign languages have emerged in a variety of contexts. For instance, sign languages have emerged in communities of different sizes, with different proportions of deaf and hearing signers and with different causes (genetic or other) of deafness (Meir et al. 2010). The context of sign language emergence has been claimed to affect its linguistic properties, such as the degree of lexical variation in a language (e.g., Meir et al. 2012). Based on the context of sign language emergence, sign languages can be classified as deaf community sign languages or shared sign languages (Meir et al. 2010; Nyst 2012). Deaf community sign languages account for the majority of sign languages and are used predominantly by a large and dispersed group of deaf individuals, most of whom are born to hearing parents (Mitchell & Karchmer 2004; Meir et al. 2010). Shared sign languages emerge spontaneously due to a high incidence of hereditary deafness and are shared by deaf and high proportions of hearing community members (Kisch 2008). Shared sign languages are found in esoteric communities, characterised by a culturally homogeneous group, with the majority of individuals born within the community (Wray & Grace 2007). It should be stressed that there is considerable diversity in these broad categories, and when possible, it is more informative to consider the makeup of individual sign language communities.

The majority of research into variation has focused on the linguistic properties and sociolinguistic features of deaf community sign languages, in which linguistic variation is often the result of schooling practices (Meir et al. 2010). In the United States, research has focused on black and white American Sign Language (ASL), which are varieties of ASL that have emerged due to race-based school segregation (McCaskill et al. 2011). In Dublin, gender-based school segregation led to a gendered Irish Sign Language lexicon, to the point of obscured communication between women and men (LeMaster 2006). In addition, age has been shown to condition variation in several sign languages, including ASL (Lucas et al. 2001), Australian Sign Language (Auslan) (Schembri et al. 2009) and British Sign Language (BSL) (Stamp et al. 2014). In BSL, younger signers were found to use fewer standard lexical variants (see Section 3.1.1, for an explanation of standard variant selection) in their region than older signers, suggesting that leveling (i.e., a reduction of variation) may be occurring, possibly due to the closure of deaf schools (Stamp et al. 2014). In ASL (Lucas et al. 2001), New Zealand Sign Language (NZSL) and Auslan (Schembri et al. 2009), region has been shown to influence sign variation. Furthermore, in a study of Indonesia's deaf community sign language, BISINDO, Palfreyman (2019) finds variables in the grammatical domains of completion and negation that are influenced by region, age and gender. In Japanese Sign Language, language variation is found in (i) cardinal numbers where for some numbers formal variation appears to be predicted by age and/or region, and (ii) kinship where younger signers tend to omit a consanguineal marker that older signers used to indicate blood relations (Sagara 2016). Finally, Sagara and Palfreyman (2020) compare the

numeral systems of Japanese Sign Language and Taiwan Sign Language and find that region and age influence variation.

A recurrent claim is that inter- and intra-signer lexical variation is more prevalent in shared sign languages than in deaf community sign languages, though the amount of lexical variation has not been systematically compared on a large scale across these categorisations of sign languages (Meir et al. 2010; 2012). For instance, it has been observed that there is more lexical variation in the young, shared sign language Al-Sayyid Bedouin Sign Language (ABSL) than in the young, deaf community sign language Israeli Sign Language (Meir et al. 2012: 276). Both of these sign languages emerged around the same time, in the 1930s (Meir et al. 2012).

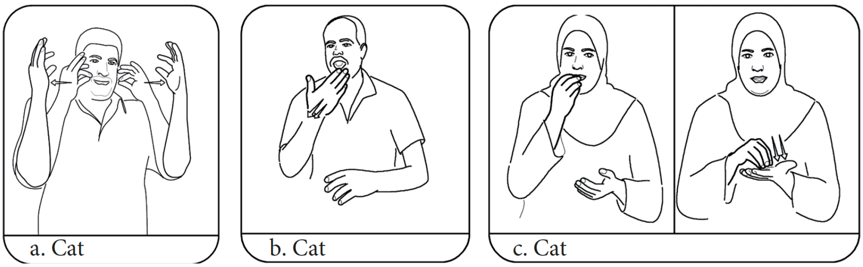

Figure 3-1. Three lexical variants for cat in ABSL (figure from Meir et al. 2012: 276). [Reproduced with permission from Wendy Sandler]

In ABSL there is variation in everyday concepts such as onion, morning, tomato and cat. For instance, as shown in Figure 3-1, there are three signs for cat each with a different iconic origin: a cat's whiskers, a cat meowing and a cat eating (Meir et al. 2012). In addition, a comparison of lexical variation in the shared sign language Providence Island Sign Language (PISL) and the deaf community sign language ASL further illuminates differences in the amount of lexical variation which may be characteristic of these two types of sign languages. In a lexical elicitation study with five signers, Washabaugh (1986) found that 70% of everyday concepts have more than two variants, providing preliminary evidence that PISL is not highly conventionalised. Washabaugh (1986) conducted the same study with five ASL users and found that a minority of concepts elicited more than two variants (28.6%). Hence, there exists some evidence that shared sign languages may exhibit more lexical variation and less conventionalisation than deaf community sign languages. As stated, there are significant differences between sign languages within each category; in comparing the two mentioned shared sign languages, one distinguishing factor is the social structure of the communities, namely the density of signers: for the PISL community is sparser than the ABSL community. Lexical variation in PISL and ABSL provide preliminary evidence of heightened variation in shared sign languages, but this finding should be interpreted with caution considering the small sample sizes in these studies and the considerable demographic variability in the category of shared sign languages.

Why might shared sign languages exhibit more variation than deaf community sign languages? The noted relationship between linguistic properties and community size is not new, with researchers positing that smaller communities tolerate more linguistic variation than large communities (e.g., Wray & Grace 2007; Trudgill 2015). Specifically for shared signing communities, Meir et al. (2012) consider the shared social and psychological information, or common ground, to alleviate the pressure for linguistic convergence. Meanwhile, for deaf community sign languages, it is beneficial for the language to exhibit a high degree of conventionalisation because of the large number of communicative partners, including strangers (Meir et al. 2012), and because these languages are often formally taught. Previous computational models showed that smaller communities should converge more quickly on linguistic features (e.g., Baronchelli et al. 2006). However, a recent computational model by Thompson, Raviv, and Kirby (2019) suggests that the high degree of variation present in smaller populations can be accounted for by memory limitations; in small, close-knit populations, a higher degree of variation is tolerated because individuals can remember others' idiolects, as posited by de Vos (2011). Hence, one may hypothesize that the amount of lexical variation present in shared sign languages is in part related to the type of community structure.

Previous studies of variation in shared sign languages have sought to quantify the amount of lexical variation present in the language, but it remains unanswered how this variation within the language is conditioned. Are shared sign languages and deaf community sign languages conditioned by the same social variables? As these categorisations are extremely broad, it is more informative and more precise to ask which features of a signing community shape lexical variation, and what lexical dispersal patterns in young sign languages can tell us about the processes that lead to their emergence. In the present study, we conduct one of the first in-depth investigations into how the lexicon of a shared sign language – specifically, Kata Kolok – is shaped by sociolinguistic factors.

3.1.1 METHODOLOGICAL ISSUES

In order to study lexical variation, researchers have commonly used the method of sublexical parameter comparison, in which contrastive features such as 'location' and 'movement' are recorded as identical, similar or different to the features of other signs (e.g., D. McKee & Kennedy 2000). Hence, the majority of previous research has focused on identifying phonological differences within the lexicon. An early study using this approach investigated lexical variation in five signers and four dictionaries from different areas to confirm that Mexican Sign Language is a single language (Bickford 1991).

Later studies compared the recorded phonological features to an identified standard variant using multiple logistic regression analysis. For instance, in a study of lexical variation in BSL, Stamp et al. (2014) determine a standard variant for each region using two sources: (i) variants from BSL teaching resources and variants chosen in an earlier BSL study (Woll et al. 1990), and (ii) variants produced by elderly signers that were confirmed to be the standard variant by a local deaf community fieldworker in each region. Subsequently, the lexical variant used by each participant in a given region is compared to the lexical variant deemed as the standard variant for that region. The comparison between the produced variant and the standard variant is coded as binary across all participants, recording if the produced variant is the same as or different from the standard variant.

This type of analysis is not well suited to study lexical variation in shared sign languages for several reasons. First, sublexical parameter comparison requires the identification of phonological parameters in a sign language. To date, there have not been many in-depth studies of the phonology of shared sign languages. There has been a study of the phonology of ABSL, in which authors claim that it lacks minimal pairs and conclude that phonology is incipient in ABSL (Israel & Sandler 2011). For Kata Kolok, an investigation into the possibility of contrastive features, and exactly which features are contrastive, is currently underway (Lutzenberger 2020). Second, it is not straightforward to identify a standard variant for Kata Kolok because it is not clear that a set of lexical items is associated with a particular group of signers, a necessary step if following the methods of previous lexical variation studies that use multiple logistic regression analysis. Regional and age-related changes have enabled the categorisation of signs in deaf community sign languages, but such changes are not immediately relevant in the Kata Kolok community. In previous studies, region was considered on a much larger scale (e.g., different regions in Australia and New Zealand in Schembri et al. 2009); the Kata Kolok community is much smaller geographically. As all Kata Kolok signers live relatively close together and frequently interact, regardless of their age, age-related differences are not anticipated. Finally, multiple logistic regression requires a binary comparison; previous studies compared a standard variant for a given group to the variant produced by participants in the study. Hence, this statistical analysis does not capture the full degree of variation present in a language if it has more than two variants per lexical item. As previously stated, a high degree of inter-individual lexical variation is observed in shared sign languages, such as PISL (Washabaugh 1986) and ABSL (Meir et al. 2012), so limiting the analysis to a binary variable may yield an unwanted reduction in our analysis of lexical variation. In short, the method of sublexical parameter comparison requires the identification of contrastive phonological units. Sublexical parameter comparison could potentially be analysed in a number of ways. Previous studies have used a multiple logistic regression which is not an appropriate analysis for studying lexical variation in communities with a large amount of inter-individual variation.

Notably, several small-scale studies have investigated lexical variation in shared sign languages without using sublexical parameter comparison. Osugi, Supalla, and Webb (1999) studied lexical variation in an "assimilated signing community" on the island of Amami O Shima in southern Japan. They used a lexical elicitation task with three groups of participants, based on geographical proximity, meaning that social interactions were frequent within each group but not necessarily across groups. Each group was lexically internally consistent to varying degrees (Osugi et al. 1999). Furthermore, Reed (2019) studied 12 deaf people living in the Nebilyer/Kaugel region of the rural Papua New Guinea highlands. She calls this group a "regional sign network", which has weak sign ties between individuals in a larger network of predominantly hearing people. To study lexical differences, Reed (2019) identifies variants using sign base comparison, that is, by iconic base. She finds that signers with closer proximity to each other geographically are also more lexically similar. Finally, Hartzell, Ergin, Kürşat and Jackendoff (2019) use the same technique of classifying signs based on iconic prototype to study lexical variation in Central Taurus Sign Language (CTSL). In their study of lexical variation of common objects, fruits and vegetables, CTSL signers show complete conventionalisation on two lexical items, while the other nine lexical items studied range from having two to 13 variants. A notable exception of identifying lexical variants using a sign's iconicity (alongside its form and meaning) in a deaf community sign language is from Konrad's (2013) documentation of lexical structure in German Sign Language (DGS).

In the present study, we devise a methodology that takes into account the underlying iconic motivation and mapping of a sign (see Section 3.2.4), which is similar, if not identical to aforementioned methods which make use of a sign's iconicity. We implement this method to circumvent issues which would have resulted from using sublexical parameter comparison analysed with multiple logistic regression. Instead of an analysis requiring participants' responses to be reduced to a binary variable, we consider the lexical distance between all pairs of participants in our study to see if sociolinguistic factors predict lexical distance.

3.1.2 KATA KOLOK AND ITS LEXICON

Kata Kolok is a sign language that emerged spontaneously in a village community in North Bali, Indonesia, due to a high incidence of hereditary deafness. In a community of 3,032 inhabitants, currently 1.02% are deaf (Lutzenberger in press). The majority of the inhabitants of the Hindu village run small, local businesses or earn their living from daylabor or subsistence farming of crops like cassava, rice, and turmeric. Socially, inhabitants belong to one of the ten village clans (*dadya*). Clan membership of women changes after marriage along patrilineal lineage. Hence, a woman will transfer into the husband's clan through marriage. In the village, deafness has occurred across all village clans (see Figure 3-2).

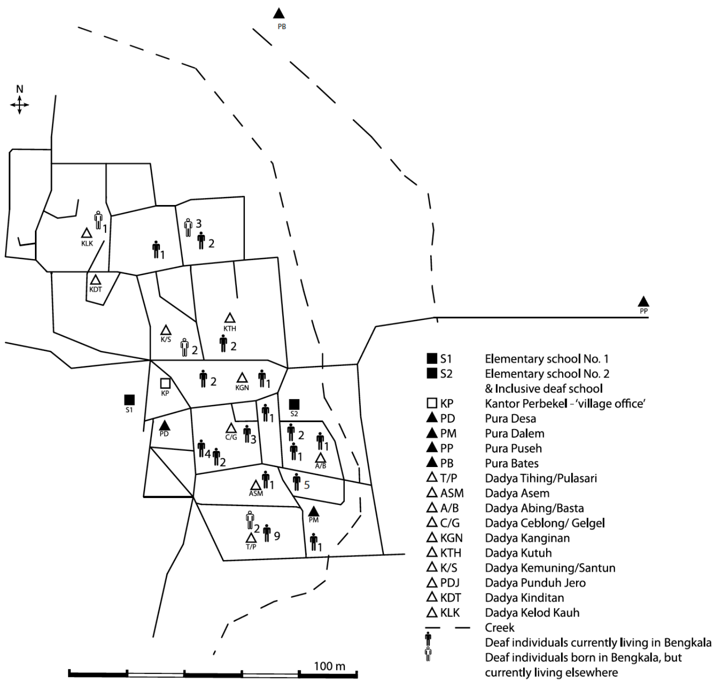

Figure 3-2. Deaf people across the village clans (Figure from de Vos 2012b: 27). [Reproduced with permission from Connie de Vos]

Besides clan membership, family compounds play an important role in determining social interactions. Kin of several generations live together in groups of houses creating a courtyard. These are often used for socializing and communal work, such as preparations of offerings for religious ceremonies.

The emergence of Kata Kolok dates back at least six generations (Winata et al. 1995; de Vos 2012b). Kata Kolok is used in all contexts of daily life among the deaf as well as by a large proportion of hearing signers (de Vos 2012b). Based on a village-wide survey, Marsaja (2008: 96–100) establishes that at least 57% of the village community has signing skills in Kata Kolok. Among the hearing signers, most are of lower fluency and all deaf signers are considered to be fluent signers of Kata Kolok. In addition, there is a gender effect on fluency: more men are fluent signers than women, attributable to social interaction patterns, resulting from the strong patrimonial cultural system which provides more opportunities for men to partake in public activities, leave the home and interact with outsiders than for women (Marsaja 2008).

Having emerged as an isolate, without contact with BISINDO, Kata Kolok shows some typologically unusual patterns, such as an absolute Frame of Reference and an enlarged signing space (de Vos 2012b). In the lexicon, Kata Kolok possesses a strikingly smaller set of lexicalised signs for colour and kinship terminology than the surrounding spoken language, Balinese, yet Kata Kolok has an extensive counting system (de Vos 2012b). De Vos (2012b) takes this as evidence that sharing the same culture does not necessarily lead to linguistic similarity. In a study of colour categories in Kata Kolok, colour terms were elicited using 80 colour chips from the Munsell colour chart (see Majid & Levinson 2007; Majid et al. 2018) from eight deaf Kata Kolok signers, revealing that Kata Kolok signers use four lexicalised colour signs for the basic colours black, white, red and grue, a category combining green and blue shades. In addition, Kata Kolok signers use less conventionalised strategies to describe colours: searching for and pointing to the matching colour in their environment (e.g., on shirts) and referring to a prototypical object of this colour (e.g., banana for yellow). With four conventionalised colour signs, the colour term inventory of Kata Kolok is rather small (Berlin & Kay 1969; de Vos 2011). Spoken Balinese has a fully lexicalised system with more than double the number of colour terms than Kata Kolok (de Vos 2012b) and a preliminary study of colour terms in

BISINDO reports that many colour terms are conventionalised, detailing 11 colour terms which exhibit varying degrees of lexical and phonological variation (Palfreyman 2016a). Clearly, Kata Kolok has not simply adopted the linguistic structures of the surrounding and preexisting environment. Rather, Kata Kolok signers have developed their own system with various degrees of conventionalisation without major external influences.

Kinship terminology in Kata Kolok is more restricted in number of terms and more general in its application of the terms than in Balinese (de Vos 2012b). A corpus investigation was used to identify the four lineal kinship terms grandparent, mother, father, and offspring. To specify and hence to disambiguate the referent, grandparent or offspring can be followed by the signs male or female. Non-lineal relatives are referred to by the sign SAME. With four kinship terms, Kata Kolok does not only have fewer lexicalised terms than spoken Balinese but also is located at the lower end of the size of kinship term inventory spectrum across different languages (de Vos 2012b). Once again, this shows the independent development of structure in Kata Kolok. Limited colour and kinship terminology have been observed in other sign languages emerging in enclaves with high congenital deafness as well, for example in PISL (Woodward 1989), Ban Khor Sign Language in Thailand (Nonaka 2004), and Adamorobe Sign Language in Ghana (Nyst 2007), and may well be a characteristic of shared sign languages.

3.2 METHODOLOGY

3.2.1 PARTICIPANTS

In order to understand how sign variation is influenced by sociolinguistic factors, participants with varied sociolinguistic profiles were sampled. Our sampling focused on maximizing the number of deaf participants, of different age groups and from different clans. Hence, some intersections of sociolinguistic groups are more strongly represented than others. Some groups could not be sampled because they do not exist (e.g., deaf individuals in clan 9) or no longer live in the village, and other groups are not represented because of our limited sample size.

The age groups represented in this study are young (14–31), middle-aged (33–53) and older (56–71). Due to the type of community at hand, a small community and hence a limited pool of participants from which to sample, some hearing participants were under the age of 18. For signers under the age of 18, parents approved their participation in the study. The youngest signer in our study was 14. Previous studies focused on how geographical location on a large scale affects sign variation (e.g., Schembri et al. 2009). Here, we study geographical location on a much smaller scale, within the Kata Kolok community, by considering the clan a signer belongs to (also studied by Marsaja 2008). Finally, we were interested to see if deaf and hearing people use different variants.

Other sociolinguistic factors that were not explicitly taken into account when sampling but were recorded are gender and if an individual is part of a deaf family (i.e., if an individual resides in a family compound consisting of one or more deaf individuals). In other words, we wanted to sample both women and men, and individuals in a deaf family and individuals that are not in a deaf family, but we were not strict about having matched group sizes. Following research from Marsaja (2008) on the Kata Kolok community and claims about how social structure affects variation, we investigate if the women exhibit more in-group variation than the men, as the latter have input from more sources in their involvement in public activities, more possibilities to interact with outsiders, and so forth (Marsaja 2008). Because family members of deaf people have frequent exposure to Kata Kolok from their deaf family members, it is probable that the sign variants used by individuals in a deaf family are more aligned than with individuals not in a deaf family. The demographic characteristics of participants analysed in this study are summarised in Table 3-1.

Table 3-1. Participant demographic information.

	total	**clan**										**clan**		**gender**		**deaf family**	
Age		1	2	3	4	5	6	7	8	9	10	yes	no	F	M	yes	no
young	13	5	1	1	3	0	1	1	1	0	0	5	8	5	8	8	5
middle-aged	20	4	2	2	4	0	1	4	3	0	0	10	10	11	9	16	4
older	13	3	3	1	1	0	2	1	2	0	1	5	8	5	8	8	5
total	46	12	5	4	8	0	4	6	6	0	1	20	26	21	25	32	14

3.2.2 DATA COLLECTION

Four research assistants worked with Lutzenberger to recruit participants in the community, two of whom have been working with researchers on studying Kata Kolok prior to this project and two were recruited for the first time. First, a fluent hearing Kata Kolok signer in his 60s who is a teacher at the local primary school including the deaf unit and often functions as spokesperson of the deaf, helped in identifying and recruiting hearing participants. Second, a young deaf research assistant from generation five and member of a multigenerational deaf family in the village functioned as addressee during the picture description task and led the interview. Both of these research assistants reside in the village and have worked fruitfully with Lutzenberger and de Vos for several years. The two newly recruited assistants and Lutzenberger helped to mediate between spoken Indonesian, Balinese, Kata Kolok and English with hearing participants for informed consent and instructions.

All 46 participants were videotaped for the study. Sessions were recorded in a house under construction that was at the time not being worked on, owned by the older research assistant. The room was equipped with a blue cloth to ensure a neutral background, a carpet, a small stool and a table. Participants could choose to sit on the floor or on the small stool on the right side of the slightly higher object on which the laptop was placed and adjusted accordingly. At the start of each session, one research assistant and Lutzenberger, facilitating the session, guided participants through an information sheet and a consent form. More specifically, for the hearing participants a hearing research assistant went through the consent form in written Indonesian and explained and translated content where necessary (due to illiteracy, bad eyesight, or insufficient information) into spoken Balinese. For deaf participants, Lutzenberger explained the consent form in Kata Kolok, and these participants are familiar with the procedure from working with de Vos and Lutzenberger from 2007 and 2014, respectively. In both cases, Lutzenberger was present in the room to answer questions and clarify uncertainties. Once participants understood the documents, they either signed or gave their thumbprint on the form. With the help of a research assistant, hearing participants then proceeded to provide sociolinguistic information about themselves (see Appendix 3-A). For deaf participants, the sociolinguistic information was completed from (i) Lutzenberger's knowledge from observations and informal conversations during field trips, and (ii) the older research assistant's knowledge of the community. Part of the sociolinguistic information consisted of describing one's interactions with deaf individuals (see Appendix 3-A, question H2), which is used for the social network analysis. From there, participants were shown an example of what they would be asked to do in the picture description task. Participants were instructed to look at the picture on the laptop and sign what is in the picture. During the task, the research assistant controlled the laptop, and asked participants what point for each stimulus. Other than this, no explicit instructions were given.

This study contains three components: a picture description task of the lexicon, a sentence repetition task and gathering additional sociolinguistic information about Kata Kolok signers. The sessions followed a slightly different protocol for deaf and hearing participants. For deaf participants, the elicitation task was embedded in a larger set of lexical elicitation tasks using pictures and real objects, which was part of a separate study (see Chapters Four and Five). The sentence repetition task was completed last by most deaf participants. No interview was conducted to determine their signing fluency as all deaf people are considered to be highly skilled and native signers (also following the classification in Marsaja 2008). For hearing participants, all sessions consisted of three parts: a short sociolinguistic interview, the elicitation task, and a sentence repetition task. Each session started with a short interview about basic daily routines to ease up participants who are not familiar with the lab-setting and to determine the fluency of participants (see Appendix 3-B for interview questions). The fluency scale is High, High-Medium, Medium, Medium-Low and Low, assigned through the judgment of the short interview by Lutzenberger who was observing the interaction. Further, for each interview question, a note was made regarding whether the question was answered and whether it was a long or a short answer, which was intended to validate the overall rating. While rating by a native signer would normally be expected to be more reliable, in a small language community like the one that uses Kata Kolok it would be more difficult to do this objectively as social relations, social structures and interaction patterns are at play as well. Despite having planned to have three independent people giving ratings (Lutzenberger, a hearing and a deaf signing research assistant), this did not work for several unforeseen practical reasons. Additionally, the sentence repetition task was completed with all hearing participants. To clarify, though deaf and hearing participants took part in sessions with different tasks, they were exposed to identical material for the elicitation task.

The picture description task consists of 36 pictures of objects familiar to participants which fall into the following categories: animals (*cat, dog, chicken, pig, cow, horse, butterfly, gecko, turtle*), food (*rambutan, salt, coffee, garlic, rice, mango, dragonfruit, chili, palm sugar*), religion (*sarong, pray, tridatu* – a yarn bracelet with religious significance, *blayag* – steamed rice wrapped in a leaf, *flower, offering*), miscellaneous items (*mobile phone, sandals, cock fight, rice cooker, mandi* – a traditional Indonesian shower, *shovel, camera*) and colours (*black, white, red, yellow*).

Though de Vos (2011) does not report that yellow is lexicalised, we were interested to follow up on this result as there were clear strategies for yellow mentioned in de Vos (2011), such as naming an object that is typically yellow (e.g., banana or turmeric) or pointing to a nearby yellow object. In addition, the previous study was conducted in 2011 so it is possible that by now a lexical sign for yellow has emerged.

Stimuli in our study consisted of either pictures taken by Lutzenberger in the field or pictures found online. It is important to note that in this task stimuli are constrained by what can be visually represented, and hence no abstract concepts or grammatical signs are elicited. Pictures to elicit signs were shown to participants using a slideshow on a Macbook Pro laptop. For all participants, the stimuli were presented in the same (random) order, as there is no expectation that the order of the stimuli will influence sign variation. Our stimulus selection was guided by insights into variation from de Vos and Lutzenberger's knowledge of variation in Kata Kolok and from ongoing work documenting Kata Kolok in the lexical database Signbank (Lutzenberger 2020). Stimuli were selected for their expected number of variants, ranging from few or no variants (e.g., *dog*) to large numbers of variants (e.g., *dragonfruit*).

3.2.3 DATA TRANSCRIPTION

The data of the elicitation task were annotated using the multimodal annotation software ELAN (Crasborn & Sloetjes 2008). The growing Kata Kolok dataset in Global Signbank was used as a reference for the sake of ease of transcription and consistency. ELAN allows for annotation in tiers. We had the following tiers: an item tier for the stimulus being described, a right hand tier, a left hand tier, a nonmanual

marker tier, a mouth gesture tier, a tier for the research assistant, a comment tier for Mudd, a comment tier for Lutzenberger and an analysis tier. In the analysis tier, we noted if a participant had produced a target (see Section 3.2.4 for an explanation of what is considered a target), multiple targets, an explanation of the stimulus, if a participant did not know the sign for the stimulus or if a participant did not understand the stimulus. For this study, we focused on the manual tiers as well as the analysis tier (see example in Figure 3-3).

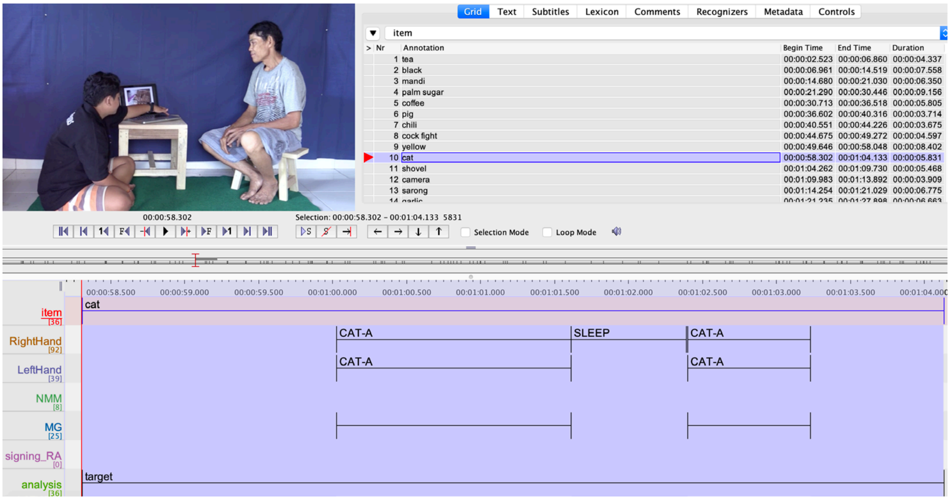

Figure 3-3. Example of ELAN annotation: description of cat by participant KR.

Signbank is lexical database software that is increasingly used by sign linguists to create rich datasets of various sign languages by building on similar and hence highly comparable methodologies (Cassidy et al. 2018). The Kata Kolok dataset, part of Global Signbank, is being created as part of Lutzenberger's PhD project (Lutzenberger 2020). Continuously expanding, the Kata Kolok dataset in the Global

Signbank currently contains approximately 1,000 entries of sign variants; these were primarily collected through spontaneous production and picture elicitations, while others have been observed in the existing Kata Kolok Corpus (de Vos 2016) or through previous elicitation and phonological descriptions. Yet, these are still being enriched, adjusted and validated with the community and new data are being added.

Mudd used the Kata Kolok dataset in Global Signbank as a guide for transcription, and hence the glosses from the Kata Kolok dataset in Global Signbank were adopted for annotation in the current project (see examples of glosses in Figure 3-4 and Figure 3-5). For the Kata Kolok dataset in the Global Signbank, the hyphen followed by a letter is a gloss used for signs which may refer to the same concept, expressing approximately the same meaning (e.g., BUTTERFLY-C and BUTTERFLY-D shown in Figure 3-4). In addition, Lutzenberger created a list of Signbank entry glosses that could be expected in response to each stimulus. The list contained signs from the same semantic domain as the sign we selected the picture for. For instance, for the stimulus *mandi*, the list contained signs like MANDI, WATER and WATER-TAP. Following this coding scheme, manual activity was annotated by comparing the signs produced to the sign gloss entries in the Kata Kolok dataset.

3.2.4 DATA CODING

Table 3-2 shows the factors considered for analysis from the demographic information recorded. 46 participants responded to all 36 stimuli in the picture description task, amounting to 1,656 trials, one trial being the sign(s) produced in response to a given stimulus by a single participant. The majority of signs produced by participants were annotated. Some longer responses (e.g., a participant telling a lengthy anecdote) were not fully annotated. In response to stimuli, the average number of signs produced across participants and stimuli was 2.56. The verbosity of participants varied (i.e., the number of signs produced per participant) (M = 2.55, sd = 1.28, min = 1, max = 5.92) and some stimuli tended to elicit longer descriptions than others (i.e., the number of signs produced per stimulus) (M = 2.57, sd = 0.69, min = 1.53, max = 4.26).

Table 3-2. Sociolinguistic factors considered for analysis.

sociolinguistic factor	**levels**
deaf status	deaf, hearing
age group	young (14-31), medium (33-53), old (56-71)
clan	Tihing/Pulasari (1), Asem (2), Abing/Basta (3), Ceblong/Gelgel (4), Kanginan (5), Kutuh (6), Kemuning/Santn (7), Punduh Jero (8), Kinditan (9), Kelod Kauh (10)
gender	female, male
deaf family member	yes, no

After coding, we removed the colour stimuli (*black, white, red, yellow*) (n=184), as they were confusing to participants. For example, when seeing the stimulus black, some participants thought the computer was having technical difficulties. We also removed the following trials that were not suitable for analysis: when a participant did not know the sign for the stimulus, when the participant did not understand the stimulus and when the participant did not produce a valid target. Valid targets are variants that are a relevant description of the stimulus and that are attested with three or more participants as a response to the stimulus. Requiring at least three participants to produce a variant was an arbitrary threshold we used, implemented with the goal of excluding gestures and idiosyncratic signs.

Targets that were part of an explanation or anecdote were considered valid for analysis; for example, as shown in Figure 3-3, participant KR describes the stimulus *cat*, which is a picture of a lounging cat, by producing CAT-A SLEEP CAT-A. For analysis, just CAT-A is considered. A total of 149 trials were removed which were considered not suitable for analysis.

Prior to analysis, variants with the same underlying iconic motivation and mapping were treated as a single lexical variant for analysis. Signs often exhibit iconicity (i.e., a motivated relation between form and referent), but different features from the referent can be selected (Klima & Bellugi 1979). Once a feature is selected from a referent (e.g., the wings of a butterfly), different types of iconic mappings can be applied (see also Figure 1 in Emmorey 2014). For instance, Hwang et al. (2017) identify three types of iconic mappings based on the mapping of a feature to the body and the hands: *manipulation*, the upper half of the body represents a human; *personification*, a non-human body is mapped onto one's body; and *object*, the hands represent static features and are separate from the rest of the body.

As shown in Figure 3-4, for example, all three variants produced to describe *butterfly* have the same underlying iconic motivation as they represent the wings of a butterfly. BUTTERFLY-C and BUTTERFLY-D share the same mapping, namely using the hands to represent the wings of a butterfly, employing the *object* strategy. Thus, BUTTERFLY-C and BUTTERFLY-D are treated as a single lexical variant, BUTTERFLY-CD, for analysis. Meanwhile, BUTTERFLY-A employs the *personification* method, in which aspects of a non-human entity are mapped onto the human body. As BUTTERFLY-A and BUTTERFLY-CD have different underlying iconic motivations, these are the lexical variants that we consider for analysis for the stimulus *butterfly*.

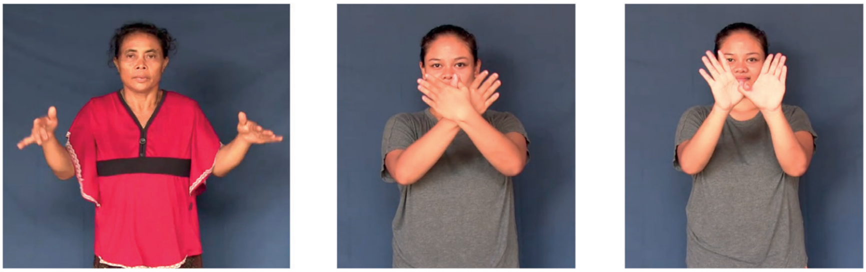

Figure 3-4. Variants produced for the stimulus *butterfly*: BUTTERFLY-A (left), BUTTERFLY-C (middle) and BUTTERFLY-D (right). BUTTERFLY-C and BUTTERFLY-D are treated as BUTTERFLY-CD for analysis as they have the same underlying iconic motivation (i.e., the wings of a butterfly) and mapping (i.e., onto the hands). BUTTERFLY-B is not shown, as it was not produced by participants in this study.

Collocations, or signs that occur together frequently, were identified when coding the data and these were analysed as compounds and thus treated as a single lexical variant for analysis if they were produced more than three times in the same way. For example, in response to the stimulus *palm sugar*, participants often produced CANDY and BREAK. CANDY and BREAK when occurring together, irrespective of the order, were treated as a single lexical variant, CANDY-BREAK, for analysis, for the stimulus *palm sugar*. To clarify, following this example, if CANDY and BREAK were produced in a sequence but not directly following each other, they would be considered as individual signs for analysis.

After classifying variants by underlying iconic motivation and mapping and determining compounds, four stimuli (*blayag, cat, cow, dog*) had only one variant and thus were removed prior to data analysis (n=156). After removing the colours, stimuli eliciting only one variant and trials not suitable for analysis, 1,166 trials were analysed, consisting of 28 stimuli.

3.2.5 ANALYSIS

In the analysis, we focus on the first variant produced by a participant, despite participants typically producing a string of signs often embedded in descriptions, anecdotes, etc. We make this choice because it is easier to analyse and we consider the first variant to be most salient, as will be elaborated upon in the discussion (Section 3.4). To understand how Kata Kolok sign variation is shaped by sociolinguistic factors, we apply two methods: entropy and lexical distance.

Entropy is used to measure the amount of consistency in a group (see Section 3.3.2). This measure takes into account the number of variants and also the distribution of the variants in a group. Here, entropy is calculated for each stimulus for different sociolinguistic groups. Entropy (H) is calculated over the percentages produced for each variant (x), given as

$$H=-\Sigma p(x) \log 2\ p(x)$$

and is summed over all variants produced for a stimulus per sociolinguistic group. Low entropy would indicate that a group produces the same sign for a stimulus. High entropy would indicate that a group produces different signs for a stimulus.

Once an entropy score is calculated per stimulus and per group, a mean score over all stimuli is calculated.

In the second method, we calculate the lexical distance between all pairs of participants, a method also used by Bickford (1991) and Reed (2019). Lexical distance is a score from 0 to 1, with 0 indicating that two participants have produced the same variants for all signs and 1 indicating that two participants have produced different variants for all signs. In order to calculate the lexical distance between two participants in our sample, we take the intersection of stimuli valid for analysis by both participants. Stimuli for which participants produce different lexical items are counted and then divided by the total number of stimuli compared. After repeating this process for all participants in our sample, we produce a lexical distance matrix in which the distance between all participants is stored. With the lexical distance matrix, we then use multidimensional scaling (MDS) in order to visualise the distances between participants in our dataset. Using this technique, we translate the distance matrix onto a two-dimensional space, with each point representing a participant, allowing us to visualise which sociolinguistic hypotheses were borne out. Additionally, with the collected social network data, we used a Mantel test to investigate if the lexical distance between deaf participants correlated with their social network.

3.3 RESULTS AND INTERPRETATION

3.3.1 QUANTIFYING LEXICAL VARIATION

Like we discussed in Section 3.1, previous studies have reported a high degree of lexical variation among everyday concepts in the shared sign languages ABSL (Meir et al. 2012) and PISL, where the majority of everyday concepts have more than two lexical variants (Washabaugh 1986). Our study of sign variation in the shared sign language Kata Kolok also finds a high degree of variation, with 75% of stimuli in our study eliciting more than two variants. Four stimuli (*cat, cow, dog, blayag*) produce a uniform response from all participants. Hence, despite the high degree of variation in most responses, we find there is sample-wide consistency in responses to certain stimuli. Table 3-3 shows the number of variants elicited per stimulus in the study.

Table 3-3. Variants produced.

category	**1 or 2 variants**	**3 or 4 variants**	**5-8 variants**
animals	*cat (1)*, *cow (1)*, *dog (1)*, *butterfly*, *chicken*	*pig*, *turtle*, *cock-fight*, *gecko*, *horse*	
food	*rice*	*tea*, *rambutan*, *mango*, *chili*, *salt*, *coffee*, *palm sugar*	*dragonfruit*, *garlic*, *rice cooker*
praying	*blayag (1)*	*ceremony*, *flower*	*sarong*, *tridatu-bracelet*, *offering*
miscellaneous	*shovel*	*sandals*, *phone*	*mandi*, *camera*

The stimuli chosen for our study should not all be considered everyday concepts. We posit that signers are familiar with these, but do not use them daily. Thus, the high degree of variation reported in this study may partially be due to the stimuli selection, in which some stimuli, such as the religious ones, do not occur in daily conversation yet are prominent aspects of the lives of Kata Kolok signers. Further, in contrast to previous studies, the present study included both deaf and hearing signers from the Kata Kolok community. Hence, it could be that the amount of variation observed stems from differences between these groups. We investigate this possibility in the following section.

3.3.2 ENTROPY – A MEASURE OF VARIATION

Israel and Sandler (2011) used the mode and spread of variants in order to study phonological variation in three sign languages. They found that the amount of sublexical variation in these languages correlates with the age and social setting of a sign language. Along similar methodological lines as Israel and Sandler (2011), we also consider the mode and spread of variation using entropy. Using entropy as a measure to study variation, no significant differences were found between groups of the sociolinguistic variables reported in this study (see Table 3-2 for sociolinguistic variables and groups). Despite the null result, we wish to elaborate on this method as the focus of the current article is largely on methodological challenges in studying lexical variation, and future researchers of lexical variation are likely to consider this measure for analysis. In this section, we focus on deaf and hearing participants in order to illustrate why using entropy as a measure to capture lexical differences in the current study is not suitable. Though we focus on deaf/hearing status here, other sociolinguistic factors (e.g., gender and age) follow the same reasoning. As shown in Figure 3-5, there appears to be little difference in entropy over stimuli between deaf and hearing participants, confirmed by a Wilcoxon Signed-Ranks test which indicated no significant difference between entropy scores of deaf and hearing participants across stimuli ($Z = 144$, $p = 0.18$).

An example of entropy with deaf and hearing participants illustrates that entropy is not a well-suited measure to capture lexical variation in the present study, because it does not capture qualitative differences in sign production. We highlight two stimuli, *offering* and *palm sugar* (Figure 3-6 and Figure 3-7, respectively), where deaf and hearing participants approach the task differently. In both cases, deaf and hearing participants tend to produce somewhat internally consistent signs. For the stimulus *offering*, hearing participants produced five variants, predominantly PRAY or the collocation PRAY and PRAY-CL, a depicting sign referring to the general shape of the offering positioned in front of their crossed legs. These descriptions are arguably semantically underspecified descriptions of the stimulus offering, depicting the size and shape of the object. In contrast, deaf participants produced six variants, including signs for *offering* produced with various underlying iconic motivations which were often combined with PRAY to form a compound. While the number of variants is similar, the variants themselves show a different approach to representation. One interpretation is that the descriptions produced by deaf participants are more specific descriptions of the stimulus than the descriptions produced by hearing participants. The entropy scores for this stimulus reveal that there is more variation overall within the deaf group than within the hearing group, as here deaf participants have produced six variants for *offering*, with no dominant variant.

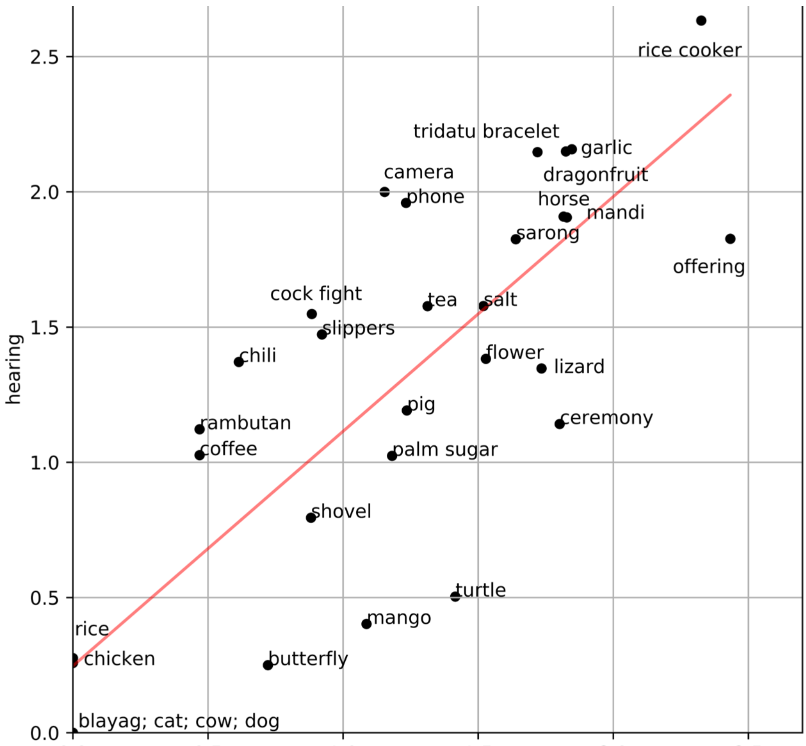

Figure 3-5. Entropy of deaf and hearing participants for each stimulus. Points closer to the x-axis have a higher entropy (i.e., more variation) in the deaf group and points closer to the y-axis have a higher entropy in the hearing group. The line is fitted to the points, indicating that there is no significant difference in entropy over all stimuli ($Z = 144$, $p = 0.18$).

Second, for the stimulus *palm sugar*, hearing participants produced four variants, but the majority produced CANDY-B, which is a sign used to refer to sweetness. Deaf participants produced three variants, of which the most frequent was CANDY-BREAK (a compound discussed in Section 3.2.3), arguably a more specific description of the food than the description produced by the hearing participants. For this stimulus, the two groups are internally consistent, with each group favouring one variant.

Figure 3-6. Deaf and hearing participant first target responses to the stimulus *offering*.

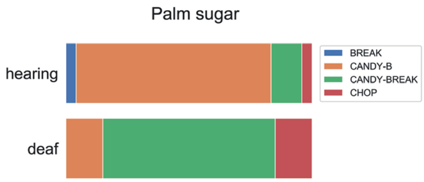

Figure 3-7. Deaf and hearing participant first target responses to the stimulus *palm sugar*.

Using entropy as a measure, the groups show similar amounts of group-internal consistency for the stimulus *palm sugar*. Yet, entropy does not account for the qualitative differences in signs produced between these groups; a future study will further investigate the types of iconic signs that deaf and hearing participants produce in detail. To investigate how the Kata Kolok lexicon is shaped it is crucial to account for the different variants that participants produce.

Studies of several sign languages have found the lexicon to be conditioned by age. For instance, Stamp et al. (2014) have shown leveling, or a reduction of variation, in younger BSL signers. For Kata Kolok, we did not have a clear prediction about the effect of age on lexical differences, as it is common for people to spend time in family compounds, and thus around individuals of all ages. A suitable way to study leveling is to look at entropy scores across age groups. Evidence of leveling from entropy scores would be found if the young age group exhibited lower entropy (i.e., less variability) than the older age group. We use a Wilcoxon Signed-Ranks test and find that there is no significant difference between entropy scores of young and older participants across stimuli ($Z = 104$, $p = 0.07$). Hence, in Kata Kolok we do not see evidence of leveling. Rather, throughout the age groups a similar degree of lexical variation is maintained.

3.3.3 LEXICAL DISTANCE

Lexical distance is a measure that allows us to take into account the variants that participants produced. It is measured by comparing the variants produced by two participants. If the distance is 0, participants have the same vocabulary. The vocabulary of participants consists of the first variant that participants produce for a stimulus. The lexical distance matrix consists of the lexical distances between all participants. Table 3-4 provides a subset of the lexical distance matrix showing three participants. For instance, it is shown that participant JU and HGU have produced similar variants (lexical distance of 0.26), while HLR and HGU have produced many different variants (lexical distance of 0.68).

Table 3-4. Subset of the lexical distance matrix.

	HLR	HGU	JU
HLR	0	0.68	0.64
HGU	0.68	0	0.26
JU	0.64	0.26	0

Using MDS, we visualise the distances between participants from the lexical distance matrix in a two-dimensional visualisation. Figure 3-8 visualises the participants showing their participant codes. Participants who have a short lexical distance (e.g., JU and HGU) appear near each other, while participants with a long lexical distance (e.g., HLR and HGU) appear further apart on the MDS visualisation. In order to assess the hypotheses of sociolinguistic influence on the Kata Kolok lexicon, sociolinguistic features of participants are highlighted in the different plots of Figure 3-9. The participants stay in the same position on all plots, but different sociolinguistic features are shown.

The most evident result from the sociolinguistic groupings shown in the MDS visualisations is the lexical differences between deaf and hearing participants. In Figure 3-9A, deaf participants are clustered towards the upper left corner, while most hearing participants are clustered toward the lower right corner. To confirm that the lexical distance within the deaf and hearing groups is smaller than between groups, a logistic regression was run to assess whether the coordinates of the MDS visualisation predict if a participant is deaf or hearing. We used a Chi-squared test to compare two models, one with the coordinates as predictors and one without. The model with the coordinates from the MDS visualisation is significantly better at predicting if participants are deaf or hearing ($\chi2(2) = 29.07$, $p < 0.05$). In Kata Kolok there appears to be evidence that sign variation is conditioned by whether an individual is deaf or hearing. This is in line with the previous examples of the stimuli *palm sugar* and *offering*. Overall, deaf and hearing groups show preferences for signs with different underlying iconic motivations and mappings. The specific strategies that deaf and hearing signers employ will be a topic of further study.

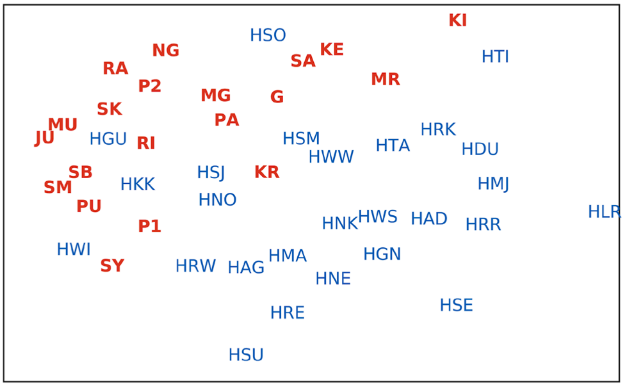

Figure 3-8. MDS visualisation of the lexical distance between participants, with deaf participants coloured in bolded red and hearing participants coloured in blue.

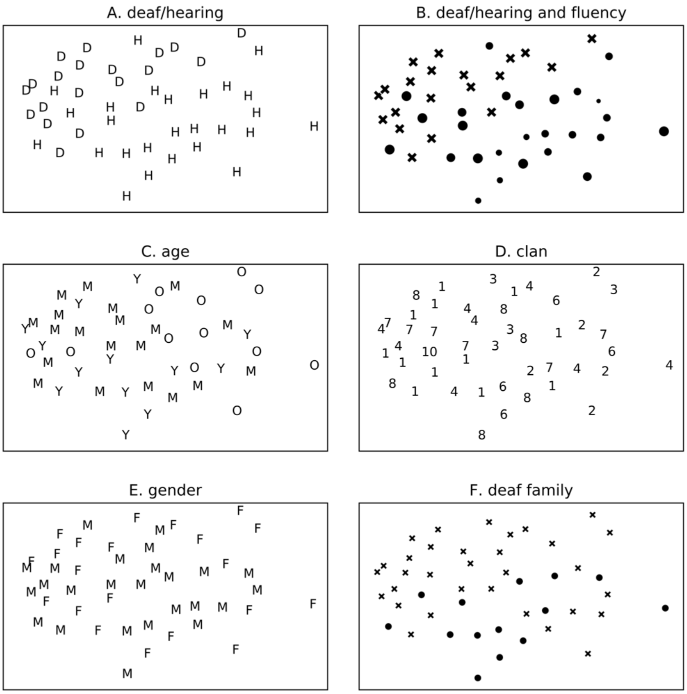

Figure 3-9. MDS visualisations of lexical distance showing different sociolinguistic variables. Figure 9A shows deaf (D) and hearing (H) participants. Figure 9B shows deaf (crosses) and hearing (dots) participants. The data points are sized by fluency: the larger the point, the more fluent the signer. Figure 9C shows age groups: young (Y), middle-aged (M), and older (O). Figure 9D shows the 10 different clans to which participants belong. Figure 9E shows female (F) and male (M) participants. Figure 9F shows participants in a family with a deaf individual (crosses) and participants in a family with no deaf individual (dots).

Additionally, a K-Nearest Neighbours analysis was used in order to see if neighbours in the lexical distance matrix share sociolinguistic features. This analysis was conducted on the original lexical distance matrix, so it is closer to the data than using statistical methods on the MDS visualisation. Here, we check multiple values of k (k=3 and k=5) which we find to be appropriate values of k given our size of our sample. Typically, this type of analysis is conducted on a much larger sample, so the results presented here must be interpreted with caution. For each participant, k participants most lexically similar to them (‘neighbours’) were identified, and the most common sociolinguistic feature (deaf or hearing) of k neighbours was compared to the deaf/hearing status of the original participant. When k=3, we find that hearing participants are accurately predicted by their neighbours in 18 out of 26 cases (69%), and deaf participants are accurately predicted by their neighbours in 12 out of 20 cases (60%). To assess if these outcomes from K-Nearest Neighbours are above chance, we use a binomial test. Our algorithm finds that the deaf/hearing status of a participant’s three nearest neighbours does not predict deaf individuals above chance ($p = 0.18$) nor hearing individuals above chance ($p = 0.24$). When k=5, hearing participants are accurately predicted by their neighbours 22 out of 26 cases (85%), and deaf participants are accurately predicted by their neighbours in 11 out of 20 cases (55%). When k is larger (i.e., more neighbours are considered), the accuracy of hearing participants is improved, likely because there are more hearing participants in the sample, so this type of analysis favours them. Using a binomial test, our algorithm finds that the deaf/hearing status of a participant’s five nearest neighbours predicts hearing individuals above chance ($p < 0.05$) but not deaf individuals above chance ($p = 0.37$).

In shared sign languages, it is typical for hearing people to account for the majority of the signing population (Meir et al. 2010) and Kata Kolok is no different: the vast majority of Kata Kolok signers are hearing (over 95%), but are fluent to varying degrees (Marsaja 2008). Following Marsaja (2008), we consider all deaf signers in this study to be in the highest category (High) of our fluency scale. As Figure 3-9B shows, there appears to be a relationship between fluency and the lexical distance to a deaf participant: the hearing participants who have a short lexical distance to deaf participants are mostly fluent signers. It is probable that these individuals spend more time with deaf people, hence they have a higher sign similarity to deaf people and also are more fluent signers. The hearing signers are further away from deaf participants in terms of lexical distance, exhibiting varying degrees of fluency. In order to handle unknown signs, less fluent signers may improvise, using improvised gesture, rather than using conventionalised signs. However, as these improvised gestures are not conventionalised, they would not appear as target variants in our study.

Marsaja's (2008) study of fluency in the Kata Kolok community finds that men tend to be more fluent signers than women, likely resulting from the social mobility men have. Therefore they have more input opportunities from various signers than women. Because of this we expect men overall to be more consistent and women to be lexically similar to fewer individuals. Figure 3-9E shows male and female participants in our study. From this visualisation, it is apparent that more men cluster in the centre than women, while women tend to be distributed around a centre grouping of men. A logistic regression was run to assess whether the coordinates of the MDS visualisation predict if a participant is female or male, using a Chi-squared test to compare two models, one with the coordinates as predictors and one without. The model with the coordinates from the MDS visualisation is not significantly better at predicting if participants are female or male ($\chi 2(2) = 2.13$, $p = 0.34$). We return to the lexical distance matrix and perform a K-Nearest Neighbour analysis to determine if one's gender can be accurately predicted by the gender of one's neighbours in the distance matrix. When $k=3$, we find that men are accurately predicted by their neighbours in 17 out of 25 cases (68%), and women are accurately predicted in eight out of 21 cases (38%). Using a binomial test, our algorithm finds that the gender of a participant's three nearest neighbours in the lexical distance matrix does not predict men above chance ($p = 0.23$) nor women above chance ($p = 0.5$). When $k=5$, we find that men are accurately predicted by their neighbours in 20 out of 25 cases (80%), and women are accurately predicted by their neighbours in six out of 21 cases (29%). Using a binomial test, our algorithm finds that the gender of a participant's five nearest neighbours does predict the men above chance ($p < 0.05$) but women are not predicted above chance ($p = 0.13$). Hence, when $k=5$, the similarity of men's lexicon is detected, reflecting what is shown in Figure 3-9E.

There is no evidence in our study of an effect of clan on lexical variation. Figure 3-9D shows the clan that participants belong to, which are ordered by proximity as shown on Figure 3-1. Table 3-1 shows the demographic information of participants, showing that some clans are much more prevalent than others in our sample. Here, we see no effect of clan on lexical proximity. In previous studies, region has been shown to affect variation (Lucas et al. 2001; Schembri et al. 2009). However, the clan system in the Kata Kolok community is on a much smaller geographical scale than these previous studies. Despite Marsaja's (2008) claim that clan alliances are the strongest ties in the Kata Kolok community, we find no linguistic evidence of this in our study. In addition, women relocate to the clan of the husband after marriage. The clan where a woman lives currently was the only one taken into account, despite if she moved clans when married. It is possible that women are more linguistically in line with the clan they formerly were a part of.

Further, how does being a member of a deaf family affect lexical similarity to deaf participants? In Figure 3-9F, in the lower middle area of the plot there appears to be a cluster of individuals who are not members of a deaf family. Overall, in our sample sign alignment does not appear to be predicted by whether individuals are in a deaf family. What can be seen in Figure 3-9F is that a group of hearing participants in deaf families (lower right corner) are not lexically close to deaf participants. Finally, as previously stated, we did not have strong predictions about how age would affect lexical variation. With regards to lexical distance, as shown in Figure 3-9C, age does not appear to condition sign variation.

As there is currently no standard analysis for this type of study, here we present two different statistical methods: a logistic regression on the MDS coordinates and a K-Nearest Neighbours analysis on the original lexical distance matrix, which both have benefits and shortcomings. We think these approaches can be used to study variation quantitatively.

In addition to seeing how the previously discussed sociolinguistic factors affect the Kata Kolok lexicon, we additionally investigate the role of the Kata Kolok social network – reported social ties between individuals. This may be more informative than looking at groupings along other sociolinguistic lines due to the close-knit nature of this signing community. For hearing participants, the deaf participants with whom they spent time was collected in the sociolinguistic interview (see Appendix 3-A, question H2). However, in order to see if this correlates with lexical distance in our experiment, we are lacking data on hearing-hearing social ties. Hence, only the social network of deaf people was investigated in relation to lexical distance. As deaf participants did not take part in the interview, their social ties were reported by Lutzenberger (see Section 3.2.2 for more detail). Social ties reported were not always bi-directional, but bi-directionality is a requirement for using Mantel testing. Thus, even when a one-way social tie was reported, for analysis, the relationship was considered bi-directional to adhere to Mantel test requirements.

In coding the social network matrix, the social distance from an individual to his- or herself is 0, to a reported friend is 1 and to an unreported individual is 2. For example, as seen in Table 3-5, MG and JU are reported to spend time together (social distance of 1) while MG and KI are not reported to spend a substantial amount of time together (social distance of 2).

Table 3-5. Subset of the social network matrix.

	MG	**JU**	**KI**
MG	0	1	2
JU	1	0	2
KI	2	2	0

Using the Mantel test, a Pearson correlation was computed to assess the relationship between the social network matrix and the lexical distance matrix of deaf individuals. There was a significant, but very weak positive correlation between the two matrices ($r = 0.18$, $n = 20$, $p < 0.05$), indicating that individuals who spend time with or report to be close to socially weakly correlates with lexical choices. This analysis would be improved by better data on interactions between participants and complete information from the social network of hearing participants.

3.4 DISCUSSION

In the present study, we have investigated variation in the Kata Kolok lexicon. In order to do so, we attempted to find appropriate methodologies and analytical tools to study this type of sign language. The majority of previous studies of lexical variation investigated deaf community sign languages, which present different affordances than shared sign languages. Not only may the context of language emergence affect variation (see de Vos 2011), but here we have suggested that it also affects how we can study variation. To determine variants in our study we take into account the underlying iconic motivation and mapping of a sign, as opposed to previous studies of deaf community sign languages which analyse sublexical parameter comparison using multiple logistic regression (e.g., D. McKee & Kennedy 2000).

Two deaf community sign languages which used a sign's iconicity in identifying lexical signs are from Konrad's (2013) study of DGS and Richie, Yang, and Coppola's (2014) study of homesigners in Nicaragua. Konrad (2013) claims that it is important to consider a sign's iconicity when identifying lexical (conventionalised) signs to avoid directly mapping the spoken language lexicon to the sign language lexicon. In addition, a sign's iconicity can be reactivated, and often conventionalised lexical signs undergo a process of de-lexicalisation and re-iconisation (Konrad 2013: 112). Richie et al. (2014) code the homesigner's individual gestures using their *conceptual component*, referring to the iconic representation of an aspect of a stimuli's meaning. These two examples, from studies of DGS and homesigners in Nicaragua, show the value of considering the iconicity of signs in studies of any type of signing community.

Several previous studies used multiple logistic regression to analyse sublexical parameter comparison with the goal of determining what sociolinguistic factors predict the use of standard variants (e.g., Stamp et al. 2014). The present study could not apply these same techniques. Sublexical parameter comparison could not be used at this stage, as the study of the possibility of phonology in Kata Kolok is underway (Lutzenberger 2020). Further, previous studies identified standard variants and analysed them using a multiple logistic regression analysis. Because there is no clear group of high-prestige signers in Kata Kolok, it is not evident how to identify standard variants. Crucially, a multiple logistic regression analysis requires binary input: comparing variants produced to a standard variant, hence categorizing them as either standard or non-standard variants. Given the amount of lexical variation recorded in the present study of Kata Kolok, with some stimuli eliciting up to nine variants, it would greatly reduce the richness of the data if we had categorised the variants in two groups. It should be noted that once contrastive phonological units are identified, sublexical parameter analysis could be used with a different analytical tool (other than multiple logistic regression) if there is no clear prediction about linguistic groupings (e.g., regional differences) and a large amount of variation.

In order to study variation in Kata Kolok, first, we calculated the entropy score of sociolinguistic groups and second, we calculated the lexical distances of the first variant produced by participants. Using MDS visualisations, we observed the potential effect of various social factors on lexical distance. To analyse the distances, we performed a logistic regression with the MDS coordinates. A limitation of using a logistic regression here is that it is performed on the MDS coordinates, and not on the lexical distance matrix. Circumventing this issue, we performed a K-Nearest Neighbours analysis with the original lexical distance matrix to determine if the three and five lexically most similar participants to another predict a given social factor. This analysis uses the raw data, but because the sample size is not large, the K-Nearest Neighbours analysis is not used in a typical way (e.g., no training and test sets). Finally, we compare the lexical distance matrix to a social network matrix, to see if the two correlate. With only reports of social ties between deaf participants, this analysis does not encompass the entire sample. We have therefore presented several new quantitative methodologies to study shared sign languages, but our study and the measures we applied are not without limitations.

In the picture description task, our stimuli were sometimes confusing to participants; participants sometimes described other parts of the picture than we intended. As discussed in Section 3.2.4, colour stimuli were particularly confusing to participants and were thus removed prior to analysis. Further, for linguistic, cultural and educational reasons, it is unnatural and at times difficult to ask Kata

Kolok signers to produce a single sign in response to the picture description task. Hence, the majority of trials resulted in a string of signs, and not a single, isolated variant ready for analysis. To account for this, we explored ways to consider the full production of a participant for analysis. Unfortunately, we were unable to conceive of a method to take into account all of the factors we deem valuable: the verbosity of a participant, the number of signs on average elicited for a given stimulus, the order of variants produced, the frequency of variants per stimulus, the number of variants produced for a stimulus and the frequency of stimuli in real life. We expect that an analysis of multiple variants produced by participants should consider as many of these factors as possible, somehow weighted. To truly understand variation in Kata Kolok from the participant responses in this study, an analysis of the full utterance is necessary. Unfortunately, this is beyond the scope of the present study.

To elaborate on one point we find critical in understanding variation, we hypothesize that the frequency of a concept will also affect the amount to which it exhibits variation; the more a concept is discussed, the more conventionalised the form is likely to be. For example, *dog* is a concept which occurs in everyday life and we see that it is uniform across all participants. Other stimuli that participants may interact less with, such as *offering* which is only present in religious ceremonies, exhibit more variation. Thus, this study reports a high degree of variation overall, but it appears that everyday objects are more conventionalised than reported in previous studies of lexical variation of shared sign languages. To confirm this, we would need information on the frequency of different concepts from spontaneous data in the Kata Kolok community.

In this study, we collected fluency data on participants to see if fluency levels influence variation, and to see how well the sentence repetition task fares with users of a shared sign language. The sentence repetition task was unsuccessful with the Kata Kolok signers, in that they did not repeat what was signed in the stem videos, but rather responded to what was signed. Many psycholinguistic tasks are rather unnatural to people, especially those who have lower education levels or no previous education (Speed, Wnuk & Majid 2018). In other words, using a sentence repetition task with sign language communities might be suitable mainly for Western countries with longstanding traditions of embedded literacy. In addition, a general limitation of this method is its dependency on cognitive processes, such as short-term memory. Hence, it is possible that this method does not capture the fluency of signers but rather tests their ability to perform in this type of cognitive task. Thus, in order to study fluency in the Kata Kolok community, a survey approach is most appropriate (as reported by Marsaja 2008), despite how long the task takes.

The nature of this investigation was exploratory and thus we have analysed many sociolinguistic variables to observe their effect on sign variation. In our analysis, we have considered each social factor separately. It is likely that many of these variables interact, and that some variables account for the variation observed in others. For instance, it is very likely that deafness, fluency and whether an individual is part of a deaf family interact. Statistically teasing apart these variables was not tried in the current study, as the statistical tools to do this are unknown. Future work in shared sign language communities must continue to seek analytical tools appropriate for understanding variation. We posit that due to the tight-knit social structures characteristic of shared sign languages, a fruitful direction for this type of research is in understanding how social networks and kinship shapes variation. In order to investigate this, it would be ideal to have social network data on who individuals interact with and how often these interactions occur across a given community. With this information, it would be possible to also address what biases shape sign choice, such as frequency bias or prestige bias (Boyd & Richerson 1985).

One remaining question is about the nature of the lexical variation observed in the Kata Kolok community. From the social network analysis in this study and from fieldwork undertaken by Lutzenberger and de Vos, we know that participants in our study are frequent communication partners, hence we presume that the vast majority of variants produced are understood across the community. This raises a question about the nature of this variation: do Kata Kolok signers use these variants interchangeably (i.e., productive synonyms or active lexicon) or, are Kata Kolok signers aware of these variants in a more abstract sense but do not use them (i.e., perceptual synonyms or passive lexicon)? The current study points to the hypothesis that Kata Kolok signers may use variants interchangeably, hence as productive synonyms, evidenced by participants tending to produce a chain of variants to refer to a stimulus. We consider the first variant to carry meaning as it is retrieved first, indicating what we consider to be a preference for that variant. However, as participants often produce many of the identified variants for a stimulus, our intuition is that a signer may produce one of the many variants they know in conversation, dependent on the interlocutor, the setting, etc. Because of the small community size, the participants are frequent communication partners, and thus, partners are likely familiar with others' idiolects. This idea is suggested by de Vos (2011) and supported by a computational model (Thompson et al. 2019). In contrast, it may be the case that for deaf community sign languages, perceptual synonyms are the norm; for instance, in the Corpus of NGT (Sign Language of the Netherlands), it appears that signers tend to be familiar with variants typical of other regions, but they do not produce those and rather produce a variant typical of their own region (Onno Crasborn, personal communication).

3.5 CONCLUSION

All sign languages are embedded in communities with unique social make-ups, and their structure undoubtedly affects the degree of linguistic variation, and how variation is present in these communities. To conclude, we highlight a potential distinction between deaf community sign languages, which likely exhibit perceptual synonyms, and shared sign languages, which may instead exhibit productive synonyms. We found that Kata Kolok signers are likely to produce many variants in response to our picture elicitation task, revealing that these signers are perhaps more prone to produce a variety of lexical variants. In studying lexical variation, future work must be done to conceive of methods to analyse multi-sign utterances. Here, we have presented one of the first in-depth studies of how the lexicon is shaped by sociolinguistic factors in a shared sign language, while pioneering new methods. We present preliminary evidence that age does not predict the amount of variation in the Kata Kolok lexicon, that deaf and hearing signers may have different lexical preferences, and that men may have more internally consistent lexicons than women. Further work must be done on refining the tools used to accurately measure variation in various types of signing communities. Shortly, we intend to look at variation on the sublexical level in more detail, as well as a qualitative analysis of the types of (iconic) responses by deaf and hearing signers.

APPENDIX 3-A: PARTICIPANT INFORMATION

A. Name

B. Deaf/Hearing

C. Gender

D. Age or generation

E. Clan

F1. How many people do you have in your family?

F2. How many sons/daughters do you have?

G1. Do you have deaf people in your family?

G2. How many deaf people in your family?

H1. Do you meet with deaf people frequently?

H2. Who are the deaf people you meet with frequently?

I1. Did you go to school?

I2. Where did you go to school?

APPENDIX 3-B: INTERVIEW QUESTIONS

A. How many people do you have in the family?

B. How many sons/daughters do you have?

C1. Do you have deaf people in your family?

C2. How many?

D1. Do you meet with deaf people frequently?

D2. Who are they?

D3. Where do you meet them?

E1. Did you go to school?

E2. Where?

F1. Where have you been this morning?

F2. What did you do?

G1. Have you eaten?

G2. What did you have for lunch/dinner?

H. When is your next ceremony

DATA AND ANALYSIS FILES

The annotated responses of participants, sociolinguistic information and analysis files can be found at https://doi.org/10.6084/m9.figshare.12272588.v1.

ACKNOWLEDGEMENTS

We would like to thank all Kata Kolok signers who did and did not participate in this study and our research assistants. A special thanks to Anique Schüller for sharing her sentence repetition task methodology with us (Schüller 2018), and to Yannick Jadoul and Marnix van Soom for help with the statistical analysis. Extremely detailed feedback from two anonymous reviewers and the editor of the special issue of *Asia-Pacific Language Variation* this publication is part of, Nick Palfreyman, was invaluable in ameliorating this manuscript. In addition, we are grateful for the feedback from the participants of the Symposium on sociolinguistic variation in signed and spoken languages of the Asia-Pacific region.

CHAPTER FOUR

FORMAL VARIATION IN THE KATA KOLOK LEXICON

Chapter adapted from: *Lutzenberger, H., Vos, C. de, Crasborn, O., & Fikkert, P. (2021). Formal variation in the Kata Kolok lexicon. Glossa: a journal of general linguistics, 6(1).* https://doi.org/10.16995/glossa.5880

4 FORMAL VARIATION IN THE KATA KOLOK LEXICON

ABSTRACT

Sign language lexicons incorporate phonological specifications. Evidence from emerging sign languages suggests that phonological structure emerges gradually in a new language. In this study, we investigate variation in the form of signs across 20 deaf adult signers of Kata Kolok, a sign language that emerged spontaneously in a Balinese village community. Combining methods previously used for sign comparisons, we introduce a new numeric measure of variation. Our nuanced yet comprehensive approach to form variation integrates three levels (iconic motivation, surface realisation, feature differences) and allows for refinement through weighting the variation score by token and signer frequency. We demonstrate that variation in the form of signs appears in different degrees at different levels. Token frequency in a given dataset greatly affects how much variation can surface, suggesting caution in interpreting previous findings. Different sign variants have different scopes of use among the signing population, with some more widely used than others. Both frequency weightings (token and signer) identify dominant sign variants, i.e., sign forms that are produced frequently or by many signers. We argue that variation does not equal the absence of conventionalisation. Indeed, especially in micro-community sign languages, variation may be key to understanding patterns of language emergence.

KEYWORDS

variation; gradience; methodology; micro-community sign language; Kata Kolok

4.1 INTRODUCTION

Despite being produced and perceived in distinct modalities, signed and spoken languages parallel on all levels of linguistic structure.

Much like spoken languages, the lexicons of sign languages are shaped by phonological specifications. In 1960, Stokoe (1960) showed that signs in American Sign Language (ASL) are compositional, consisting of the parameters 'handshape', 'movement' and 'location', that differentiate between signs (phonemic contrasts). It was later recognised that signs are composed of finer feature distinctions which can be analysed by a feature geometry model, just like spoken phonemes (Brentari 1998; van der Kooij 2002). Feature sets are most easily determined through lexical contrast. For example, the sign pairs TO-LIVE-IN and HOLIDAY, and ALSO and HOLIDAY represent minimal pairs in Sign Language of the Netherlands (NGT; Figure 4-1). The first pair (TO-LIVE-IN and HOLIDAY) differs in handshape features and the second (ALSO and HOLIDAY) in location features (van der Kooij 2002: 21f.). Specifically, TO-LIVE-IN uses a handshape with thumb and index touching and HOLIDAY is produced with all fingers extended; HOLIDAY is articulated at the ipsilateral side of the *mouth* and ALSO at the contralateral side of the *chest*. Besides these differences, all other features are shared.

TO-LIVE-IN HOLIDAY ALSO

Figure 4-1. Minimal pairs of signs in NGT: TO-LIVE-IN and HOLIDAY; HOLIDAY and ALSO. Images retrieved from Global Signbank (Crasborn et al. 2019).

The featural organisation of signs allows for comparing pairs of signs in terms of their formational similarity. Minimal pairs can serve as evidence for phonologically distinctive feature values of a language. Sign comparisons have also been widely operationalised to determine form similarities within and across sign language lexicons, in order to assess genealogical relationships (Woodward 1991; 1993; D. McKee & Kennedy 2000; Currie, Meier & Walters 2002; Xu 2006; Sasaki 2007; Al-Fityani & Padden 2008), and to correlate formational variation with social factors (Bayley et al. 2000; Bayley, Lucas & Rose 2002; Lucas et al. 2002; Schembri et al. 2009; Fenlon et al. 2013; Siu 2016).

While sign phonology has been extensively documented and analysed, most of this research is conducted into sign languages used in large urban deaf communities, here referred to as *macro-community sign languages*[11] (Schembri 2010; Schembri et al. 2018). Among sign languages used within small and tight-knit rural communities, or *micro-community sign languages* (Schembri 2010; Schembri et al. 2018), the status of phonology is unclear. Initial studies of sign language emergence in these settings show that the form of signs varies greatly across signers and iconicity is the strongest force driving sign formation (Sandler et al. 2011). For example, in Al-Sayyid Bedouin Sign Language (ABSL), a young micro-community

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[11] The discussion about terminology especially in the field of sign language emergence is extensive and ongoing (see for example de Vos & Pfau 2015; or Hou 2016). As laid out in de Vos & Pfau (2015), many determining factors are confounded and depending on the context of discussion, different and multiple labels may be used to classify a language without being mutually exclusive. For the purpose of this study, we adopt the terminology first suggested by Schembri (2010) within the framework of sociolinguistic typology (Schembri et al. 2018). This terminology is chosen without taking position on the relevant theoretical background and for the sake of simplicity and clarity. Note that these terms are not always used by the authors themselves in previous literature (e.g., Sandler and colleagues (2011) and Meir and colleagues (2010) refer to ABSL as village sign language and as emerging sign language and Kisch (2008) describes the community as shared signing community).

sign language of a Bedouin village in Israel, signs to refer to a dog used across signers are motivated by the dog's barking, but signers differ greatly in how the barking is encoded (Sandler et al. 2011: 520). The authors also note that minimal pairs (as illustrated in Figure 4-1 for NGT) are unattested in ABSL, leading them to conclude that phonological structure has not yet emerged in this language. This raises the fundamental questions as to if, how, and when phonological structure emerges in young sign languages. Crucially, micro-community sign languages are distinct from macro-community sign languages with respect to ecological niche and emergence setting, leaving multiple viable hypotheses regarding the causes and mechanisms underlying the attested phenomena (de Vos & Pfau 2015). Moreover, the methodological approach to studying variation has focused on the level of an iconic motivation in micro-community sign languages (e.g., Richie et al. 2014; Hou 2016; Horton 2018; Hou 2018; Neveu 2019; Reed 2019; Horton & Riggle 2019; Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020) and on the sublexical level in macro-community sign languages (e.g., Bayley et al. 2000; 2002; Lucas et al. 2002; Fenlon et al. 2013; Siu 2016).

This study charts the formational variation in Kata Kolok, another micro-community sign language that emerged six generations ago in a village community in rural Bali, Indonesia. We examine the extent of variation in the form of signs by analysing responses across 20 deaf Kata Kolok signers to a picture elicitation task. We combine different techniques that have been used for sign comparisons and introduce a newly developed measure of variation. This method yields a numeric score and incorporates variation across: (i) iconic motivations,

(ii) surface realisations, (iii) feature differences. A gradient measure is able to unify variation stemming from multiple sources, each of which may vary to differing degrees within the same sign. We argue that especially in studies discussing sign language emergence, both token distributions within the dataset and distribution of variants across participants are fundamental to capturing variation adequately.

4.2 BACKGROUND

4.2.1 ICONICITY

Iconicity, defined as the structured mapping between meaning and form, acts as an organisational force across all natural languages (Perniss et al. 2010; Dingemanse et al. 2015). Taub (2001) describes iconicity in sign languages as a process of analogue building between semantic and phonological representations. Certain aspects from or related to a sensory image are first selected, then schematised, and finally linguistically encoded by mapping them onto the articulators, i.e., the signer's hands and body. More specifically, overlap in experiences and sociocultural and linguistic background of language users impacts the construal and the interpretation of iconicity (Wilcox 2004; Occhino 2017; Occhino et al. 2017).

One concept may result in many different iconic mappings. For example, the signs for BIRD in ASL and Turkish Sign Language (TİD) entail iconic mappings based on different sensory images and consequently, different schematisation and encoding (Figure 4-2). The ASL sign selects the sensory image beak and maps the signer's hand to the bird's beak, articulating it at the mouth to reflect shared structural and functional traits of a bird's beak and a human's mouth. The TİD sign selects and schematises the wings of the bird, mapping the wings onto the signer's arms, with a flapping motion to represent flying.

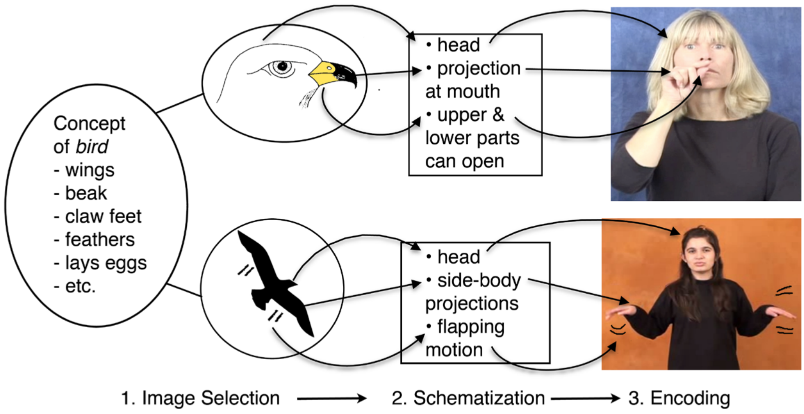

Figure 4-2. Analogue-building of the sign BIRD in ASL (top) and TİD (bottom) (from Emmorey 2014: 2). [Reproduced with permission]

Examining phonology and semantics shows that iconic mappings are compositional. Indeed, for the ASL sign BIRD, iconic mappings can be analysed at the phonological level by examining the features (i) 'handshape', (ii) 'location', and (iii) 'handshape change'. Thus, (i) a handshape with an aperture relation between index finger and thumb relates to the shape of the beak, (ii) the sign is produced at the *mouth*, reflecting shared properties between the beak and the mouth, (iii) the handshape *opens and closes*, reflecting the movement of a bird's beak. Both examples provided in Figure 4-2 show iconic mappings on multiple formational levels, yielding signs with different iconic motivations. Recent research has further suggested that iconic mappings extend beyond single lexemes; certain mappings are recurrent across the lexicon (van der Kooij & Zwitserlood submitted). Naturally, iconic mappings are situated within the cultural context in which a language is used, and/or emerges; thus, cultural knowledge shapes what features are available for selection and mapping.

To sum up, iconicity is a powerful force organising sign language lexicons. Semantic information related to a concept may be linguistically encoded through analogue-building. Properties of or related to the concept provide the raw materials which then become schematised and mapped onto the signer's articulators, creating iconic signs. This process can lead to different forms across languages and within a sign language.

4.2.2 COMPARISONS OF SIGNS

Comparisons of signs have long been a staple in both the field of lexicostatistics, where form similarities across different sign languages are used to establish phylogenetic relations (Woodward 1991; 1993; D. McKee & Kennedy 2000; Currie et al. 2002; Xu 2006; Sasaki 2007; Al-Fityani & Padden 2008) and sociolinguistics, where comparisons of signs within a single language target sociolinguistic variables (Bayley et al. 2000; 2002; Lucas et al. 2002; Schembri et al. 2009; Fenlon et al. 2013; Siu 2016). Studies on sign language emergence, and particularly emerging phonology, have also relied on comparisons of signs produced by signers with varying sociolinguistic profiles from the same linguistic community (Israel 2009; Israel & Sandler 2009; Sandler et al. 2011; H. Morgan 2015). In the following sections, we provide details about the methodological approaches and findings in each of the fields where sign comparisons are frequently used.

4.2.2.1 CROSSLINGUISTIC COMPARISONS

Within lexicostatistics, pairs of signs for the same concept from different macro-community sign languages are compared on different formational parameters ('handshape', 'location', 'movement', 'handedness', 'other'), often classifying signs as identical, similar, or different (Woodward 1991; 1993; D. McKee & Kennedy 2000; Currie et al. 2002; Xu 2006; Sasaki 2007; Al-Fityani & Padden 2008). More recent crosslinguistic comparisons are based on the feature level, using a match/non-match criterium (Yu, Geraci & Abner 2018; Börstell, Crasborn & Whynot 2020), or an adapted Levenshtein distance (also known as edit distance between two forms) (Parks 2011; Omardeen 2018). Such comparisons result in a numeric score rather than a categorical outcome, and thus are more appropriate to measure differences across sign language lexicons, allowing to include subtle differences in sign formation.

However, while form similarities in spoken languages have long been taken as evidence for linguistic relatedness, cognates in sign languages may also be due to overlap in iconic mappings stemming from similarities in human experiences that cross-cut cultures. Al-Fityani and Padden (2010) and Börstell and colleagues (2020) show that unrelated sign languages display form similarities. In particular across the basic vocabulary, sign languages show high degrees of formational similarity, possibly due to similar iconic mappings. For example, the ASL, New Zealand Sign Language and Auslan share 19% of the signs from a Swadesh list, including signs like GOOD, BIRD, CAT, CHILD, NARROW, RED, SUN (D. McKee & Kennedy 2000). However, integrating iconic motivations into sign comparisons has proven to be a challenge, especially for assessing relatedness, and thus, has not often been attempted. The implementation of a comparison of the iconic motivation before the parametric comparison as suggested by Xu (2006) still overestimates phylogenetic relations (Su & Tai 2009). It is possible that, as suggested by Ebling and colleagues (2015), a more fine-grained analysis of image-producing techniques and underlying motivation is needed, however no successful method has been made available at this point.

Summing up, crosslinguistic comparisons quantify form similarities based on parameter or feature overlap (Woodward 1991; 1993; D. McKee & Kennedy 2000; Currie et al. 2002; Xu 2006; Sasaki 2007; Al-Fityani & Padden 2008; Parks 2011; Omardeen 2018; Börstell et al. 2020). Crosslinguistic similarities may be due to shared iconic motivations or historic relatedness, with iconicity providing a complicating factor in phylogenetic analyses. The few studies that take iconicity into account are limited in their capacity to scale-up and lack a numeric outcome (Xu 2006; Su & Tai 2009; Ebling et al. 2015).

4.2.2.2 SOCIOLINGUISTICS

Comparisons of signs within the same language are frequently conducted to study sociolinguistic variation. Early work on signing varieties of Mexico and Costa Rica compares signs from word lists and dictionaries to determine dialectal variation (Bickford 1991; Woodward 1991). More recent studies are more specific about how linguistic and sociolinguistic factors affect sublexical variation, in particular age, region, and gender. Using large-scale datasets with signers of diverse demographics, these studies analyse the parametric deviation from a citation form using multivariate analyses (Bayley et al. 2000; 2002; Lucas et al. 2002; Schembri et al. 2009; Fenlon et al. 2013; Siu 2016). For example, Bayley and colleagues (2000) find an effect of age by region in the use of the three variants of the ASL sign DEAF (Figure 4-3) alongside a tendency for the third pictured variant (*continuous contact*) to occur in compounds. In studies examining variation within a language, sign comparisons are either concerned with a class of signs sharing a specific parameter (e.g., the extended index finger handshape in Bayley et al. 2002; Schembri et al. 2009; or the location parameter in Fenlon et al. 2013; Siu 2016; Lucas et al. 2002) or a class of signs that share the same meaning (e.g., Bayley et al. 2000). Iconicity, however, is not commonly considered, and does not appear as a major factor in the comparisons.

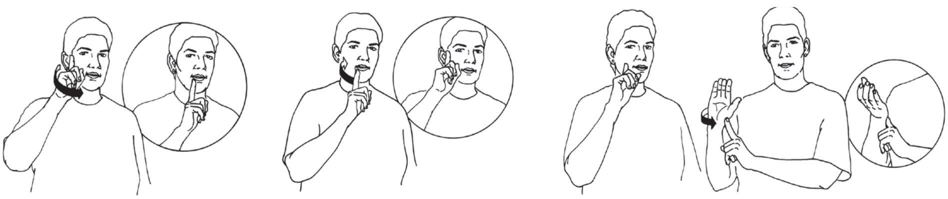

Figure 4-3. Three sign variants for DEAF in ASL (from left to right): movement *ear* to *chin*; movement *chin* to *ear*; continuous contact with *cheek* (in the compound DEAF-CULTURE) (from Bayley et al. 2000: 85). [Reproduced with permission]

To conclude, comparative work on signs within a single macro-community sign language does not primarily quantify form similarities or engage with iconicity. Sociolinguistic studies analyse large samples to identify which sociolinguistic variables influence formational variation in terms of deviance from a citation form (Bayley et al. 2000; 2002; Lucas et al. 2002; Schembri et al. 2009; Fenlon et al. 2013; Siu 2016). Nevertheless, the sociolinguistic determinants of the choice of specific variants in interaction remain to be investigated.

4.2.2.3 EMERGING PHONOLOGY

To examine phonological structure in young sign languages, researchers have employed picture-elicitation tasks, comparing how the same concept is encoded across different signers. The variants produced are then compared across signers to establish the degree of lexical convergence. To date, two studies have examined emerging phonological structure; Sandler and colleagues (Israel 2009; Israel & Sandler 2009; Sandler et al. 2011) examine ABSL, a young sign language of a rural community in Israel, and Morgan (2015; 2017) studies Kenyan Sign Language (KSL), a young sign language that arose in a deaf school in urban Kenya. These studies have suggested that in young sign languages, signers first converge on the same iconic image before aligning the exact phonological form (Sandler et al. 2011; H. Morgan 2015). As we are interested specifically in sublexical variation, studies investigating lexical variation in other small signing communities are not discussed here in detail. Nevertheless, these studies overlap with the present one in some methodological aspects, in particular the role of iconic motivations (Richie et al. 2014; Hou 2016; Neveu 2019; Reed 2019; Horton & Riggle 2019; Reed & Rumsey 2019).

In a crosslinguistic study, Sandler and colleagues compare the systematicity across ten signers of ABSL, Israeli Sign Language, and ASL in the form of signs on a picture-elicitation task (Israel 2009; Israel & Sandler 2009; Sandler et al. 2011). Monomorphemic responses are analysed (these constitute 43% of the data), with the most frequent iconic motivation considered. Comparing responses within the same sign language and then across languages, they find that ABSL, the young micro-community sign language, has the lowest degree of convergence, and

ASL, the older macro-community sign language used across the US, the highest. Variation is measured on the phonological feature level, using *mode*, count of the most frequent feature in a set, and *number of variants*, number of features occurring in a set of sign responses with shared iconic motivation. Sandler and colleagues (2011) conclude that ABSL signers strive for a holistic iconic motivation rather than a compositional sign. However, it is difficult to know how far this outcome is affected by their decision to focus on monomorphemic responses, and to exclude competing variants with different iconic motivations.

Morgan (2015) also uses a picture-based elicitation task to examine the emerging lexicon of KSL. Within the KSL lexicon, the degree of conventionalisation was found to vary from sign to sign, leading Morgan (2015) to hypothesise that signers first converge on an iconic motivation (or *conceptual target*) before aligning their phonology. Across the 20 deaf KSL signers sampled, items like *salt* elicit uniform lexical responses while others such as *island* elicit highly descriptive and probably idiosyncratic responses, similar to ABSL. Morgan posits that during the process of conventionalisation, signs may either converge on a single iconic motivation (e.g., how the fruit is eaten in GUAVA) or stabilise as a compound (e.g., READ^TINY for beans) before aligning in phonological form (H. Morgan 2015).

Summing up, sublexical variation has often been connected to the age of a sign language and its conventionalisation. As observed in KSL and ABSL, signers appear to conventionalise iconic mappings despite large amounts of feature-level variation. The fact that both of these sign languages show variation on the level of the iconic motivation and the sublexical level indicates that variation does not materialise on a single level.

4.2.3 KATA KOLOK

4.2.3.1 DEMOGRAPHIC SKETCH

The sign language Kata Kolok emerged spontaneously in a village community in North-Bali, Indonesia, due to sudden and sustained incidences of hereditary deafness (de Vos 2012b; Marsaja 2008). Deafness was propagated due to geographical isolation and consanguineous marriage patterns within the labour-intensive community (Friedman et al. 1995). Kata Kolok has been passed on throughout at least six generations of deaf signers (Friedman et al. 1995; de Vos 2012b). At present, 33 deaf signers from generation three through six reside in the village permanently, their ages ranging from three years (generation six) to ~80's (generation three) (Lutzenberger in press).[12] Communal living in family compounds with shared religious, social and cultural practices has led to a high proportion of hearing villagers with signing skills (Marsaja 2008).

The tight-knit community of roughly ~3,000 people is socially and geographically structured into ten clans for which membership is determined by birth (Lutzenberger in press). Deaf people have been born into all ten village clans (Marsaja 2008). Following a patrilineal tradition, women transition to their husband's clan through marriage. Within clans, intergenerational households are the norm. This results in tight family bonds where younger generations care for older generations, and childcare becomes a shared task, involving older generations.

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[12] The literature on sign language emergence lacks consensus on how language age is counted and reported, e.g.,- biological generations, cohorts of signers, etc. and explicit discussions or explanations for the delineation of a generation (Kisch 2012). In this study, we follow the timeframe laid out in de Vos (2012b) and provide rough age categories for different generations. Crucially, generation one in this account constitutes five deaf siblings who had an older deaf uncle.

The professional landscape of the villagers has long centred around subsistence farming, raising livestock, day labour, or running small local businesses. Recent advances in technology and mobility continue to affect the community's demographics. There is increasing employment within government-supported jobs such as constructing infrastructure or tourism. As a result, villagers may seek job opportunities outside the village and may even relocate to more densely populated areas. This also creates new opportunities for younger deaf villagers who increasingly attend school, or even grow up, in more urban parts of Bali where a variety of Indonesian Sign Language (BISINDO) is used (Lutzenberger in press).

4.2.3.2 SKETCH OF THE PHONOLOGY AND THE LEXICON

Kata Kolok is a sign language isolate, having developed without influence from other sign languages (Marsaja 2008; Perniss & Zeshan 2008; de Vos 2012b). Moreover, the surrounding spoken languages Bahasa Indonesia and Balinese do not seem to have strongly influenced the structure of Kata Kolok (Marsaja 2008; Perniss & Zeshan 2008; de Vos 2012b). Evidence for this is, for example, the virtual absence of mouthing, the conventional pairing of manual signs and imitating a spoken word which is a prominent feature in many macro-community sign languages (Crasborn et al. 2008; Bank 2015). In Kata Kolok, mouthing has been observed only with limited vocabulary and by specific deaf signers; the word <kopi> alongside the sign COFFEE or <apa> accompanying the sign WHAT. Increasing contact with BISINDO especially among younger signers (Moriarty 2020) who have also received basic education may trigger increased presence of mouthing and occasional lexical borrowings in

specific conversational settings, topics, and interlocutors.

Low conventionalisation is found in core domains of the Kata Kolok lexicon, paralleling other micro-community sign languages across the world (e.g., Washabaugh 1986; Nyst 2007; Schuit 2014). Both colour and kinship terms show a limited paradigm of lexicalised signs in Kata Kolok. Kata Kolok uses the four lexicalised colour signs WHITE, BLACK, RED, and GRUE (de Vos 2011) and the three lexicalised kinship signs MOTHER, FATHER and OFFSPRING (de Vos 2012b).

High variation in the Kata Kolok lexicon is partly influenced by social factors. Mudd and colleagues (2020) analyse the first target sign in response to a picture elicitation task of 36 common concepts from 20 deaf and 26 hearing Kata Kolok signers to determine the effect of social factors on sign variation. Using measures for lexical distance and neighbourhood density, they find that gender and hearing status, but not other social variables, such as generation, may predict the use of specific signs (Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020). This contrasts with studies on macro-community sign languages that often find that age and region strongly predict the choice of sign variants (e.g., Bayley et al. 2002; Stamp et al. 2014).

Neither the lexicon nor the phonology of Kata Kolok have been studied in detail. Marsaja (2008) summarises basic building blocks of Kata Kolok in terms of ‘handshapes’, ‘locations’, and ‘movement’ features attested in his corpus. However, their status as phonetic or phonologically contrastive features remains unclear. De Vos (2012b) revisits Marsaja’s classification and suggests some modifications in terms of frequency or discrepancy of a few handshapes. Crucially, Kata Kolok uses an extended signing space, reflected in some sign locations that are infrequent or even unattested in other sign languages, e.g.,the *hip* or the *teeth* (Marsaja 2008; de Vos 2012b). Lutzenberger (2018) finds major crosslinguistic differences in the phonological characteristics of name signs, a particular group of signs attributed to individuals, between Kata Kolok and NGT with respect to the use of locations, nonmanuals, and specific handshapes. Similar to preliminary characteristics of Kata Kolok features and the atypical use of space (Marsaja 2008; de Vos 2012b), these findings indicate typologically distinct patterns in Kata Kolok's phonology.

To sum up, Kata Kolok shows typological differences to other sign languages in terms of various aspects of its phonology and lexicon, and high degrees of variation in the lexicon.

4.2.4 PRESENT STUDY

Studies investigating spoken languages and macro-community sign languages often treat variation as a rich resource to answer questions about linguistic diversity, inter-speaker variability, and linguistic landscapes of communities. However, studies on sign language emergence typically focus on convergence between signers rather than variation. In this study, we aim to reach a better understanding of the phonological properties of the lexicon in Kata Kolok through examining variation. To that end, we ask the following question: what is the variation in the form of signs found across 20 deaf Kata Kolok signers in response to the same picture prompts as in Mudd and colleagues (2020) (see Chapter Three)? We combine methods from lexicostatistics and previous work on emerging phonology in order to analyse the present state of the lexicon in Kata Kolok. Systematic feature-based comparisons used in lexicostatistics have not previously been adapted to data from micro-community sign languages, and common analyses used in sociolinguistics are unsuitable for micro-community sign languages as it is hard to define a standard variant, as explained by Mudd and colleagues (2020). The measure introduced in this study combines techniques of all those methods, taking into account all relevant signs in a response from a large-scale sample of 60% of the deaf adult Kata Kolok signers.

4.3 METHODOLOGY

4.3.1 PARTICIPANTS

The sample in this study comprises the same 20 deaf signers (11 female) of Mudd and colleagues (2020), all of whom permanently reside in the village and use Kata Kolok as their primary mode of communication. Participants are sampled from generation three (ages ~65-80) through five (ages ~18-35) (see Table 4-1), as there are no deaf generation two (ages ~80+) signers alive and deaf generation six (ages ~2-5) signers are young children. We also sampled in such a way to maximise diversity in the socio-demographic profiles of the signers.[13]

Table 4-1. Overview of participants.

code	G	KI	MR	SA	SM	KE	KR	MG	NG	PA	PU	RA	SK	MU	RI	JU	P1	P2	SB	SY
generation	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5	5	5	5	5
gender	M	F	F	M	M	F	M	F	M	M	F	F	F	F	F	M	F	F	M	M

[13] For more information on the participants see Mudd and colleagues (2020).

4.3.2 STIMULI

Due to the low literacy rate among our participants, we used picture stimuli. Participants were shown 36 pictures of common objects, spanning the semantic domains *food, animals, colours, praying, miscellaneous* (see Appendix 4-A for a full list). Pictures were either taken in the field during previous field trips, or found on the internet (for materials see Lutzenberger, Mudd & Ni Made Sumarni 2018). Stimuli selection was informed by the authors' linguistic and cultural knowledge of the community. In addition, as the task was originally administered to both deaf and hearing participants (Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020), stimuli were selected to match the knowledge of hearing people with varying degrees of signing fluency. In order to get a broad sample of signs with different degrees of variation, stimuli were selected based on the expected lexical variation for each item (high, medium, low). These classifications drew on insights from the Kata Kolok Corpus, consulting local deaf research assistants and language knowledge of the first author, a fluent Kata Kolok signer (for selection process see Chapter Three).

4.3.3 PROCEDURE

Data was collected during a field trip in November, 2018. Recording took place in an empty room, and the task was administered by a local deaf research assistant. Before each session, the task was explained to the participants and consent was obtained through signature or thumbprint. The research assistant, who was instructed to act as interlocutor, sat opposite the participant and independently navigated the participant through the stimuli one-by-one on a laptop. The entire

session was videotaped using a Canon Legria HF G26 camera at 25 frames per second.

The present set of stimuli was embedded into a larger set of picture- and object-based elicitations. All participants had previously participated in this kind of elicitation and were thus fairly familiar with the task. For this reason, instructions provided to the participant were minimal and mostly delivered during the informed consent by using fictive examples while explaining the procedure. The research assistant invited the participant to respond to a picture through either directing the attention to the screen through eye gaze alone, or a short, signed construction that translates into 'What is this?'.[14]

4.3.4 CODING

The recorded responses were annotated using ELAN (Crasborn & Sloetjes 2008; *ELAN [Computer software]* 2020) and glossed using the Kata Kolok dataset in the lexical database Global Signbank (Crasborn et al. 2018; Lutzenberger 2020). All coding was done by the first author, including annotations for activity of both hands of the signer, facial expressions, the stimulus item, any signing of the research assistant, and chunks directly related to the picture stimulus (Figure 4-4).[15] In cases where the research assistant named the stimulus before the participant, all subsequent signs

[14] The construction used by the deaf research assistant often included a backwards head tilt and a brow raise which are common markers of questions, and was sometimes combined with a point towards the laptop $\text{PT}_{\text{laptop}}$ or a sequence of a pointing and a generic question sign $\text{PT}_{\text{laptop}}$ WHAT $\text{PT}_{\text{laptop}}$.

[15] 1example, etc.) but used this coding only as a reference point since these categories are not mutually exclusive (see Figure 4-4).

were marked as primed (pGLOSS). Immediate and exact repetitions, i.e., next following sign produced by the participant is the same surface realisation as produced by the research assistant, were marked as xGLOSS and excluded from the analyses.

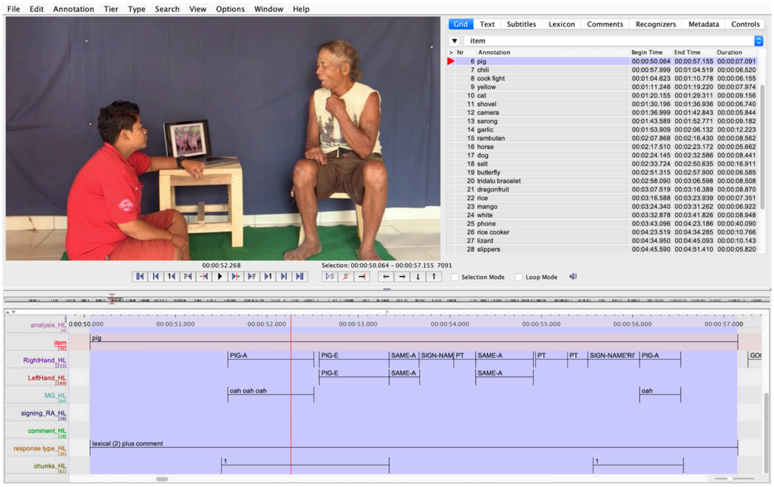

Figure 4-4. Screenshot of an annotated ELAN file, detailing the coding scheme.

Every sign produced in response to a picture stimulus was coded for form in order to preserve minimal formational differences (phonological or phonetic). The Global Signbank dataset was edited alongside the annotation process, creating a new entry whenever there was no entry for a specific sign variant yet. Sign variants were grouped by shared iconic motivation using numbers, e.g., PIG-1 and PIG-2. Different realisations of the same iconic motivation are marked with capital letters e.g., COW-1A, COW-1B, COW-1C (Figure 4-5). The iconic motivation coding included finer-grained distinctions such as between walking and galloping legs of a horse, similar to what Ebling and colleagues (2015) refer to as *imaging techniques*. Similar to studies previously mentioned (Richie et al. 2014; Hou 2016; Horton 2018; Hou 2018; Neveu 2019; Reed 2019; Horton & Riggle 2019; Reed & Rumsey 2019), this study uses iconic motivation as a grouping factor for sign variants. Since an analysis and in-depth discussion of iconic patterns and associated mappings is beyond the scope of this paper, we provide a list of iconic motivations for signs in this study in Appendix 4-B and refer to Mudd and colleagues (2020a) for further discussion of patterned iconicity in the same dataset. In order to provide a measure for coding reliability, the first author re-coded the iconic motivation for 11% of the items (n=4; first two and last two items) as well as the feature coding of surface realisations for 10% of the produced iconic motivations (randomly sampled). Intra-coder reliability scores are reported in percentage of overlap, and Cohen's Kappa for iconic motivation, chunks of target responses, and feature coding: iconic motivation (95% overlap; Kappa = 0.94), chunks of target responses (95% overlap; Kappa = 0.909), gloss of surface realisations (97% overlap), and feature coding (94.6% overlap; Kappa = 0.943). Videos and ELAN transcriptions are archived in The Language Archive (Lutzenberger et al. 2018).

PIG-1 PIG-2 COW-1A COW-1B COW-1C

Figure 4-5. Variants of PIG include different iconic motivations, marked by a number, namely killing a pig (PIG-1) and a pig eating (PIG-2). Variants of COW share the same iconic motivation of the cow's horns but show different surface realisations, marked by a number followed by a capital letter (COW-1A, COW-1B, COW-1C).

4.3.5 ANALYSES

Unlike previous work (Israel 2009; Israel & Sandler 2009; Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020), we analyse all sign tokens naming or directly describing the picture and exclude only those parts of answers that provide additional information. Responses were classified as off-target in case the stimulus was not recognised (correctly), and when signers provided lengthy explanations, personal narratives, descriptions of details and elaborations without explicitly referring to the target. In the following sections, we describe the analyses in detail. First, we explain the general idea and workings behind how variation may be measured. Then, we discuss how frequency can affect the proposed measuring and how it can be weighted to gain a more nuanced measure.

4.3.5.1 MEASURE OF VARIATION

In order to address the question as to how to quantify formational variation in our dataset, we developed a new measure of variation. This measure integrates three levels inherent to a sign (iconic motivation; surface realisation; feature differences; Figure 4-6)[16], and results in a numeric and gradient score, the *variation index*.

Iconic Motivation (IM) functions as a grouping criterion for sign variants. As pointed out by Israel (2009), it does not make sense to compare the form of signs

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[16] For the purpose of this study, we obstain from equating iconic motivations with lexical variants and surface realisations with phonological variants since this traditional distinction is based on phonological parameters while this measure is concerned exclusively with the feature-level. Furthermore, freeing ourselves from these labels allows us to stay closer to the form without categorising signs prematurely

that do not share the same iconic motivation as no form similarity is expected.[17] Returning to the example of sign variants for pig and cow provided in Figure 4-5, we can identify different iconic mappings: the cow's horns in COW-1, killing a pig in PIG-1, and how a pig eats in PIG-2. Each is scored as 1 on the level of IM for the variation index. IM can be used independently as an accumulative count of unique iconic motivations occurring in response to a given stimulus. In Figure 4-6, accumulative IM yields a score of 2 for *pig* as responses include two iconic motivations, namely PIG-1 and PIG-2, and a score of 1 for the item *cow*.

Surface Realisation (SR) is a count of the different surface realisations with the same iconic motivation. In Figure 4-5, both variants for pig, PIG-1 and PIG-2, have a single surface realisation, resulting in each a score of 1 for SR. Among the COW-1 signs however, COW-1A, COW-1B and COW-1C are three different surface realisations of the same iconic motivation. The SR for COW-1 is thus 3. Note that the relationship between IM and SR is minimally one-to-one; each iconic motivation occurs with a minimum of one SR.

Feature Differences (FD) explore the locus of variation within surface realisations of each iconic motivation. The feature coding is based on Global Signbank, comparing signs based on 14 different features:

- Handedness
- Hand Configuration Strong Hand
- Hand Configuration Weak Hand
- Handshape Change

[17] Note that we coined Iconic Motivation as grouping criterion since the use of picture stimuli is conducive to eliciting signs with iconic motivation. However, this may be broadened to a sign's origin to accommodate both iconic and non-iconic signs; as long as two variants have clearly distinct origins, they may be regarded as sign variants. With this extended understanding, the proposed method should be equally applicable to iconic and non-iconic signs.

- Relation between Articulators
- Location
- Relative Orientation Movement
- Relative Orientation Location
- Orientation Change
- Contact Type
- Movement Shape
- Movement Direction
- Repeated Movement
- Alternating Movement

FD counts the number of features that differ across the attested surface realisations. In the case of the three cow-1 variants pictured in Figure 4-5, all differences concern the configuration of the hands; specifically, the curvature of the fingers and thumb extension of the strong hand and the weak hand. The FD in cow-1 is therefore 2.

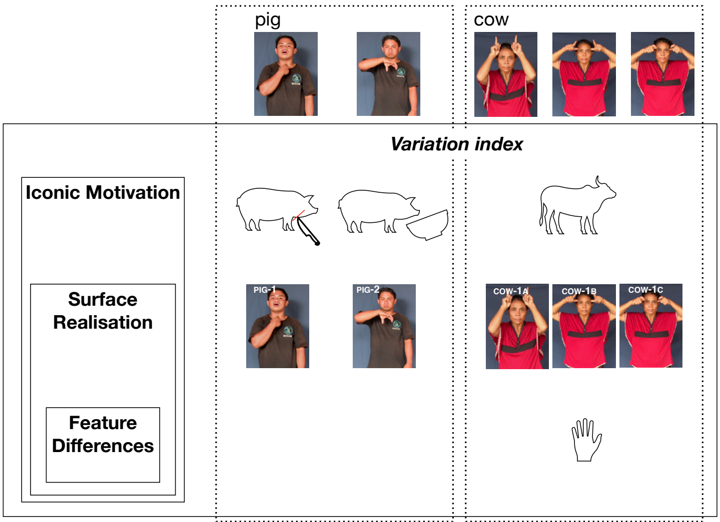


Figure 4-6. Nested structure of the different levels of the measure.

Overall, this measure provides the opportunity to compare different levels as well as different sign variants. Within one item, we can compare variation across different iconic motivations based on the following formula:

$$\text{Variation} = \frac{\left(\text{IM} + \text{SR} + \frac{\left(\frac{\text{FD}}{14}\right)}{\text{SR}}\right)}{3}$$

A variation index is calculated per iconic motivation, hence IM is the constant 1; each variation index is normalised by dividing feature differences by the constant 14 for the 14 available features, and the number of surface realisations SR; the entire formula is divided by the three levels (IM, SR, FD). For example, COW-1 received a score of 1 for IM, a score of 3 on SR, and a score of 2 on FD. Each of these levels of variation are weighted equally, hence (1 + 3 + ((2/14)/3))/3=1.35. Another fictious sign variant COW-2 with a different iconic motivation and a single surface realisation result in a variation index of 0.67 (see Table 4-2). The difference in variation between the two COW-variants is reflected in their variation indices: COW-1 shows a higher score, i.e., more variation, than COW-2. Note that a variation index of 0.67 is the minimal value of any sign variant with a single surface realisation because of the one-to-one relationship between iconic motivation and surface realisation. We will refer to this baseline as no variation here after and elaborate in Section 4.6 on some implications of the fact that the absence of variation may be caused by either extreme uniformity or a hapax, i.e., unique variant in the data set.

Table 4-2. Example calculation of variation indices.

Item		Iconic motivation (IM)	IM	Surface Realisations (SR)	SR	Feature Differences (FD)	FD	Variation index
cow	COW-1A	COW-1	1	COW-1A	3	Hand configuration strong hand Hand configuration weak hand	2	1.35
	COW-1B	COW-1		COW-1B				
	COW-1C	COW-1		COW-1C				
	COW-2A	COW-2	1	COW-2A	1	N/A	0	0.67
pig	PIG-1A	PIG-1	1	PIG-1A	1	N/A	0	0.67
	PIG-2A	PIG-2	1	PIG-2A	1	N/A	0	0.67

Variation indices may be calculated per iconic motivation and account for the formal variation within an item at both the level of surface realisations and feature differences. Note that this measure focuses on the forms that occurred in the data. It does not take into account the linguistic environment of specific forms, any aspects of the participant/social factors, or the frequency of a sign variant. The following section discusses how frequency can be woven into the measure.

4.3.5.2 WEIGHTED VARIATION INDEX

As a next step, we further develop the variation index in order to increase the ecological validity of the comparison among different sign variants. First, we combine the variation index with token frequency in the dataset. Second, we combine the variation index with the number of signers producing a specific variant, i.e., scope of use across the population. In other words, we apply weight by frequency, once token-based and once signer-based.

Token-based weighting aims to relativise the variation index in terms of reflecting high frequency or idiosyncratic sign variants. In the scope of this study, token frequency refers to sign variants produced within an item or pooled across all items. A *token-weighted variation index* is calculated as the product of the proportion of each sign variant and the unweighted variation index as explained in the section here above:

$$\text{Variation}_{\text{token-weighted}} = \text{Variation} * \frac{\text{freq sign}}{\text{total signs}}$$

First, we calculate token-weighted variation indices within items. We obtain the proportions for each iconic motivation as the number of tokens of an iconic motivation/surface realisation within an item divided by the total number of tokens of all iconic motivations/surface realisations of the particular item. For a fictious example, COW-1 has been produced at 20/30 tokens and COW-2 at 10/30 tokens in *cow*. Thus, COW-1 accounts for 67% and COW-2 for 33% of the 30 sign tokens. The token-weighted variation index for COW-1 then is 0.9 (1.35*0.67) and for COW-2 0.2 (0.67*0.33). Comparing the token-weighted variation indices more accurately captures the idea that COW-1 shows more variation while also being more frequent than COW-2.

Second, we move beyond the item by deriving proportional values for each sign variant from the entire dataset (tokens of sign variant/total tokens). Following the same approach, proportional values for iconic motivations or surface realisations are multiplied with an updated unweighted variation index. Updating the unweighted variation index is necessary as some sign variants may feature in responses to multiple picture stimuli, e.g., sign variants for RED are frequently produced in response to the picture stimulus *dragon fruit* (pitaya) as well as the colour *red*. Now, sign variants can be compared freely to each other, allowing us to fully capture the variation in the dataset.

However, token frequency does not account for a single signer producing a certain sign variant several times. We gain a more nuanced insight into how widespread specific sign variants are across our participant pool when applying weight through attested variants per signer. Here, we count how many of the 20 signers produce a specific sign variant in each item and then multiply the fraction with the unweighted variation index:

$$\text{Variation}_{\text{signer-weighted}} = \text{Variation} * \frac{\text{N signer}}{20}$$

4.4 RESULTS

4.4.1 DESCRIPTIVE RESULTS

The data yielded a total of 1,739 relevant sign variants (151 iconic motivations) to refer to 35 stimuli that entered the analyses. Due to confusability in the picture stimulus we excluded responses to *salt* altogether; the picture showed two different packages of salt, leading to misinterpretations of the picture and some signers creating contrast and others providing general descriptions. In all other items, off-target responses (n=24) and immediate and exact repetition of signs prompted by the research assistant (n=21) were excluded. Note that we deal with the form of signs and their token frequency in the data obtained in this experiment only. Characteristics of the participants, e.g., individual verbosity or correlations of idiosyncratic variants are not under investigation here. Initial analyses of selected social variables have been addressed in Chapter Three.

In line with Chapter Three, we observe variation even when considering only the deaf participants. Different stimulus items elicit different numbers of iconic

motivations, which, in turn, differ greatly in the number of surface realisations and their feature differences. The number of iconic motivations documented across the 35 included items ranging from one single iconic motivation in *dog, chicken*, and *cow* to as many as nine different iconic motivations in *rice cooker* (see Figure 4-7).[18] This broad range may indicate different degrees of conventionalisation in sign variants. Equally possible is a more general problem inherent to the nature of picture elicitations, namely differing degrees of precision when naming or describing the picture stimuli, or both.

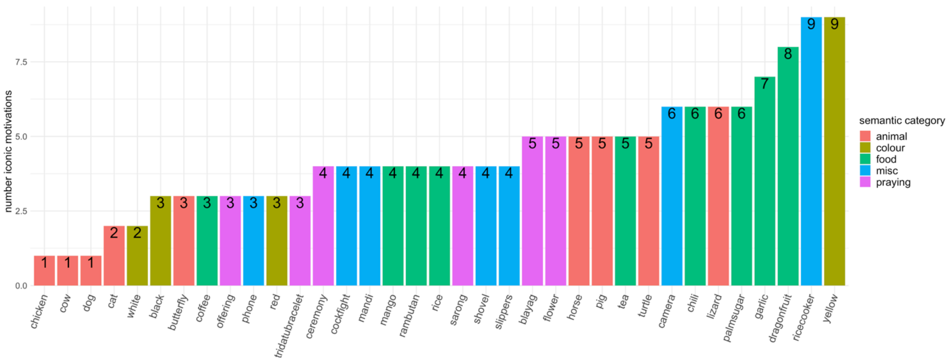


Figure 4-7. Number of iconic motivations produced per item.

Across all items, iconic motivations with a single surface realisation are frequent (68/151, 45%). Conversely, 55% of the data includes iconic motivations with more than one surface realisation. Specifically, iconic motivations with two (34/151, 22.5%), three (27/151, 17.9%), four (10/151, 6.6%), five (4/151, 2.7%), six (5/151, 3.3%), seven (2/151, 1.3%), and even with eight (1/151, 0.7%) surface realisations are attested. On

[18] Note that the number of iconic motivations elicited per item differs from the one reported in Mudd and colleagues (2020) as this study is based on the full response rather than a single target sign per signer for each stimulus.

the level of feature differences, variants of the same iconic motivation vary between 0 to 12 features. As discussed in Section 4.3.5.1, comparisons of formal aspects across different iconic motivations are not meaningful as no similarity is expected.

4.4.2 VARIATION INDEX

Variation indices are calculated for each iconic motivation in each item. Figure 4-8 plots all signs in the analysis and their respective variation indices by item. The majority of signs shows a variation index between 1 and 1.5 (mean = 1.43; sd = 0.63; range = 0.67 - 3.03). Signs near the y-axis show no variation (variation index 0.67), mostly due to a single surface realisation. Signs with a variation index higher than 2 are infrequent.

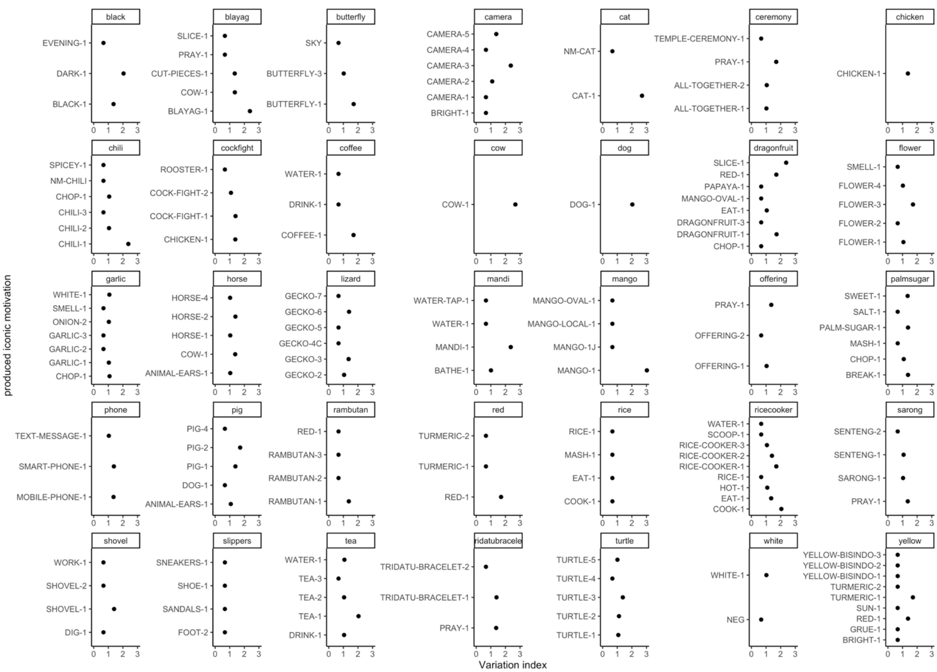


Figure 4-8. Variation index (x-axis) calculated for iconic motivations (y-axis), grouped by item.

Variation occurs to different degrees on different levels. Stimuli that are represented by a single iconic motivation such as *chicken, dog*, and *cow* show different variation indices caused by variation on the surface and feature level (Figure 4-8; Figure 4-9). CHICKEN-1 has three different surface realisations of the same iconic motivation while there are five for DOG-1 and seven for COW-1 (Figure 4-9). The three surface realisations of CHICKEN-1 vary in three features, the five surface realisations of DOG-1 are a result of differences in six features, and the seven surface realisations of COW-1 differ in four features. Taken together, these differences reflect in different variation indices for CHICKEN-1 (1.37), DOG-1 (2.03), and COW-1 (2.68). These examples clearly show that items eliciting a single iconic motivation do not necessarily yield similar degrees of variation on the other levels.

Figure 4-9: Variation across three items eliciting one iconic motivation: *chicken, dog*, and *cow*.

For items eliciting multiple iconic motivations such as *camera*, variation indices do not distribute evenly across all iconic motivations as sign tokens split into more iconic motivations (Figure 4-8). Three of the six iconic motivations in response to the picture stimulus *camera*, BRIGHT-1, CAMERA-1, and CAMERA-4, occur with a single surface realisation, resulting in no variation (variation index 0.67). The other three iconic motivations show different variation indices: CAMERA-2 has two realisations that differ in seven features (variation index 1.10), CAMERA-3 has six realisations with nine feature differences (variation index 2.37), and CAMERA-5 has three variants varying in five features (variation index 1.37) (Figure 4-10). Once again, this shows that (i) variation emerges on different levels that may vary independently from each other (i.e., fewer surface realisations do not always mean fewer feature differences), and (ii) some iconic motivations show no variation.

Figure 4-10. Variation across selected variants elicited to the prompt *camera*.

The variation indices reported until now quantify variation in terms of unique iconic motivations. However, the more responses feature a certain iconic motivation, the more opportunity it has to show variation. Sign variants that are produced only once can only have a single surface realisation, resulting in no variation, while sign variants that occur x times could have maximally x different surface realisations and could differ in up to 14 features. Token frequency shapes how much variation can be attested in a given dataset, and indeed, variation indices correlate positively with frequency ($r = 0.69$, $p < .001$): sign variants that have been produced more often tend to have higher variation indices.

4.4.3 WEIGHTED VARIATION

In the following, we report weighted variation indices, first taking into account token frequency, and then the number of signers producing specific sign variants as laid out in Section 4.3.5.2.

The token-weighted variation index within an item shows different effects on stimuli eliciting a single iconic motivation or multiple ones. For items such as *chicken, dog*, and *cow* that elicited a single iconic motivation, weighting results in identical scores as the weighting factor is 1: the token-weighted variation index remains at 1.36 for CHICKEN-1, at 2.03 for DOG-1 and at 2.68 for COW-1 (Figure 4-11). For items that elicited more iconic motivations such as *camera*, the token-weighted variation index highlights differences: BRIGHT-1 (token-weighted 0.04; unweighted 0.67), CAMERA-1 (token-weighted 0.09; unweighted 0.67), CAMERA-2 (weighted 0.12; unweighted 1.10), CAMERA-3 (token-weighted 1.0; unweighted 2.37), CAMERA-4 (token-weighted

0.05; unweighted 0.67) and CAMERA-5 (token-weighted 0.29; unweighted 1.37), reflecting the amount of variation in light of how much opportunity a sign variant has to vary. CAMERA-3 remains the variant with the highest token-weighted variation index among the iconic motivations in this item, yet the variation is now proportional to the high number of signs corresponding to this iconic motivation (Figure 4-11). This facilitates comparisons of variation across iconic motivations from the same item. In short, a token-weighted variation index approximates the actual productions in the data better than the unweighted variation index and thus improves how the scores reflect the observed variation.

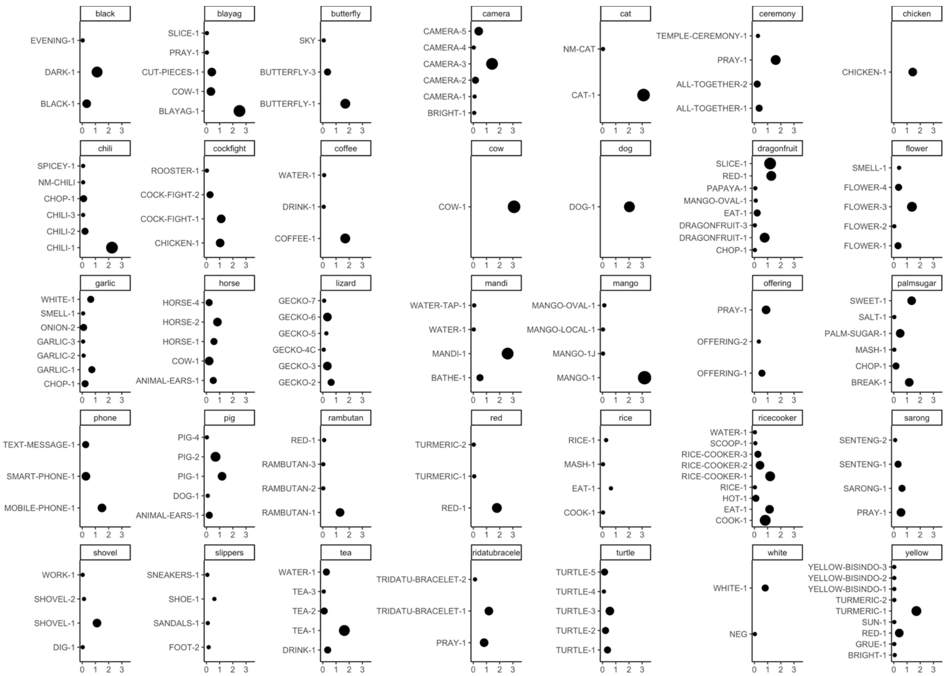


Figure 4-11. Token-weighted variation (x-axis) for iconic motivations (y-axis) produced in each item. For sake of clarity, point size is adjusted by frequency.

Treating the data as a mini-corpus, i.e., no grouping by item, the token-weighted variation index identifies a tendency for dominant variants.[19] A large part of the data clusters with low(er) token-weighted variation indices, indicating no dominant variants (see Appendix 4-C for all datapoints with variation), yet dominant surface realisations become apparent through a considerably higher token-weighted variation index. Figure 4-12 provides only a snippet of the data for the sake of readability, showing surface realisations elicited in three selected items with different degrees of variation: *tea, dog*, and *camera*. TEA-variants cluster together, showing a wider distribution of token-weighted variation indices; no clearly dominant variant becomes apparent. In contrast, DOG-1A (n=24; token-weighted 0.03) shows higher token-weighted variation index than DOG-1B (n=3; token-weighted 0.004), DOG-1C (n=3; token-weighted 0.004), DOG-1D (n=1; token-weighted 0.001), or DOG-1E (n=3; token-weighted 0.004), due to considerably higher frequency applied to the same unweighted variation index (Figure 4-12). Similarly, CAMERA-3A (n=24; token-weighted 0.01) has the highest token-weighted variation index out of all CAMERA-variants as it occurred most frequently in the data (n=7). Note that the power of frequency is particularly visible in iconic motivations that occur in response to more than one stimulus, leading to a very high overall frequency (e.g., RED-1 was produced in 68 tokens as compared to 24 DOG-1 tokens and 16 CAMERA-3 tokens). However, we must not forget that a considerable portion of the data shows no variation (68/151, 45%).

[19] In contrast to lexicography and efforts of language standardisation, this paper is aimed at documenting and measuring variation in the dataset. For this reason, we make no claim that dominant variants should be regarded as citation forms. Dominant variants emerge as a result of frequency of sign variants in the data; they are linked to frequency and more specifically, frequency within this specific dataset.

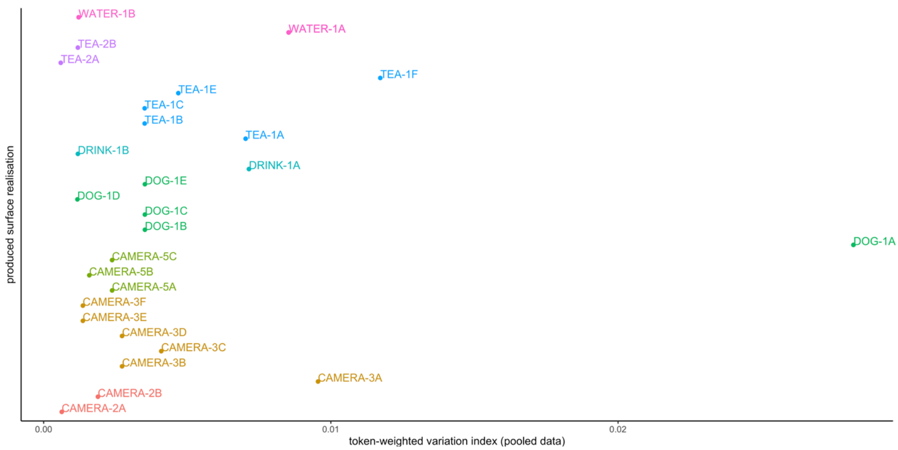


Figure 4-12. Examples of token-weighted variation index (x-axis) for each produced surface realisation (y-axis), pooled across all data and colour-coded by iconic motivation. Plot includes only sign variants with variation (>1 surface realisation).

The signer-weighted variation index corroborates dominant variants. Whereas weight by token frequency only identifies which variants are produced often, weight by signer identifies how widespread variants are across participants. For ease of readability, Figure 4-13 illustrates the same selected examples as in Figure 4-12 (find full graph with all data with variation in Appendix 4-D). Figure 4-13 demonstrates that TEA-1 (brewing loose leaves) is more widespread across participants than TEA-2 (steeping tea bag). Indeed, we may even pinpoint specific dominant surface realisations. Within TEA-1 (unweighted 2.04), two surface realisations are produced by 12/20 signers: TEA-1A (signer-weighted 0.51) and TEA-1F (signer-weighted 0.71), only differing in 'handedness' (TEA-1A is two-handed; TEA-1F is one-handed). Maybe even more striking is the example of DOG-1 variants (unweighted 2.03): DOG-1A (signer-weighted 1.42) was produced by 14/20 signers, DOG-1B (signer-weighted

0.20) and DOG-1C (signer-weighted 0.20) by two and DOG-1D (signer-weighted 0.10) and DOG-1E (signer-weighted 0.10) by one participant. Without doubt, DOG-1A represents the most widespread variant and the high unweighted variation index stems from variants produced by only few participants. These examples are clear evidence of (i) patterned variation that often includes particularly widespread surface realisations, and (ii) variation as a result of few signers producing non-dominant variants, either due to idiosyncratic characteristics (potentially caused by individual socio-demographic profiles), or preference of another iconic motivations.

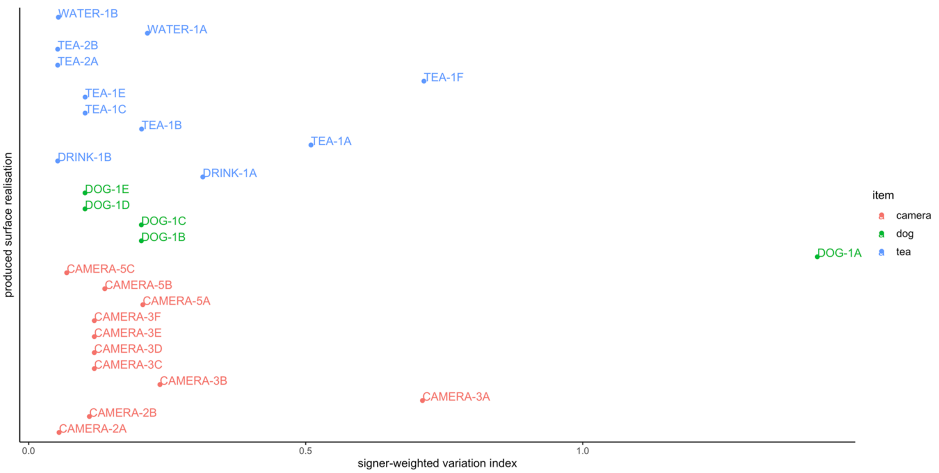


Figure 4-13. Examples of signer-weighted variation index (x-axis) for each produced surface realisation (y-axis), colour-coded for item. Plot includes only sign variants with variation (>1 surface realisation).

To sum up, both frequency-based weightings improve the ecological validity of the measure; a token-weighted variation index demonstrates how tightly variation and frequency are intertwined (further discussed in Section 4.6.1), a signer-weighted variation index identifies the dispersion of sign variants both in terms of iconic motivations and surface realisations across the population. In other words, Figure 4-12 and Figure 4-13 as well as the graphs of the full data (Appendix 4-C and Appendix 4-D) provide two different ways of looking at the same dataset (i.e., the effect of, first, the number of produced tokens, and second, the number of signers using a particular variant). Nevertheless, both point towards the same dominant variants, i.e., iconic motivations and/or surface realisations that are (i) more frequent than others (token-weighted) and (ii) more widespread across participants (signer-weighted). Given that we allow for one signer producing multiple signs, dominant variants crystallise even more clearly with the signer-weighted variation index than with the frequency-weighted variation index.

4.5 MEASURING VARIATION

Studies in sign language emergence focus on the iconic motivation as developing systems may not yet exhibit phonological structure. The following section is dedicated to laying out how the variation index compares to and improves existing methods. To this end, we provide a case study of three items from our data comparing our method to the measure of Israel (2009) and Israel and Sandler (2009): mode and number of variants. As a reminder, Israel and Sandler narrow their analysis to the most frequent iconic motivation provided in responses to a picture stimulus; they then do a feature analysis of this subset of signs calculating mode and number of variants for each feature class. Note that the mode is calculated relative to the number of signers who produce this iconic motivation, leading to different items having differently sized sets. Israel and Sandler use the number of surface realisations as a measure of sign-level variation.

For this case study, we re-use the three stimuli from Figure 4-12 and Figure 4-13 as they elicited different degrees of variation: *tea, dog*, and *camera*. Following Israel and Sandler's method of analysing one-sign responses, we selected the first target sign in each response when the response contained multiple. For each of the three items, we identified the most frequent iconic motivation (TEA-1, DOG-1, CAMERA-3) and then calculated the mode and the number of variants for each feature as described in Israel (2009) (Figure 4-14A). The set sizes differ greatly: DOG-1 was produced by 19 signers, TEA-1 by 16 signers, and CAMERA-3 by nine signers.

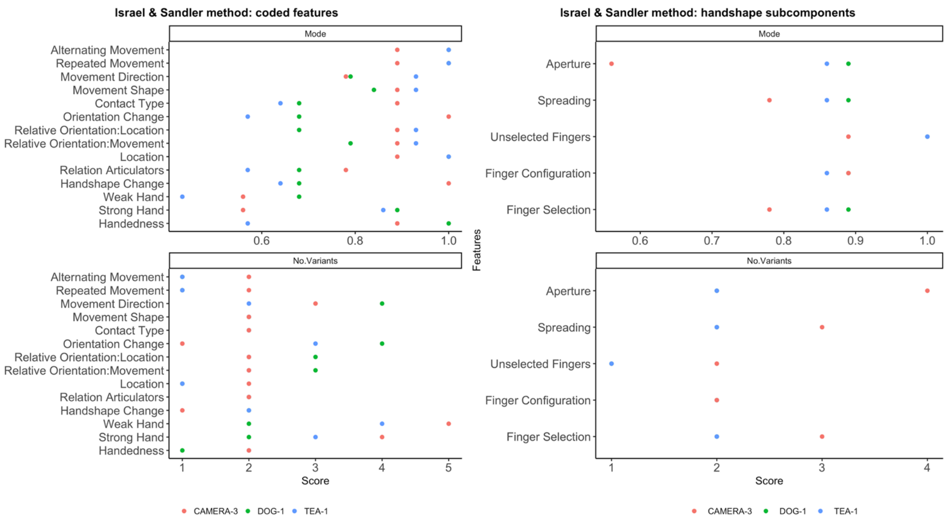


Figure 4-14. Visualisation of method used by Israel and Sandler (mode and number of variant measures) for the items *tea* (blue), *dog* (green), and *camera* (red), using all coded features in the current study and some subcomponents of handshape. Features on the y axis, score on the y-axis.

Figure 4-14 illustrates that TEA-1, DOG-1, and CAMERA-3 differ in the variation they exhibit in different feature classes. A low number of variants often coincides with high mode (i.e., low variation); for example, TEA-1 has only one variant in 'location', 'repeated movement' and 'alternating movement' and accordingly shows maximal mode in these features while CAMERA-3's four variants in the handshape feature 'aperture' co-occur with a mode of 0.56 in this feature. Moreover, DOG-1 is an example that nearly all signers produced, i.e., it represents the example with the largest set, and displays similar amounts of variation in different handshape subcomponents of the 'Strong Hand' (2.23 variants and mode of 0.89): 1.9 variants in 'finger selection', 1.77 variants in 'aperture', 1.66 in 'spreading' and 1.56 in 'finger configuration', and a mode of 0.87 for 'finger configuration', 0.85 for 'spreading' and 0.84 for both 'finger selection' and 'aperture'. Sign-level variation, captured as the number of surface realisations in Israel (2009), is diverse in this case study: five variants were produced for DOG-1, five for TEA-1, and six for CAMERA-3. Hence, on this measure, DOG-1 and TEA-1 are less variable than CAMERA-3.

Figure 4-13 exemplifies the same surface realisations using the signer-weighted variation. We chose the signer-weighted variation index as a baseline for comparison to Israel and Sandler's method as the analysed iconic motivation is identified by the number of signers. In line with this method, DOG-1, TEA-1 and CAMERA-3 are the dominant iconic motivations using the variation index. Nevertheless, Figure 4-13 demonstrates that in many cases, more than one iconic motivation is frequent, e.g., DOG-1 is used by 16 signers and DRINK-1 by seven signers in tea and CAMERA-3 was produced by nine signers and CAMERA-5 by six signers in camera. This may be linked to including multiple signs per response; the knowledge of signers is not restricted to a single variant, and indeed, DRINK-1 sometimes features in the same response as TEA-1. In cases like camera, it may be less clear what variant should be considered the most frequent one; CAMERA-3 is only marginally more widespread than CAMERA-5, which suggests that analysing more than one iconic motivation is necessary to appropriately represent the variation. In addition to identifying the most widely shared iconic motivations, we find that specific surface realisations are more frequent than others with the same iconic motivation: DOG-1A (14/20 signers), TEA-1F (7/20 signers), and CAMERA-3A (6/20 signers). These surface realisations have higher signer-weighted variation indices (Figure 4-13) because they are shared across more signers. In short, while zeroing in on the most frequent iconic motivation is one way of reducing "noise", the variation index shows that preserving variation through factoring in token-frequency or signer-frequency later on may be helpful to uncover structure in variation.

While both the variation index and Israel and Sandler's method point to different degrees of variation within a sign, one of the major differences between the methods lies in the measure itself. Israel and Sandler's method presents us with many connected measures rather than one unified measure. Their studies aim at a crosslinguistic comparison of phonological stability on the language-level which might explain why they opted for this method. However, features do not occur in isolation and we therefore argue that separate feature measures need to be re-incorporated into the context of the sign. The variation index aims for a more encompassing measure that unifies different levels of a sign and takes into account contextual information, here token- and signer-frequency. In contrast to Israel and Sandler's measures, the variation index does not integrate particular feature values but instead tallies the mismatching features. Accounting for feature value differences could be incorporated into the variation index as an extra level in the future, potentially even by adapting Israel and Sandler's mode.

Israel and Sandler's method is driven by maximal convergence between signers while the variation index is based on charting variation, and thus capturing structure in variation also in less frequent sign variants. There are three main advantages of the variation index: (i) in line with many other studies, the measures of Israel and Sandler (2009) are based on one-sign-per-response type of data (e.g., Sandler et al. 2011; Hartzell et al. 2019; Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020). As multi-sign responses are commonly reported for lexical elicitation data from micro-community sign languages (e.g., H. Morgan 2015; Hartzell et al. 2019; Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020), the variation index accommodates responses with multiple signs. (ii) Mode and number of variants focus on the most frequent iconic motivation, leading to eliminating much of the variation in the very first step. By examining all produced iconic motivations, the variation index allows for participants knowing and providing synonyms or multiple variants in an elicitation task. (iii) Israel and Sandler's and our own data show that there is a lot of variation as to whether signers produce the same iconic motivation in response to an item. For some items, signers highly aligned on iconic motivation (e.g., *dog, chicken, cow*) while for others they are very dispersed (e.g., *rice cooker*). Rather than selecting only one iconic motivation (which may be only marginally more frequent), the variation index factors in token-frequency and participants as a weighting factor later on and thus preserves variation. This enables us to uncover conventions also in less frequent iconic motivations. Although the variation index may not (yet) integrate exact feature value measures, it accounts better for the ecological realities of a signing community. Integrating all levels of a sign yields not only a more comprehensive but also a more nuanced account of variation that allows us to objectively assess and compare variation within and across emerging and established systems. In addition, the automatic comparison makes this method easy to be scaled up to large datasets.

Nevertheless, there are also some shortcomings of the variation index. The three levels considered are all interrelated which may make the variation index somewhat counter-intuitive. While iconic motivation and surface realisations stand in a one-to-one relationship to each other, this is not the case for surface realisations and feature differences. Surface realisations that differ from each other but share the same iconic motivation are grouped together. Form variation arises within an iconic motivation as minimally one surface realisation. Variation among these surface realisations is driven by differing features, resulting in more (or fewer) surface realisations than feature differences. Despite the different relations to each other, all levels contribute to the overall score where a higher value represents more variation. Determining which level contributes the most variation in a variant can, however, only be localised in a separate step; each level can provide a different piece of the puzzle, e.g., the number of produced iconic motivations per item provides information about how many mappings are used to refer to a given concept. Altogether, the variation index builds on the complexity of interrelated levels to provide a comprehensive approach to variation.

As explained previously, no variation means that an iconic motivation has been produced with a single surface realisation. Due to the one-to-one relationship between iconic motivation and surface realisation, this yields the variation index of 0.67. For the majority of cases, no variation is due to the lack of tokens; hapaxes i.e., single tokens of (idiosyncratic) sign variants cannot show variation. A limited number of signs, however, show no variation due to extreme uniformity across all tokens. SHOE-1A (n_{token}=29; n_{signer}=18), OFFERING-2A (n_{token}=19; n_{signer}=10), TEMPLE-CEREMONY-1A (n_{token}=13; n_{signer}=8), RICE-1A (n_{token}=12; n_{signer}=8), MANGO-OVAL-1A (n_{token}=12; n_{signer}=4), GECKO-5A (n_{token}=10; n_{signer}=5), TRIDATU-BRACELET-2A (n_{token}=9; n_{signer}=4) have been produced with a high(er) frequency but with a single surface form. Thus, albeit less frequent, a variation index of 0.67 may also result from the lack of type variation. Developing the variation index further could aim for normalising the scores to make them more easily interpretable and potentially even circumvent this ambiguity.

4.6 DISCUSSION

This study has introduced and applied a new way of measuring variation in sign formation across a signing community numerically, taking into account three interrelated levels inherent to every sign: 1) iconic motivation, 2) surface realisation, 3) feature differences. As such, it builds on previous work which primarily focuses on the feature level (Israel 2009; Israel & Sandler 2009; Parks 2011; Sandler et al. 2011; H. Morgan 2015; Omardeen 2018; Börstell et al. 2020). These variation indices yield gradient outcome measures for sign variants, allowing us to capture that across the 20 deaf signers sampled, different sign variants exhibit various degrees of variation on different levels. Moreover, this study shows the impact of frequency on what variation can be attested, cautioning the generalisations that can be made from a limited dataset. We have suggested two types of frequency-based weightings of the variation index to increase the ecological validity of the measure; weighting by token frequency identifies sign variants of high usage and weighting by signer identifies sign variants that are particularly widespread across the population. Both identify dominant and non-dominant variants, demonstrating a variation continuum.

4.6.1 VARIATION AND FREQUENCY

This study demonstrates that limited datasets are at risk of overinflating variation; sign variants that are produced frequently have more opportunity to vary while a single token of a sign variant cannot vary from anything. Indeed, most studies on the emergence of phonology and the lexicon in micro-community sign languages are based on picture elicitations instead of corpus data with robust frequency information (e.g., Israel 2009; Israel & Sandler 2009; Sandler et al. 2011; Richie et al. 2014; H. Morgan 2015; Horton 2018; Hou 2018; Reed 2019; Hartzell et al. 2019). Variation as measured in this study can be applied to different kinds of data, ideally drawing on both elicited and spontaneous corpus data from different languages or even home sign data that can be compared directly.

Previous analyses of emerging phonology have focused on commonalities across signers, by singling out the most frequent iconic motivation and/or features among responses to a stimulus for analysing variation (Israel 2009; Israel & Sandler 2009; Sandler et al. 2011). For example, Sandler and colleagues (Israel 2009; Israel & Sandler 2009; Sandler et al. 2011) view the most frequent iconic motivation as (most) conventionalised. On these grounds, they examine variation by zooming in on the iconic motivation of barking for *dog* in ABSL, and examine handshape variation within that subset. Our results suggest that such methods might underestimate the degree of variation, given our observation that high frequency of an iconic motivation does not necessarily equal low variation on other levels, and that high-variation variants do not all vary to the same extent and in the same aspects. Especially in studies with limited datasets such as elicited data it is fundamental to understand and acknowledge the correlation between frequency and variation to avoid overinterpretation.

In corpus-based research on spoken languages it has been established that high frequency words change more quickly than low frequency words (Frisch 1996; Bybee & Hopper 2001; Bybee 2010). We found that iconic motivations that are attested frequently often go hand in hand with high variation indices. As indicated previously, this may indeed be related to the increased opportunity for variation to surface. This phenomenon may also be linked to forces of language change, with high frequency signs demonstrating a locus of rapid language change while less frequent sign variants may be less variable. Nevertheless, our study deals with frequency as the tokens within this limited dataset of elicited productions rather than corpus-based frequencies. It is unclear how the type of language task influences the obtained frequency distributions. To corroborate whether or not the variation patterns in this data set are related to token-frequency or reflect language change, we would need to expand the dataset.

4.6.2 HIGH VARIATION AND SYNONYMS

Micro-community sign languages have often been described to exhibit a high degree of variation (e.g., Washabaugh 1986; Meir et al. 2012). Multiple explanations have been suggested to account for this, including the lack of pressure to converge on linguistic symbols due to high common ground (de Vos 2011; Meir et al. 2012).

Morgan (2015) observes that iconic motivations themselves are a locus of variation in KSL. We observe the same in Kata Kolok; few items in our study elicit a single iconic motivation, e.g., *dog*, while the majority elicit multiple iconic motivations, e.g., *camera* or *pig*. Of the elicited iconic motivations, some are both more frequent and widely shared across signers, e.g., PIG-1 with 25 tokens across 17 signers compared to PIG-2 with 14 tokens across eight signers and ANIMAL-EARS-1 with seven tokens by four signers. Morgan (2015) attributes the presence of multiple iconic motivations to ongoing convergence across signers and Mudd and colleagues (2020) argue that high familiarity with a concept may reduce variation. On top of this, greater prominence of the stimulus and/or the iconic mapping in one's surrounding might also trigger (individual) preferences for certain iconic mappings and thereby stimulate the selection and persistence of different iconic motivations. For example, pigs are commonly killed by men while feeding pigs might be considered more (but not exclusively) a female task. To test and disentangle these hypotheses empirically, iconicity ratings would have to be collected, potentially alongside a measure of visual prominence.

Research on patterned iconicity suggests that specific types of objects tend to result in specific iconic strategies, i.e., signs for tools often relate to handling or manipulating the tool while signs for food items are often linked to size, shape and manipulation (Padden et al. 2013; 2015; Hwang et al. 2017; Hou 2018). In line with this, sign variants elicited for the items *camera* and *pig* show different strategies: most iconic motivations elicited for camera relate to holding, handling, or manipulating a video camera whereas iconic motivations in pig map to different aspects around a pig, namely handling/manipulating (killing), embodiment of the animal (feeding), and appearance. While it is possible that sign variants are indeed the result of selection and convergence as suggested in Morgan (2015), it is also possible that qualitatively different mappings such as in the PIG-variants affect the preservation of multiple different iconic motivations in Kata Kolok and other micro-community sign languages.

Different ideas have been put forth to explain high variation in micro-community sign languages. Previously suggested by de Vos (2011), Meir and colleagues (2012) and Meir and Sandler (2019) and corroborated by a computational model by Thompson and colleagues (2019), the high degree of shared knowledge and the limited number of community members may allow for high variation. Both make it possible to tolerate idiosyncrasy, i.e., remembering idiosyncratic variants. The high overlap in experiences among signers of small communities may enhance the availability of a large range of possible iconic mappings and hereby accommodate for a large number of (idiosyncratic) sign variants. Recently, Tkachman and Hudson Kam (2020) have argued that rather than community size, tight kinship relations and early signing exposure across deaf signers accounts for the high lexical variation in young micro-community sign languages. While the present study adds that dominant sign variants are shared by many participants and produced often, the question of how to account for the considerable variation of non-dominant variants still remains.

Nevertheless, pressures leading to reducing the number of synonyms with different iconic motivations are unclear. As explained in Section 4.2.1, concepts provide many properties for potential iconic mappings that may be linguistically encoded. As a result, sign language lexicons may include synonyms with different iconic motivations. For example, three variants of DOG in NGT are based on three different iconic motivations (Figure 4 15): (i) the dog's paws, (ii) holding something in the mouth as dogs often do, (iii) calling a dog by patting one's thigh.

Figure 4-15. Three sign variants with different iconic motivation for DOG in NGT.

If the reduction of iconic motivations is indeed a first step in conventionalisation as suggested by Morgan (2015: 14 f.), the abundance of synonyms with or without shared iconic motivation in macro-community sign languages points to an obvious lack of conventionalisation. In BSL, 22 conventionalised variants of PURPLE[20] have been found as a result of regional variation (Stamp et al. 2014). In contrast to work on sign language emergence, this variation in the BSL or the NGT lexicon is argued

[20] BSL Signbank lists 17 different variants: https://bslsignbank.ucl.ac.uk/dictionary/words/purple-1.html.

to be rooted in and maintained by various sociolinguistic factors; e.g., age, region, educational background. Altogether, it is unclear how different pressures resulting in the reduction of variation on the level of iconic motivations interact, and whether they differ fundamentally in different signing communities.

4.6.3 VARIATION AND CONVENTIONALISATION

Different fields approach variation in different ways: studies on macro-community sign languages embrace variation as sociolinguistic phenomenon, while, in research on sign language emergence, variation across signers is generally taken as a lack of conventionalisation. Where Sandler and colleagues (2011) argue that the extreme variation in ABSL is explained by the lack of a phonological system, we would like to propose that a more in-depth approach may help to uncover processes and mechanisms underlying variation and conventionalisation.

This study shows that a gradient measure exposes structured variation. Sign variants for DOG in ABSL are presented as an example of extreme variation in Sandler and colleagues (2011). All DOG-variants share the iconic motivation ‘barking’ but all ten ABSL participants produce different surface forms, leading to the claim that ABSL signs are driven by holistic, iconic prototypes without combinatorial structure (Sandler et al. 2011: 520). Among our Kata Kolok signers, dog elicited a single iconic motivation, also ‘barking’, with substantial variation in surface realisations and feature differences: DOG-variants in Kata Kolok yield feature-level variation on six features distributed over five surface realisations. The signer-weighted variation index reflects that 70% of the Kata Kolok participants produced the same surface

realisation DOG-1A. In contrast to ABSL, the variation in DOG-1 results from six participants who produce different surface realisations. Thus, although dog elicits variation in both ABSL and Kata Kolok, our approach gives more insight into the underlying structure of variation. In the case of DOG-1, we can localise the variation to 30% of the signers, suggesting that the driver is likely to be individual participant effects rather than the lack of a phonological system.[21] We plan to explore the effect of social factors on sublexical variation in a future study by combining the current method with the method used in Mudd and colleagues (2020).

Sign language emergence scenarios often describe a development from (i) no language to (ii) a communication system with high variation and little structure, in which variation decreases as structure increases until (iii) reaching structural benchmarks set by research on macro-community sign languages (Meir & Sandler 2019). While this route may be justified for some linguistic aspects, for example grammatical elements (e.g., A. Senghas & Coppola 2011; Pfau & Steinbach 2011; Johnston et al. 2015; Pfau 2015; but see Safar 2020), the fundamental idea is nurtured by reducing variation to optimally low variation (without taking into account the ecological niche of the particular language). Macro-community sign languages, however, may previously have escaped this pressure and are, now char-

[21] In this paper, we are not taking position on whether or not Kata Kolok exhibits duality of patterning or whether differing features are phonologically contrastive in Kata Kolok for two reasons: 1) perception experiments are needed to corroborate whether feature differences are phonologically contrastive or instances of phonetic variation; this study concerns production data and only very limited insights about perception are available for Kata Kolok in this respect; 2) van der Hulst & van der Kooij (2021) have argued that grammatical phonological rules are less common among signed than among spoken languages, and that phonology and morphology in sign languages are tightly intertwined which questions whether duality of patterning actually is a helpful concept to apply to sign languages.

acterised as established, analysed on different grounds. For example, levelling, i.e., the reduction of variation, is attributed to language emergence in Nicaraguan Sign Language for spatially modified verbs (A. Senghas 2003) while it has been explained as sociolinguistic variation in the BSL lexicon, an older macro-community sign language (Stamp et al. 2014). In macro-community sign languages, variation is increasingly perceived as a sign of linguistic diversity and richness, while variation in micro-community sign languages retains a negative connotation of immaturity (Moriarty Harrelson 2017; 2019; Kusters & Sahasrabudhe 2018; Braithwaite 2020; Hou & Kusters 2020; Kusters et al. 2020).

This tension may arise from the focus on convergence rather than variation in the literature on sign language emergence (Israel 2009; Israel & Sandler 2009; H. Morgan 2015; Meir & Sandler 2019). Conventionalisation and variation are often understood as “opposing forces” (Meir & Sandler 2019: 9), with the reduction of variation signaling conventionalisation. While we do not intend to question the general idea that decreasing variation increases conventionalisation, we would like to discuss two main problems with a reduction-based definition that are more broadly linked to a discussion about language emergence, language change, and language ideologies (Moriarty Harrelson 2017; 2019; Kusters & Sahasrabudhe 2018; Braithwaite 2020; Hou & Kusters 2020; Kusters et al. 2020). First, a reduction-based definition implies an ideal state of maximal convergence and minimal variation, i.e., a single variant, that any (emerging) language strives for. However, studies increasingly document substantial (sociolinguistic) variation on different levels of description across spoken languages (Bybee 2006; 2010) and well-researched macro-community sign languages (e.g., Stamp et al. 2014; Börstell & Östling 2016; Schembri et al. 2018). It is thus unclear why minimal variation is expected to be a hallmark of an "established language". Linked to this is the second issue, namely the paradox of determining a start and an end point of a process. Although conventionalisation is generally described as a process (Burling 1999; Schmid 2020), signs tend to be discussed in categorical terms (lexicalised versus non-lexicalised, conventionalised versus non-conventionalised). This generates the expectation of an ideal end state that can (and should) be reached, i.e., selection of one conventionalised variant and dismisses the fact that variation may be structured; like in other domains, the increasing trend to examine gradience in language use (e.g., Cormier, Quinto-Pozos, et al. 2012; Ferrara & Halvorsen 2017; Lepic 2019) may be beneficial to understanding both variation and conventionalisation.

Rather than viewing conventionalisation and variation as opposing forces, we may want to move on to understanding them as two sides of the same coin. Lepic (2019) argues that understanding signs as a forced choice between two categories (lexicalised vs. non-lexicalised) instead of on a lexicalisation continuum prevents us from understanding the degree to which mental representations are established. Similarly, internalising conventionalisation (and variation) as continua may help us gain a deeper understanding of how they shape language emergence, language change, and language use. The findings of this paper stress that discussing conventionalisation in a binary manner can be misleading: unlike states, processes require gradient measures that are complex, sensitive to frequency and able to capture different degrees of variation on different aspects of a sign (see also Meir &

Sandler 2019; Tkachman & Hudson Kam 2020). Understanding conventionalisation and variation as tightly related continua may allow us to acknowledge and deal with them more appropriately in different types of signing communities, paving the way for valid comparisons across languages that differ greatly in their socio-cultural and ecological niche.

4.7 CONCLUSION

This paper has developed and applied a new measure of variation in the forms of signs. The comprehensive approach to variation suggested here relies heavily on integrating three interrelated levels as they may show different degrees of variation. In other words, there is not always a logical trade-off between more and less variation among different levels within a sign; low variation on one level does not equal low variation on another level. Indeed, we propose to consider the possibility that variation does not necessarily equal to the absence of conventionalisation. We also suggest that, particularly in micro-community sign languages, footprints of individual language users may be especially prominent. Measuring variation as suggested here allows us to calculate and weight variation indices for individual iconic motivations and surface realisations, which can then be utilised to answer further questions about the effect of social factors, or phonological characteristics. In this study, all signs produced in this dataset were treated as individual signs. As single sign responses are rare, weighted variation indices may be devised to address the issue of chains of signs, potentially identifying compounds and collocations in a more efficient way. Moreover, weight by signer touches upon social factors that

may play a fundamental role in variation across small communities. In a future study, we plan to address the contribution of social factors in order to explore the source and context of sign variants, helping to further disentangle the high collinearity of social factors in micro-community sign languages such as Kata Kolok. Our study teaches us to be cautious about overinterpreting data from restricted datasets and provides a new tool to examine and even compare variation within diverse sign language lexicons. This sets the ground for comprehensive comparisons of variation across micro- and macro-community sign languages with minimal methodological differences, bringing us closer to embrace variation irrespective of the ecological niche in which they emerged.

APPENDIX 4-A: PICTURE ELICITATION TASK STIMULI

Picture elicitation task stimuli, selected by expected variation (not specific to a single level).

category	little or no variation	some variation	much variation
colour	black white	red	yellow
animals	cat dog chicken	pig cow horse	butterfly lizard turtle
food	rambutan salt coffee	garlic rice mango	dragon fruit chili palm sugar
praying	sarong praying / ceremony tridatu bracelet (yarn bracelet with religious significance)	blayag (steamed rice wrapped in leaf) flower	offering
miscellaneous	mobile phone sandals	cock fight rice cooker mandi shovel	video camera

APPENDIX 4-B: ICONIC MOTIVATION

unique_glosses	iconic motivation
ALL-TOGETHER-1A	space
ALL-TOGETHER-1C	space
ALL-TOGETHER-2A	space
ALL-TOGETHER-2B	gathering (CL)
ANIMAL-EARS-1A	ears w/ hand = entity
ANIMAL-EARS-1B	ears w/ hand = entity
ANIMAL-EARS-1C	ears w/ hand = entity
ANIMAL-EARS-1D	ears w/ hand = entity
BATHE-1A	wash with hand
BATHE-1B	wash with hand
BLACK-1A	hair
BLACK-1B	hair
BLACK-1C	hair
BLAYAG-1A	wrapping
BLAYAG-1B	wrapping
BLAYAG-1D	wrapping
BLAYAG-1E	wrapping
BLAYAG-1F	wrapping
BLAYAG-1H	wrapping
BREAK-1A	breaking
BREAK-1B	breaking
BREAK-1C	breaking
BRIGHT-1A	unclear
BUTTERFLY-1A	arms = wings
BUTTERFLY-1B	arms = wings
BUTTERFLY-1C	arms = wings
BUTTERFLY-1E	arms = wings
BUTTERFLY-3A	hands = entity
BUTTERFLY-3B	hands = entity
CAMERA-1B	camera on shoulder
CAMERA-2A	camera w/ hand = entity
CAMERA-2B	camera w/ hand = entity
CAMERA-3A	filming through lens
CAMERA-3B	filming through lens
CAMERA-3C	filming through lens
CAMERA-3D	filming through lens
CAMERA-3E	filming through lens
CAMERA-3F	filming through lens
CAMERA-4A	holding camera with both hands
CAMERA-5A	twisting camera lens
CAMERA-5B	twisting camera lens
CAMERA-5C	twisting camera lens
CAT-1A	whiskers
CAT-1B	whiskers
CAT-1C	whiskers
CAT-1D	whiskers
CAT-1E	whiskers
CAT-1F	whiskers
CAT-1G	whiskers
CHICKEN-1A	beak
CHICKEN-1B	beak
CHICKEN-1C	beak
CHICKEN-1D	beak
CHILI-1A	spicy
CHILI-1B	spicy
CHILI-1C	spicy
CHILI-1D	spicy
CHILI-1E	spicy
CHILI-1G	spicy
CHILI-2A	plant w/ hands = entity
CHILI-2B	plant (grows hanging down)
CHILI-3A	shape
CHOP-1B	cutting w/ hands = board/blade
CHOP-1C	cutting w/ hands = board/blade
CHOP-1G	cutting w/ hands = board/blade
COCK-FIGHT-1A	fight w/ hands = entity
COCK-FIGHT-1B	fight w/ hands = entity
COCK-FIGHT-1C	fight w/ hands = entity
COCK-FIGHT-2A	fight w/ hands = beak
COCK-FIGHT-2B	fight w/ hands = beak
COFFEE-1A	unclear
COFFEE-1B	unclear
COFFEE-1C	unclear
COFFEE-1D	unclear
COOK-1B	fire - pot
COOK-1C	fire - pot
COOK-1D	fire - pot
COOK-1E	fire - pot
COOK-1F	fire - pot
COW-1A	horns
COW-1B	horns
COW-1C	horns
COW-1D	horns
COW-1E	horns
COW-1F	horns
COW-1G	horns
CUT-PIECES-1A	slicing
CUT-PIECES-1B	slicing
CUT-PIECES-1C	slicing
DARK-1A	darkness
DARK-1B	darkness
DARK-1C	darkness
DARK-1D	darkness
DARK-1E	darkness
DIG-1A	digging w/ hands = hands or rake
DOG-1A	barking

DOG-1B	barking
DOG-1C	barking
DOG-1D	barking
DOG-1E	barking
DRAGONFRUIT-1A	scoop out
DRAGONFRUIT-1B	scoop out
DRAGONFRUIT-1C	scoop out
DRAGONFRUIT-1D	scoop out
DRAGONFRUIT-3A	plant w/ hands = entity
DRINK-1A	drinking
DRINK-1B	drinking
EAT-1A	eating w/ hands = hands
EAT-1B	eating w/ hands = hands
EAT-1C	eating w/ hands = hands
EAT-1D	eating w/ hands = hands
EVENING-1C	sunset?
FLOWER-1A	flower head opening
FLOWER-1B	flower head opening
FLOWER-2C	sniffing
FLOWER-3A	flower behind ear w/ hand = entity (stick)
FLOWER-3C	flower behind ear w/ hand = entity (stick)
FLOWER-3D	flower behind ear w/ hand = entity (stick)
FLOWER-3E	flower behind ear w/ hand = entity (stick)
FLOWER-4A	flower on head w/ hand = entity (head)
FLOWER-4B	flower on head w/ hand = entity (head)

FOOT-2A	point
GARLIC-1A	white at thumb?
GARLIC-1B	white at thumb?
GARLIC-2A	peel
GARLIC-3A	break open
GECKO-2A	legs / walking
GECKO-2B	legs / walking
GECKO-3A	mouth/noise
GECKO-3B	mouth/noise
GECKO-3C	mouth/noise
GECKO-4C	move on wall w/ hand = entity
GECKO-5A	point upwards
GECKO-6A	move in space w/ hand = entity
GECKO-6B	move in space w/ hand = entity
GECKO-6D	move in space w/ hand = entity
GECKO-7C	tongue
GRUE-1A	unclear
HORSE-1A	galloping legs
HORSE-1B	galloping legs
HORSE-2A	reins
HORSE-2B	reins
HORSE-2C	reins
HORSE-4A	walking legs
HORSE-4B	walking legs
HOT-1C	steam
HOT-1D	steam
MANDI-1A	pour water w/ hands = handle
MANDI-1D	pour water w/ hands = handle
MANDI-1E	pour water w/ hands = handle

MANDI-1F	pour water w/ hands = handle
MANDI-1G	pour water w/ hands = handle
MANDI-1H	pour water w/ hands = handle
MANGO-1A	peel/cut
MANGO-1B	peel/cut
MANGO-1C	peel/cut
MANGO-1D	peel/cut
MANGO-1E	peel/cut
MANGO-1F	peel/cut
MANGO-1G	peel/cut
MANGO-1H	peel/cut
MANGO-1J	peel/cut
MANGO-LOCAL-1A	size
MANGO-OVAL-1A	shape
MASH-1A	grinding w/ hands = entity
MOBILE-PHONE-1A	phone on ear w/ hands = entity
MOBILE-PHONE-1B	phone on ear w/ hands = entity
MOBILE-PHONE-1D	phone on ear w/ hands = entity
NEG	handwave (gesture)
NM-CAT	(nonmanual version: whiskers)
NM-CHILI	(nonmanual version: spicy)
OFFERING-1A	give to / release to gods
OFFERING-1B	give to / release to gods
OFFERING-2A	wind up leaves
ONION-2A	chopping
ONION-2B	cry?
PALM-SUGAR-1A	drizzling over something

PALM-SUGAR-1C	drizzling over something
PALM-SUGAR-1D	drizzling over something
PAPAYA-1A	unclear
PIG-1A	killing / stabbing pig throat
PIG-1B	killing / stabbing pig throat
PIG-1C	killing / stabbing pig throat
PIG-2A	eating
PIG-2B	eating
PIG-2C	eating
PIG-2D	eating
PIG-4A	unclear
PRAY-1A	hands folded in prayer
PRAY-1B	hands folded in prayer
PRAY-1C	hands folded in prayer
PRAY-1D	hands folded in prayer
RAMBUTAN-1A	characteristic opening of fruit and eating it out with teeth
RAMBUTAN-1B	characteristic opening of fruit and eating it out with teeth
RAMBUTAN-1C	characteristic opening of fruit and eating it out with teeth
RAMBUTAN-2A	bunch at tree
RAMBUTAN-3A	unclear
RED-1A	lips
RED-1B	lips
RED-1C	lips
RED-1D	lips
RED-1E	lips
RICE-1A	unclear

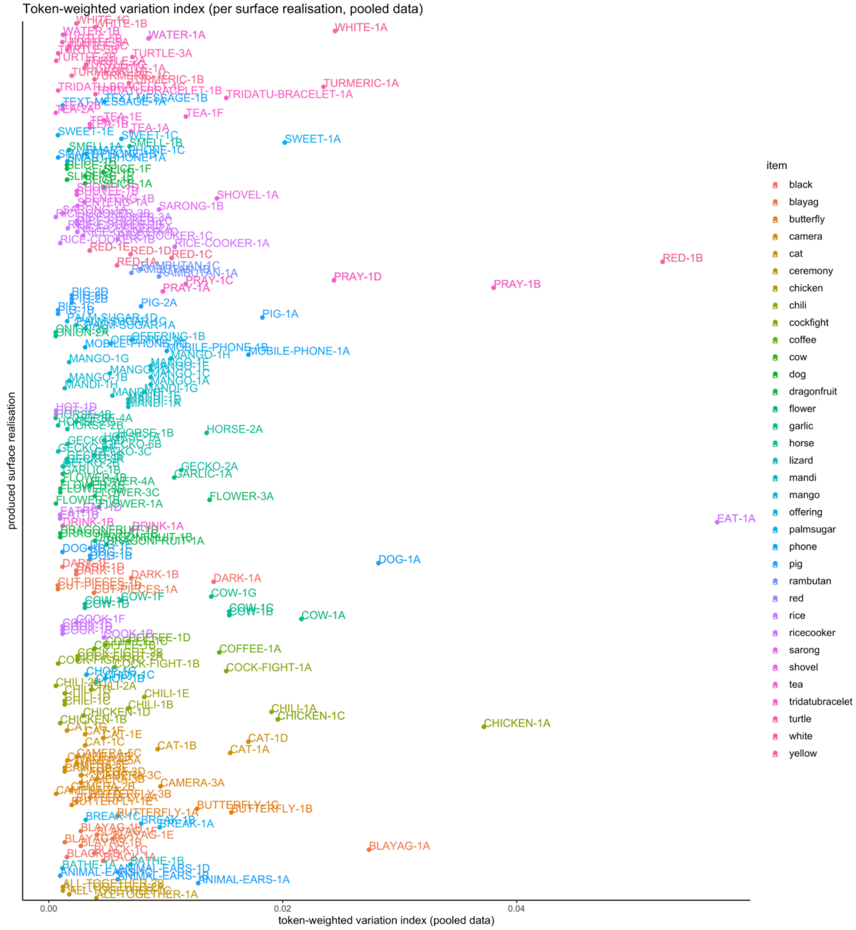
RICE-COOKER-1A	plug
RICE-COOKER-1B	plug
RICE-COOKER-1C	plug
RICE-COOKER-1D	plug
RICE-COOKER-2A	opening+closing lid w/ hand = handle
RICE-COOKER-2B	opening+closing lid w/ hand = handle
RICE-COOKER-2C	opening+closing lid w/ hand = handle
RICE-COOKER-3A	opening lid w/ hand = entity
RICE-COOKER-3B	opening lid w/ hand = entity
ROOSTER-1A	comb w/ hand = entity
SALT-1A	taste?
SANDALS-1A	unclear
SARONG-1A	manner of dressing
SARONG-1B	manner of dressing
SCOOP-1A	scooping
SENTENG-1A	manner of dressing
SENTENG-1B	manner of dressing
SENTENG-2A	knot at belly
SHOE-1A	feet walking (entity)?
SHOVEL-1A	digging using a shovel w/ hands = handle
SHOVEL-1B	digging using a shovel w/ hands = handle
SHOVEL-1D	digging using a shovel w/ hands = handle
SHOVEL-2A	digging using a shovel w/ hands = entity

SKY	point upwards
SLICE-1A	slicing
SLICE-1B	slicing
SLICE-1C	slicing
SLICE-1D	slicing
SLICE-1F	slicing
SLICE-1G	slicing
SLICE-1H	slicing
SMART-PHONE-1A	touch screen swipe
SMART-PHONE-1B	touch screen swipe
SMART-PHONE-1C	touch screen press
SMELL-1A	sniffing
SMELL-1B	sniffing
SNEAKERS-1A	put on shoe
SPICEY-1A	fan air on mouth
SUN-1A	bright?
SWEET-1A	sweet?
SWEET-1C	sweet?
SWEET-1E	sweet?
TEA-1A	brew loose tea leaves
TEA-1B	brew loose tea leaves
TEA-1C	brew loose tea leaves
TEA-1E	brew loose tea leaves
TEA-1F	brew loose tea leaves
TEA-2A	steep tea bag
TEA-2B	steep tea bag
TEA-3A	unclear (borrowing BISINDO)
TEMPLE-CEREMONY-1A	traditional music (gamelan)
TEXT-MESSAGE-1A	typing with thumbs

TEXT-MESSAGE-1B	typing with thumbs
TRIDATU-BRACELET-1A	finger trace line at wrist
TRIDATU-BRACELET-1B	finger trace line at wrist
TRIDATU-BRACELET-1C	finger trace line at wrist
TRIDATU-BRACELET-2A	around wrist
TUMERIC-1A	press
TUMERIC-1B	press
TUMERIC-1C	press
TUMERIC-1D	press
TUMERIC-2A	put on forehead
TURTLE-1A	walk w/ hand = legs
TURTLE-1C	walk w/ hand = legs
TURTLE-2A	swim w/ hand = legs
TURTLE-2B	swim w/ hand = legs
TURTLE-3A	swimming w/ hand = entity
TURTLE-3B	swimming w/ hand = entity
TURTLE-3C	swimming w/ hand = entity
TURTLE-4A	crawling w/ hand = entity
TURTLE-5A	mouth / eating
TURTLE-5B	mouth / eating
WATER-1A	suck in stream?
WATER-1B	suck in stream?
WATER-TAP-1A	water running out of tap
WHITE-1A	teeth
WHITE-1B	teeth
WHITE-1C	teeth
WORK-1A	unclear / manual work?

YELLOW-BISINDO-1A	unclear (borrowing BISINDO)
YELLOW-BISINDO-2A	initialised (borrowing BISINDO)
YELLOW-BISINDO-3A	initialised (borrowing BISINDO)

APPENDIX 4-C: TOKEN-WEIGHTED VARIATION INDEX (POOLED DATA WITH >1 SURFACE REALISATIONS)



APPENDIX 4-D: SIGNER-WEIGHTED VARIATION INDEX (POOLED DATA WITH >1 SURFACE REALISATIONS)

APPENDICES FILES

Appendices can also be found at https://doi.org/10.17605/OSF.IO/FN4XE.

ACKNOWLEDGEMENTS

We thank all Kata Kolok signers and our research assistants I Ketut Kanta, Ni Made Dadi Astini and Ni Made Sumarni for being part of this research. We thank Calle Börstell, Katie Mudd and Rehana Omardeen for discussions and three anonymous reviewers and the editor for thoughtful comments that made this paper a stronger contribution.

CHAPTER FIVE

HOW DIVERSE IS SIGN PHONOLOGY? – A COMPARATIVE STUDY OF KATA KOLOK AND SIGN LANGUAGE OF THE NETHERLANDS

Chapter adapted from: *Lutzenberger, H., Crasborn, O., Fikkert, P., & de Vos, C. (under review). How diverse is sign phonology? – A comparative study of Kata Kolok and Sign Language of the Netherlands.*

5 HOW DIVERSE IS SIGN PHONOLOGY? – A COMPARATIVE STUDY OF KATA KOLOK AND SIGN LANGUAGE OF THE NETHERLANDS

ABSTRACT

Languages are highly similar and, at the same time, extremely varied crosslinguistically. Many universals have been reported in sign phonologies, however, the sampled sign languages are biased towards (historically related) sign languages from the Global North. In this study, we examine how diverse sign phonologies might be by studying the phonology of Kata Kolok, the sign language of a Balinese village, in comparison to Sign Language of the Netherlands, the national sign language of the Netherlands. Comparing the two languages on equal methodological grounds yields (i) universalities in the inventory and (ii) common phonotactic regularities that apply to both datasets, both suggesting shared pressures, and (iii) language-specific preferences, suggesting differences in the weight of pressures. We propose that linguistic diversity is shaped by a combination of cognitive and environmental pressures, including efficiency, iconicity and language ecology. We also discuss how researcher's language ideologies and biases may have affected the framing of attested differences between rural and urban sign languages in previous work.

KEYWORDS

Kata Kolok; sign phonology; typology; linguistic diversity; universals; ideologies

5.1 INTRODUCTION

The world's 7,000 languages display great diversity on all levels of description while at the same time, there are many crosslinguistic similarities (Levinson & Evans 2010). For example, the sound inventories of documented spoken languages range from 11 to 144 phonemes (Maddieson 1984); the phonemic inventory of Rotokas, a North Bougainville language used on Bougainville Island, is with 11 phonemes among the smallest ones attested (Firchow & Firchow 1969) and that of Yélî Dnye, a Papuan language used on Rossel Island, is with 90 phonemes very large, and includes previously unattested contrasts between labial-alveolar consonants (cf. Evans & Levinson 2009). At the same time, all of the 50 spoken languages in Maddieson (1984) use stops and whenever there is a single stop series, stops are voiceless. Further, languages exhibit systematic crosslinguistic form-meaning mappings such as vowel quality corresponding to size and intensity (*katakata* "clattering" vs. *kotokoto* "clattering less noisy" in Japanese or ***pimbilii*** "small belly" vs. *pumbuluu* "enormously round belly" in Siwu) (Dingemanse et al. 2015). In short, phonologies exhibit universal and language-specific patterns.

The question of universal and language-specific features has gained new steam through the advent of sign language linguistics in the 1950s that launched researching not only geographically diverse languages but also languages of the visuospatial modality (Tervoort 1953). An ever growing body of research demonstrates that sign languages exhibit the same universal structures as spoken languages, for example in phonology (Stokoe 1960), word class distinctions (Supalla & Newport 1978; Padden 1988; Johnston 2001), and word order (Napoli

& Sutton-Spence 2014). American Sign Language (ASL) was the first sign language in which phonological structure has been described in the visuospatial modality; Stokoe (1960) demonstrated that signs could be decomposed into phonological features such as ‘handshapes’, ‘locations’, and ‘movements’ that may create lexical contrast. Since then, the concept of sign phonology has been refined based on studies describing sign phonology in various sign languages.

First and foremost, research has focused on corroborating linguistic universals using a handful of related sign languages from the Global North that share socio-demographic characteristics (Sandler & Lillo-Martin 2006; Sandler 2010). However, growing interest in more diverse signing practices (Zeshan & Palfreyman 2017) suggests a link between linguistic properties and language ecology (de Vos & Pfau 2015). Large-scale urban sign languages are characterised by a large community with loose networks of signers where most deaf children have hearing parents (Mitchell & Karchmer 2004), thus often experiencing delayed language input (Humphries et al. 2014; Hall 2017), and that have undergone at least some standardisation, e.g., through education. Small-scale rural sign languages are characterised by a tight-knit community with high incidences of (hereditary) deafness in which the sign language is acquired from birth and used by many hearing and deaf community members. For the purpose of this study, we adopt the distinction between *urban sign languages* and *rural sign languages* (Zeshan & de Vos 2012) (for discussions of classifications see Hou 2016; Reed 2019; Hou & de Vos 2021). Crosslinguistic similarities and differences alongside the language ecology have been suggested, for example, for sign phonologies (de Vos & Pfau 2015). On the one hand, all sign languages studied show overlap in the structure of signs and at least some phonemes. For example, a few handshapes are most frequent across sign language lexicons and therefore considered typologically unmarked (Battison 1980; Rozelle 2003). On the other hand, the phonemic inventory is reported to be smaller and to consist mostly of 'unmarked' handshapes in rural sign languages (Washabaugh 1986; Nyst 2007; Bauer 2014; Jorgensen, Green & Bauer 2021). There are even arguments that a particular young sign language, Al-Sayyid Bedouin Sign Language (ABSL), "does not yet have a phonological level of structure, that it is a language without duality of patterning" (Sandler et al. 2011: 536).

This raises many questions, including when and how phonological patterns arise in a new sign language, but first and foremost how diverse sign phonologies might actually be. Here, we tackle this question by investigating the phonology in the sign language Kata Kolok, used in a rural enclave in Bali, Indonesia. Kata Kolok is an excellent case study since (i) Kata Kolok's time depth is situated between ABSL and well-studied urban sign languages such as Sign Language of the Netherlands (Nederlandse Gebarentaal, NGT), (ii) Kata Kolok has been claimed to exhibit typologically unusual phonological patterns, and (iii) Kata Kolok differs fundamentally in terms of its ecology from urban sign languages. Since this study ultimately aims at advancing our understanding of universal and language-specific patterns in sign phonology, we take a comparative approach in which methodological differences are minimised: using the lexical database Global Signbank, we compare Kata Kolok to NGT, a representative case of an urban sign languages and in that sense maximally distinct to Kata Kolok. We perform two studies: first, we delineate the feature inventory of Kata Kolok as compared to NGT and evaluate existing claims about typologically unusual patterns. Second, we corroborate whether two crosslinguistic regularities (the presence of minimal pairs and phonotactic constraints) are found in our datasets and whether user judgments (perception and acceptability data) provide evidence to further sharpen the phoneme inventory of Kata Kolok. Thus, we evaluate to what extent we find regular and restricted phonological distinctions in Kata Kolok, and how this relates to what we know about NGT. We then extrapolate our findings to wider generalisations in the literature on other sign languages, in both similar and different sociolinguistic settings (Section 5.5).

5.2 BACKGROUND

5.2.1 SIGN PHONOLOGY: THE BASICS

Sign phonology refers to the sublexical organisation of signs. Studies of sign phonology describing the inventory of phonotactic patterns and other regularities across the lexicon build the basis for theoretical models (Sandler 1989; van der Hulst 1995; Brentari 1998; van der Kooij 2002). The study of sign phonology increasingly involves the construction of (corpus-based) lexical databases (Crasborn, van der Hulst & van der Kooij 2001; Crasborn et al. 2020; Fenlon et al. 2014; Hulst & Channon 2016; Caselli et al. 2017; H. Morgan 2017; Centre for Sign Linguistics and Deaf Studies 2018; Hochgesang et al. 2021).

Signs are composed of features (examples from NGT in Figure 5-1). Signs may involve one hand (SWEET-A, NICE-A) or two hands (CYCLING, TEA) ('handedness'). The articulator, here the hand, has a specific configuration ('handshape') that specifies the ‘selected fingers’, the ‘finger configuration’, ‘spreading’ and/or ‘aperture’. Some signs include a ‘handshape change’, such as *closing* (NICE-A), *rubbing*, or *wiggling*. Each sign has a place of articulation or ‘location’ on the body (SWEET-A, NICE-A), the second hand (TEA), or the space in front of the signer (CYCLING). Movement features describe how the hand(s) move(s) between two locations in terms of direction (‘movement direction’) and shape (‘movement shape’), such as *straight downwards* (TEA) or *circular forwards* (CYCLING). Depending on location and movement, there may be contact between the two hands or the hand and the body (‘type of contact’), e.g., *continuous contact* (SWEET-A). Further, the hand position is specified as the orientation of the palm, describing its position in relation to the movement and to the location, as well as potential changes (‘orientation change’) such as *flexion* or *supination*. In addition, nonmanual features such as mouth actions, facial expressions and body movements are composites of signs that may have phonological/lexical functions (Pfau & Quer 2010). Actions of the mouth are broadly divided into ‘mouthings’, mouth actions that can be related to spoken words, and ‘mouth gestures’ that are unrelated to spoken language (Crasborn et al. 2008). While mouth gestures appear to play a limited role in the of urban sign languages, mouthings are ubiquitous (Bank 2015; Bisnath 2020). Nevertheless, we lack a comprehensive way of describing and classifying phonological/lexical nonmanuals.

Figure 5-1. Examples of different signs in NGT: SWEET-A, NICE-A, CYCLING, TEA.

Initially documented for ASL and then confirmed in various other urban sign languages, sign formation is governed by three constraints: (i) Selected Finger Constraint; (ii) Symmetry Condition; (iii) Dominance Condition (Battison 1978; Klima & Bellugi 1979). The Selected Finger Constraint conditions handshape changes in monomorphemic signs (signs with just one movement): within a sign, changes of 'aperture', 'curvature' or 'spreading' (e.g., NICE-A) but none of the selected fingers are allowed. The Symmetry Condition and the Dominance Condition are in complementary distribution and shape the formation of two-handed signs (Battison 1978; Klima & Bellugi 1979). When both hands have the same handshape, they are mirror-images of each other, sharing the same movement as a simultaneous or alternating copy (e.g., CYCLING) (Symmetry Condition). When the hands have different handshapes, the weak hand must have an unmarked handshape and function as the location, i.e., remain stable while the strong hand moves (e.g., TEA) (Dominance Condition). Initially, unmarked handshapes referred to a small set of ASL handshapes as defined by frequency, articulatory ease, and early production in child acquisition (BASCO51; Battison 1978)[22]. In the meanwhile, research has suggested a universal set of six handshapes (B51SAfist) that feature in 50% of different sign language lexicons (Rozelle 2003).

Feature differences may constitute minimal pairs of signs, i.e., two signs that differ in a single feature and share all others. For example, the NGT signs FLAT-B and TRUE-A are identical except in 'handshape' (Figure 5-2A); both signs move the strong hand *straight*

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[22] Throughout this paper, we refer to handshapes in letters and numbers, following the convention introduced by KOMVA (1988) and used in Global Signbank. Images of handshapes can be found on Global Signbank under: https://signbank.science.cls.ru.nl/handshapes/show_all/.

downwards with final contact between the two hands but FLAT-B is produced with all fingers extended and TRUE-A with all fingers curved. Thus, this contrast is distinctive in NGT. Similarly, the NGT signs DAY and WHITE differ only in 'location' with DAY produced at the *cheek* in and WHITE on the *neck* (Figure 5-2C), MOTORBIKE and SPORT-C in 'orientation change' with *extension* in MOTORBIKE and *supination* in SPORT-C (Figure 5-2B), and DRY and HOMEWORK in whether or not their movement is *repeated* (Figure 5-2D).

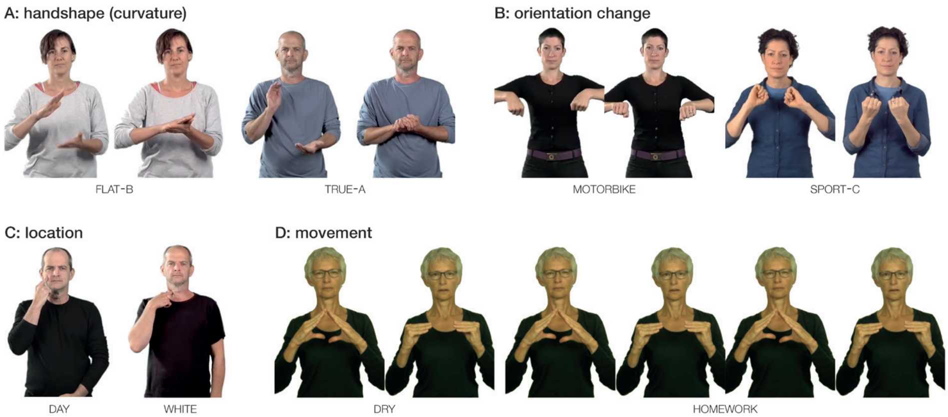

Figure 5-2. Examples of minimal pairs in NGT. (A) FLAT-B and TRUE-A contrast in 'handshape' ('finger curvature'; *extended* vs. *curved*); (B) MOTORBIKE and SPORT-C contrast in 'orientation change' (*flexion* vs. *supination*); (C), DAY and WHITE contrast in 'location' (*cheek* vs. *neck*); (D) DRY and HOMEWORK contrast in 'movement repetition' (*single* vs. *repeated*). Pictures A through C retrieved from Global Signbank (Crasborn et al. 2020). Example D modified from Klomp (2021: 106). [Example D reproduced with permission from Ulrika Klomp]

Lexical contrasts in minimal pairs, as shown in Figure 5-2, is the most straightforward evidence of phonological distinctiveness of a feature. Previously, minimal pairs were thought to be rare in sign languages (van der Kooij 2002) and Sandler and colleagues (2011) suggest that ABSL lacks minimal pairs due to its youth. By contrast, Morgan's (2017) comprehensive analysis of minimal pairs in Kenyan Sign

Language, a language that is even younger than ABSL, suggests that minimal pairs are as common as would be expected for a language of its size (H. Morgan 2017: 114).

Sign phonologies, like spoken phonologies, rely on a restricted subset of features that are phonetically and phonologically possible (Maddieson 1984; Moran 2013). Nevertheless, sign phonologies show striking crosslinguistic similarity: signs are predominately monosyllabic and sequential patterning is rare (van der Kooij & Crasborn 2008); signs seldomly include more than two distinct locations (Channon 2002) and avoid locations that are not visible, e.g., the back (Channon 2015); two-handed signs are constrained by the Symmetry and Dominance Condition (Battison 1978; H. Morgan 2012); handshape distributions are stable crosslinguistically (Rozelle 2003). However, what we know about sign language phonology has emerged from a tradition studying urban sign languages, especially ASL, and despite growing interest in comparative studies (e.g., Centre for Sign Linguistics and Deaf Studies 2018 with the Asian Signbank; Crasborn et al. 2020 with Global Signbank), our knowledge about the diversity of sign languages that emerge and are used across more diverse contexts is limited (see e.g., Nyst 2007 for Adamorobe Sign Language; Tano 2016 for Langues des Signes Bouakako; Stoianov & Nevins 2017 for Maxakali Sign Language). Since comprehensive studies of rural sign phonologies on a par with urban sign languages are absent from the literature, this study turns to studying the phonology of Kata Kolok (Section 5.2.2) and compares it to NGT (Section 5.2.3) in order to see whether the typological patterns observed above hold up against unrelated sign languages used in different sociodemographic contexts.

5.2.2 KATA KOLOK

The sign language Kata Kolok arose in a Balinese village community due to sustained hereditary deafness (Winata et al. 1995; Marsaja 2008).

The village's community structure is tight-knit and dominated by kinship relations following patrilineal tradition. Villagers belong to one of ten family clans and live in multi-generational complexes of houses around a courtyard (family compounds). The villagers' occupations have long centred around day-labour, subsistence farming, and small local businesses. Technological advancements have started to affect everyday life and mobility for example through the advent of mobile phones and scooters and, for younger generations, access to education and job opportunities in tourism. Since its emergence at least six generations ago, Kata Kolok has become linguistically and socially entrenched in the village. Deaf villagers grow up as native signers and a large portion of the ~3,000 hearing villagers has some signing skills, some of them growing up bilingually with Kata Kolok and Balinese (Marsaja 2008; de Vos 2012b).

Kata Kolok has developed as a sign language isolate (Perniss & Zeshan 2008; de Vos 2012b). Due to a history of social seclusion, Kata Kolok signers were not in contact with signers of other sign languages and the influence of the surrounding spoken languages Bahasa Indonesia and Balinese is minimal (de Vos 2011; 2012b). However, increasing mobility and literacy among younger deaf villagers have initiated language contact (Moriarty 2020). As younger generations of deaf villagers participate in formal education, they gain literacy skills in Bahasa Indonesia and signing skills in Indonesian signing varieties (BISINDO) used by deaf people across

Bali. Sign bilingualism occurs to different degrees among Kata Kolok signers: the youngest generation of deaf signers (generation six) are raised monolingually in Kata Kolok and have not yet entered formal education; deaf generation five signers are often fluent (to different extents) in both Kata Kolok and BISINDO and code-switch depending on the conversational setting; deaf generation four signers have limited (perceptive) skills in BISINDO and occasionally borrow lexical signs; the oldest living deaf generation (generation three) signers and hearing signers of all ages do not commonly interact with BISINDO users and thus generally have no perceptive or productive skills in BISINDO.

Kata Kolok's lexicon reportedly shows low lexicalisation (de Vos 2012b). For example, Kata Kolok has small paradigms of kinship (de Vos 2012b) and colour terms (de Vos 2011). There are the signs GRANDPARENT, FATHER, MOTHER, and OFFSPRING to refer to kin and four lexical colour signs (BLACK, WHITE, RED, GRUE) alongside a conventionalised searching behaviour and pointing to an object of the same colour. This contrasts with many urban sign languages that often have elaborate lexical paradigms in these semantic domains that align with the spoken languages that surround them. However, systematic crosslinguistic studies of other semantic domains are rare (however, see Majid et al. 2018). Within Kata Kolok, Mudd and colleagues (2020) suggest that lexical choices are partly governed by sociolinguistic factors. In their study, deaf participants produced more uniform responses to a picture elicitation task than hearing participants (Mudd, Lutzenberger, de Vos, Crasborn, et al. 2020), and the responses among men were more similar than the ones among women (Mudd et al. 2021).

Kata Kolok's phonology shows typological peculiarities with respect to urban sign languages in (i) the range of 'locations', (ii) 'handshapes', and (iii) the use of 'mouth actions'. Kata Kolok features locations that are peripheral and unusual in other well-documented sign languages, e.g., *hip, teeth*, or *tongue* (Marsaja 2008; de Vos 2012b). The handshape inventory is supposedly relatively small and includes many basic handshapes (Marsaja 2008; de Vos 2012b; Lutzenberger 2018). Following Sutton-Spence and Woll (1999), Marsaja (2008) classifies Kata Kolok handshapes into basic, regular and restricted ones according to a variety of criteria including formational aspects, frequency, role in two-handed signs and ease of perception. A preliminary frequency-based overview of handshape distributions in Global Signbank suggests partial overlap with urban sign languages (Lutzenberger et al. 2019; Crasborn et al. 2020). Given the variation in the form of signs across the community (Lutzenberger et al. 2021), it remains, at this point, unclear whether the documented handshape, location, and movement primes are phonetic instances or prototypical representatives of phonological categories. Despite the use of the manual alphabet among literate signers to spell (predominately names), alphabet handshapes have not been integrated in the lexicon as initialised signs, i.e., signs where the handshape represents the first letter of the spoken word, but may occasionally be borrowed from BISINDO. Mouthing is frequent in many other sign languages (Bisnath 2020) but absent in Kata Kolok except for a few lexical items (COFFEE and WHAT are accompanied by mouthing the Indonesian words <kopi> and <apa> respectively). Conversely, mouth gestures may be more prevalent than in other well-documented sign languages (Lutzenberger 2018).

5.2.3 SIGN LANGUAGE OF THE NETHERLANDS

Sign Language of the Netherlands (Nederlandse Gebarentaal; NGT) is the sign language used by signers in the Netherlands. After 30 years of lobbying (Cokart et al. 2019), the law to gain legal status as an official language passed on 20 October 2020 (Eerste Kamer der Staten-Generaal 2021). Today, NGT is used in a large variety of public, official and cultural contexts (Cokart et al. 2019; Klomp 2021).

Prawiro-Atmodjo and colleagues (2016) report 11,900 to 20,400 people with early onset of deafness (born deaf or deafened before the age of three) in the Netherlands. Most deaf children are born to hearing parents, which is likely to result in language deprivation (Humphries et al. 2014; Hall 2017), and receive cochlear implants (Klomp 2021). For a long time, entering deaf school kickstarted NGT acquisition. Today, however, most deaf children partake in mainstream education with predominately hearing classmates (Knoors & Marschark 2012; Schermer 2012; Klomp 2021).

Estimating the size of the signing community depends on many factors including whether only profoundly deaf individuals or also hearing signers are considered: the European Union of the Deaf (2021) generously estimates 15,000 deaf NGT signers, Crasborn (2018) estimates about 12,000 deaf NGT signers and with maximally 10,000 deaf NGT signers, Klomp (2021) represents the most conservative estimate. Cockart and colleagues (2019) propose a considerably higher estimate of ~60,000 NGT signers, including hearing signers like deaf people's relatives and NGT interpreters. Despite many members of the signing community being hearing, Klomp (2021: 54) argues that "people with early onset deafness constitute the core of the sign language community in the Netherlands."

Historically, NGT is related to Old French Sign Language and thought to find its emergence in deaf schools (Cokart et al. 2019). Five deaf schools across the country have shaped regional variation, particularly the lexicon (Schermer & Harder 1986; Schermer 2003; 2004). For example, lexical signs used by old signers from the Effatha deaf school in the West of the Netherlands are reported to vary from the form that is commonly used (Oyserman et al. 2021). Nevertheless, sociolinguistic factors other than region appear to influence lexical variation only marginally (Bank 2015; Klomp 2019; 2021).

Signing is documented in the Corpus NGT, a large collection of semi-spontaneous and elicited data from many deaf NGT signers (Crasborn & Zwitserlood 2008), which also builds the basis for the NGT dataset in the lexical database Global Signbank (Crasborn et al. 2019; 2020). Extensive research on NGT builds the foundation for models of sign phonology (van der Kooij 2002).

NGT shows a substantial number of phonemic handshapes; 31 distinctive handshapes were previously identified (van der Kooij 2002) while the most recent research finds some disagreement among this classification and frequencies in Global Signbank and suggests regional variation in handshape (Klomp 2021). Further, NGT uses the common five main locations (*head, neck, trunk, arm, weak hand, neutral space*) with *neutral space* accounting for more than half and *head* for about 20% of the lexicon (van der Kooij 2002; Klomp 2021). Similar to other urban sign languages, NGT uses a limited number of movement features describing shape and direction of the movement while there appears some disagreement about whether movement shape is phonetic (van der Kooij 2002) or possibly phonemic

(Klomp 2021). In terms of nonmanuals, NGT mirrors most urban sign languages: mouthings are extremely common and occur with a disambiguating (e.g., BROER and ZUS) or meaning-specifying function (e.g., GROEP) and as free mouthings; lexicalised mouth gestures are "exceptional" (Klomp 2021: 118) given the high degree of cross- and intra-signer variation (Bank 2015) and come in three types, namely disambiguating (e.g., FUNNY and LOOK-FORWARD-TO), obligatory (e.g., BE-PRESENT), and nonmanual lexemes (e.g., CHEAT). In sum, NGT is one of the most well-studied sign languages and studies largely echo with findings of other urban sign languages.

5.2.4 THE QUESTION: HOW DIVERSE IS SIGN PHONOLOGY?

The study of phonology launched the whole field of sign linguistics (Stokoe 1960). Even sixty years after the groundbreaking discovery of phonology in American Sign Language in the 1960s, the literature is heavily biased towards urban sign languages that show great crosslinguistic similarity. The growing body of research on (aspects of) sign phonologies in more diverse contexts has indeed corroborated many crosslinguistic similarities. This includes, for example, the fact that across sign languages, a few handshapes are recurrently the most frequent ones (e.g., Rozelle 2003; Nyst 2007; H. Morgan 2017; Stoianov & Nevins 2017; Jorgensen et al. 2021) and two-handed signs are constrained phonotactically (Battison 1978; H. Morgan 2012; Jorgensen et al. 2021). Nevertheless, there is no consensus on the methodologies, the set of features or the completeness of phonological investigations (Channon 2015) which complicates the evaluation of crosslinguistic similarities and differences (Haspelmath 2020). This leads to the question that we tackle in this study: how diverse are sign phonologies when methodological differences are minimalised?

In this study, we examine universal and language-specific aspects of sign phonology through studying the phonology of Kata Kolok in a comparative approach; we compare Kata Kolok to NGT using the same lexical database Global Signbank. NGT is selected as a representative example of an urban sign language. To this end, we perform two studies targeting the feature inventory and language-internal regularities. In Study 1, we chart the feature inventory of Kata Kolok as compared to NGT and test two major claims about Kata Kolok's phonology: (i) high use of few handshapes, and (ii) use of locations that are "unique and may be specific to village sign languages" (Marsaja 2008: 141). In Study 2, we corroborate whether two crosslinguistic regularities (minimal pairs, phonotactic constraints) apply to our datasets and evaluate user judgments (perception and acceptability data) from Kata Kolok signers. The two crosslinguistic regularities represent the criteria for Sandler and colleagues (2011) to conclude that ABSL had not yet fully developed phonology. The user judgments are a methodological innovation with rural sign languages, allowing to hone phonological categories by complementing production with perception data.

5.3 METHODOLOGY

5.3.1 DATA

Data from four complementary sources was used to create the Kata Kolok dataset in Global Signbank: (i) existing spontaneous conversational data from the Kata Kolok Corpus (de Vos 2016), (ii) newly collected data (semi-spontaneous and elicited), (iii) dictionaries and published work, and (iv) field-observations by two of the authors and discussions with local language consultants. First, the Kata Kolok Corpus comprises naturalistic and elicited signing collected since 2007. From the available annotated conversational data, 237 unique signs had been identified previously by one of the authors and were included without reviewing individual tokens. Second, new data was collected between 2017 and 2019 during three community visits by the first author (totalling ~7 months). This data comprises semi-spontaneous expert knowledge through (i) topic-guided free conversations (e.g., about marriage and child diseases), and (ii) unstructured informal interviews (e.g., religious practices and ceremonies or occupational expertise on weaving), and elicited data using culturally appropriate photographs, line drawings, and real objects on a diversity of topics (food items, materials, praying, household items, animals, etc.). Third, we included lexical signs that had previously been documented in dictionaries and scientific publications. Specifically, a picture dictionary of around 170 basic signs produced for the village's deaf education program (de Vos, Molendijk & Wijana n.d.), signs from publications of de Vos (2012b), Marsaja (2008) and Putri and colleagues (Putri et al. 2015; 2017; Putri & Sutjaja 2019) as well as a glossary based on Putri's unpublished doctoral thesis (Putri 2018). Fourth, few signs were added based on field observations. These signs are either variants that were observed but not videotaped, or additions made by the deaf research assistants during recording isolated signs for the database. The mixed methods approach makes it more likely that we include both high-frequency and low-frequency concepts and forms, and thus ensures a representative sample of the Kata Kolok lexicon.

The NGT dataset in Global Signbank was developed as the lexicon to annotate the Corpus NGT (Crasborn et al. 2019). The NGT dataset currently counts 4,159 entries [Signbank sample date: June 2021] that are coded for 19 different phonological features (Crasborn et al. 2020). Phonological distinctions are largely based on van der Kooij (2002), Crasborn (2001) and later work with some additional fields to improve searchability.

5.3.2 KATA KOLOK DATASET IN GLOBAL SIGNBANK

The use of lexical databases as a scientific tool to document and analyse sign phonology is steadily increasing. While some researchers chose to build their own infrastructure (H. Morgan 2017) or use open source tools such as SooSL (Bickford et al. 2016) to be able to work offline, the Signbank software (Cassidy et al. 2018) has become a widely used tool across many well-studied sign languages.

The Kata Kolok dataset has been created as part of Global Signbank (Crasborn et al. 2020). The general infrastructure and features for our analyses have been adopted and expanded from its predecessor, NGT Signbank. However, adopting this methodology requires three fundamental considerations: (i) method of creation, (ii) organisation of entries, and (iii) available feature values. First, existing databases are often constructed bottom-up, with spontaneous corpus data as the source data for the database (Cormier, Fenlon, et al. 2012; Hochgesang, Crasborn & Lillo-Martin 2018; Rossi Stumpf et al. 2020). This is challenging for Kata Kolok given multiple limitations in resources: (i) limited research on the Kata Kolok lexicon, (ii) small amount of available data with annotations, and (iii) limited budget for annotation and a small team of annotators. Language documentation since 2007 has shown that Kata Kolok signers discuss similar topics when recorded in free conversation and that pointing signs and classifiers are frequent (de Vos 2012b). Both lead to a limited set of recurrent vocabulary; the list of unique types from annotated data from the Kata Kolok Corpus yielded 237 unique types (data source (i)). Although there are more publications on Kata Kolok than for other rural sign languages, the number is still considerably smaller than for NGT. For this reason, we chose for a multi-methods approach combining spontaneous signing and elicitation.

Second, all existing databases are organised around citation forms but there is little consensus of how entries should be structured. The BSL Signbank reduces the granularity of feature coding to five different categories by distinguishing between phonological and lexical sign variants; two forms are considered phonological variants unless feature differences occur in more than one parameter (Cormier, Fenlon, et al. 2012; Fenlon, Cormier & Schembri 2015). The NGT dataset in Global Signbank maintains the fine granularity in coding and instead focuses on disentangling phonetic variation from other types of variation. In the case of Kata Kolok, citation forms are a fuzzier concept (further discussed in Section 5.5) and we know less about how to distinguish between phonetic, phonological or lexical variation. For this reason, we have adopted a generous approach. We included unique signs from the corpus. In addition, we included elicited signs under the condition that they were observed at least three times. There are two exceptions where signs were included even if fewer than three tokens were recorded: (i) signs from semi-structured interviews since these interviews were done with few signers (experts) and target expert lexicon which is likely to include low-frequency signs, and (ii) signs from a study on formal variation since it aimed to capture the full range of variants used across participants (Lutzenberger et al. 2021) (see Chapter 4).

Third, the feature values available in Global Signbank are based on the phonology of NGT. However, it cannot be expected that NGT signs use all phonetic possibilities of sign languages. When coding, we added new values whenever the available feature values were insufficient to accurately describe a Kata Kolok sign. Both BULL and FATHER (Figure 5-3A) are produced between the upper lip and the nose, but BULL closer to the nose and FATHER closer to the lip. Since it is unclear whether signers differentiate perceptually between this difference, we used the values already available in Global Signbank; *nose* for BULL and *top lip* for FATHER. The 'handshape change' in HOW-MANY (Figure 5-3B) however is not described sufficiently with the existing values which is why we added the new value *consecutive closing*.

Figure 5-3. Examples of three Kata Kolok signs: BULL, FATHER, HOW-MANY.

For all entries, we coded sign form based on pre-determined feature categories (e.g., 'location') and feature values (e.g., *head*). The features that were considered can be found in Table 5-1 (for details consult Crasborn et al. 2020).

Table 5-1. Overview of features considered in Global Signbank.

	features				
Articulator	Handedness (w/ Weak Drop or Weak Prop)	Handshape Strong Hand	Handshape Weak Hand	Handshape Change	Relation between Articulators
Location	Location				
Orientation	Relative Orientation: Movement	Relative Orientation: Location	Orientation Change		
Movement	Movement Shape	Movement Direction	Repeated Movement	Alternating Movement	
Nonmanuals	Mouth Gesture	Mouthing			
Other	Contact Type	Virtual Object	Phonology Other		

Compounds were registered as separate entries without phonological description since both compound parts were entered as independent entries with phonological description. In case one compound part was not registered as an independent sign, this entry was marked as compound part CP (GLOSS-CP).

The dataset underwent four rounds of scrutiny. Initially, we continuously added new entries for signs that had not been registered previously or occurred as homonym. Second, we reviewed the feature coding of all entries in order to unify the coding and minimise mistakes. Third, we assigned lemma ID glosses to signs with the same iconic motivation and the same meaning (e.g., two variants of PIG were given different lemma glosses when based on different iconic motivations such as killing a pig vs. a pig eating). Fourth, we manually reviewed the automatically generated list of homonyms to check for accuracy and corrected the coding accordingly. The Kata Kolok Signbank has become a living lexical dataset that continues to be expanded, refined and improved and can be accessed at https://signbank.cls.ru.nl/.

5.3.3 PROCEDURE & DATA ANALYSIS

All data was exported from Global Signbank as csv file and analysed in R (R Core Team 2019).

5.3.3.1 STUDY 1: THE KATA KOLOK INVENTORY – OVERVIEW AND TYPOLOGICAL UNUSUALNESS

Study 1 charts the inventory of Kata Kolok as compared to NGT. We focus on frequency distributions for each coded feature. In addition, we explore handshape and location in more detail in order to test whether our sample supports two existing claims about Kata Kolok: first, the handshape inventory of Kata Kolok is relatively small and consists of few basic handshapes (Marsaja 2008); second, the Kata Kolok lexicon accommodates an enlarged signing space with typologically unusual locations (Marsaja 2008). We evaluate both claims by comparing frequency distributions from our Kata Kolok dataset to NGT as well as the previous literature. Phonological primes in Marsaja (2008) are determined based on a variety of criteria including formational aspects, frequency, role in two-handed signs and ease of perception; however, no exact numbers are provided, and phonological primes are provided for only three parameters ('handshape', 'location', 'movement)'.

5.3.3.2 STUDY 2: REFINING THE KATA KOLOK INVENTORY – CROSSLINGUISTIC REGULARITIES AND USER JUDGMENTS

Study 2 serves to hone the feature inventory and to evaluate how Kata Kolok's phonology fits into the wider typology. We evaluate (i) minimal pairs, and (ii) violations of phonotactic constraints (Selected Fingers Constraint, Symmetry Condition, Dominance Condition) in both the datasets of Kata Kolok and NGT. In addition, we provide a small-scale study of user judgment (perception and acceptability data) from Kata Kolok signers.

Minimal pairs are identified using an algorithm that determines pairs of signs that differ in exactly one manual feature and outputs an automatically generated list. Morgan (2017) puts forward a conservative count of minimal pairs, counting only minimal pairs from the same signer. However, given the structure of Global Signbank, we apply a more flexible criterion and survey all existing entries as a set, irrespective of the signer producing a form. Given the relational differences between different features (e.g., ‘movement shape’ and ‘movement direction’ always co-occur), this list is (probably) not exhaustive. For the purpose of this study, we take minimal pairs as direct evidence of feature contrast and report (crosslinguistic) frequencies, types of minimal pairs and elucidate selected examples. We generally approach handshapes as holistic features but include here a refined analysis of minimal pairs of handshape subcomponents in order to corroborate robustness of handshape features.

To address violations of phonotactic constraints, we review the data in subsets. To test the Selected Finger Constraint, we examine signs with handshape changes as to whether the selected fingers change within a sign. To test the Dominance Condition, we examine two-handed signs with different handshapes as to whether the *weak hand* functions as location. To test the Symmetry Condition, we investigate whether the two hands in two-handed signs share their handshape, and movement shape and direction. In addition, we review all signs marked as unapplicable handedness ('handedness' = X) as to their validity to the constraints. We report frequencies and examples of violations, and contextualise how findings fit into the typology.

Lastly, we report novel perception and acceptability data from a small study asking whether Kata Kolok signers are sensitive to phonological distinctions in handshape and location. We animated a monkey character to sign using the Maya Autodesk software. These stimuli were originally designed for Chapter Seven. Previous experience has shown that elicitation materials involving real people or places counteract successful elicitation since Kata Kolok signers often focus on trying to identify the person or place rather than naming the stimulus. To prevent this in this study, we opted to animate a monkey character rather than using recordings of a signer as stimuli. We designed pairs of stimuli, correct targets of six Kata Kolok signs and incorrect counterparts in which we manipulated either handshape or location (see Figure 5-4).[23] We manipulated handshape in five signs, either the 'selected fingers' (COW[24], PRAY) or the 'finger configuration' (SHY, GHOST-A, COW), and 'location' in two signs (FATHER, GHOST-B). In other words, we created a manipulation by changing the selected fingers of the target sign to use a different set of fingers. For example, the Kata Kolok target sign PRAY is produced with a *5* handshape where all five fingers are extended. For the manipulation, we animated the monkey to produce a nonce sign that is identical to PRAY except in handshape; instead of extending all fingers, all fingers are curved (*A* handshape). We tested the stimuli with 11 native Kata Kolok signers (10 deaf, one hearing) and asked them to repeat the sign and to judge whether the sign is acceptable in Kata Kolok or not.[25]

The small study reported in this paper was originally planned as a larger-scale study to systematically test contrasts but unfortunately was halted due to the COVID-19 pandemic. We report the results from the 11 signers on the six pairs of stimuli for which this data is available.

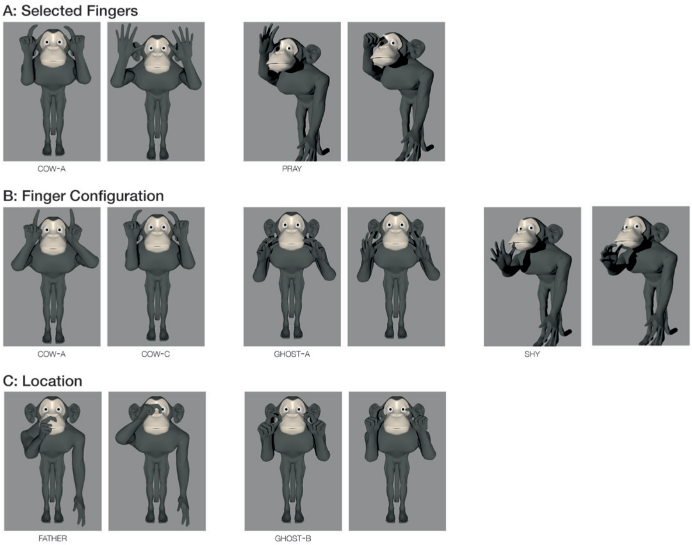

Figure 5-4. Illustration of stimuli. Animated monkey character produces the Kata Kolok target sign (left) and the manipulation (right) for the signs COW, PRAY, SHY, GHOST-A, FATHER and GHOST-B.

5.4 RESULTS

The Kata Kolok dataset in Global Signbank consisted of 1,312 entries. Of these entries, 45 compounds were excluded from the results reported in this section

[23] Stimuli videos were also used for an experiment with child participants and can be found on the Open Science Framework (https://osf.io/w62tm/?view_only=5bbe57e3068a4d9995d267d9073c1224).

[24] For cow, we included two target variants that differed in handshape and one manipulation.

[25] Acceptability judgments were elicited interactively, asking the participant whether the monkey signs well/signs the sign correctly or not. Signers were told that we are teaching the monkey to sign for a project with children who acquire Kata Kolok from birth and asked to comment on the monkeys productions, prompting them with signs/phrases like GOOD BAD?; MONKEY KNOW GOOD; MONKEY SIGNING NAUGHTY; IX-tablet NAUGHTY).

since their individual parts are already being analysed. An additional 57 entries were identified as borrowings, 30 from BISINDO varieties and 27 (probably) from other sources e.g., signs used by visiting deaf tourists (Moriarty 2020).[26] Borrowings are excluded from the analyses given their limited use and dispersion through the community and the fact that Kata Kolok signers readily identify them as non-local. The final Kata Kolok dataset comprises 1,210 entries of 852 different lemmas.

The NGT dataset in Global Signbank consisted of 4,159 entries. Following the same criteria as Kata Kolok, we excluded 229 compounds. In addition, 116 entries are verb roots, 29 are letter handshapes and 192 lack a phonological description entirely. We excluded them from the dataset. The final NGT dataset includes 3,597 different entries.

5.4.1 STUDY 1: THE KATA KOLOK INVENTORY – OVERVIEW AND TYPOLOGICAL UNUSUALNESS

At first sight, the Kata Kolok and the NGT dataset appear fairly similar (Figure 5-5). To some extent, this is related to the nature of the features themselves; at the surface level, different features allow for different numbers of feature values. For example, ‘repeated movement’ is a binary feature whereas ‘location’, like most features, is polyvalent.

[26] Some examples of lexical borrowings are colour signs, such as a BISINDO sign for yellow, and signs like NAME, FAMILY and DEAF that are used frequently in sign languages of international visitors. Interestingly, some signs appear to have been integrated and assimilated to Kata Kolok phonology; the sign AUSTRALIA, for example, no longer includes a handshape change when used by Kata Kolok signers.

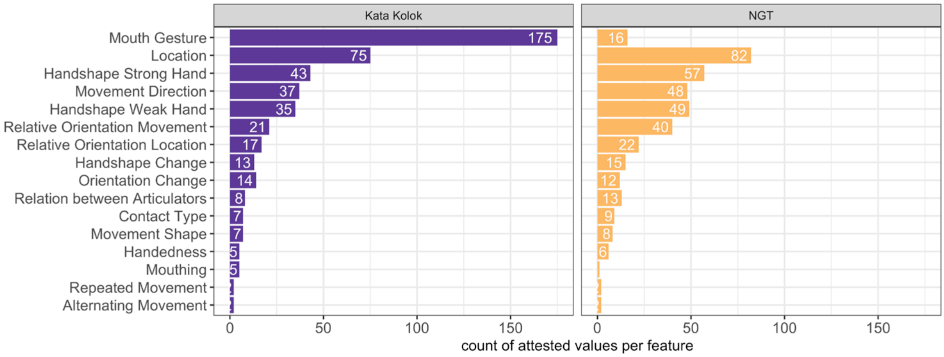

Figure 5-5. Overview of number of values per feature in Kata Kolok (left) and NGT (right). Feature on the y-axis, count of unique feature values on the x-axis.

The number of attested feature values differs between the two datasets with generally fewer in Kata Kolok than in NGT (Figure 5-5). For example, the handshapes of the strong hand are more varied in NGT (n=57) than in Kata Kolok (n=43), and more different handshapes are attested on the weak hand in NGT (n=49) than in Kata Kolok (n=35).[27] This may seem unsurprising given that the NGT dataset (n=3,597) is nearly three times the size of the Kata Kolok dataset (n=1,210). However, this may also reflect typological differences; it may confirm the existing claim that Kata Kolok's handshape inventory is smaller than the one of NGT. Furthermore, the use of the mouth represents the biggest crosslinguistic difference. On the one hand, 175 different mouth gestures are attested in Kata Kolok and 16 in NGT. This may provide evidence for a typological pattern that has been noted previously (Marsaja 2008; de Vos 2012b; Lutzenberger 2018). The high number of different mouth gestures in Kata Kolok is likely overstated due to the lack of a standardised coding scheme of nonmanuals. To confirm this, a more detailed study of mouth gestures is needed that takes a critical approach to coding, including minimising differences based on vowel length and voicing of consonants. On the other hand, the results on mouthings in Figure 5-5 are misleading: mouthings have been described as ubiquitous in NGT (Bank 2015) and as exceptionally rare in Kata Kolok (Marsaja 2008; de Vos 2012b) and yet Figure 5-5 shows no mouthings in NGT and five mouthings in Kata Kolok. This is caused by a coding difference; mouthings are considered the default in NGT and thus remain uncoded while they are exceptions, and hence coded, in Kata Kolok.

We now turn to evaluating existing claims about 'handshape' and 'location' in Kata Kolok (Marsaja 2008).

5.4.1.1 HANDSHAPES

Our Kata Kolok dataset includes 43 different handshapes, 43 on the strong and 35 on the weak hand and the NGT dataset contains 58 handshapes, 57 on the strong and 49 on the weak hand. Handshapes are reported separately for the two hands ('strong hand', 'weak hand') throughout since they can have different handshapes and different roles. The general distribution of handshapes is similar across both datasets; few handshapes feature in the majority of signs whereas many handshapes occur with low frequency (Figure 5-6). Nevertheless, which handshapes are frequent differs.

On the strong hand, three handshapes account for 40.9% of all signs in the Kata Kolok dataset and four handshapes for 41.6% of the signs in the NGT dataset (Figure 5-5). In Kata Kolok, the 'strong hand' most commonly is *B* (16.4%; 198/1210), *1* (13.2%; 160/1210), or *5* (11.3%; 137/1210), followed by *S* (8.1%; 98/1210),

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[27] Note that we collapsed complex handshapes that include multiple handshapes to count them only once. Examples of this type of complex handshapes are often derived from fingerspelling, e.g., *B* > *A* for NGT BACHELOR.

Beak_spread (6.5%; 78/1210), *Baby_beak* (6.3%; 76/1210), *C_spread* (5.7%; 69/1210), and *Money* (4.9%; 59/1210) which are frequent, yet considerably less so. Thus, the remaining 35 handshapes are used in 27.7% (335/1210) of the Kata Kolok dataset. In NGT, the handshapes *B* (15.8%; 568/3597), *1* (10.9%; 393/3597), *S* (7.9%; 284/3597) and *5* (7.7%; 276/3597) are most common, followed by *Money* (4.9%; 177/3597), *T* (4.6%; 166/3597) and *C_spread* (4.4%; 157/3597). Thus, the remaining 50 handshapes feature in 43.8% (1576/3597) of the NGT signs. On the non-dominant hand, the handshapes *B* (26.1%; 155/595), and *5* (17.3%; 103/595) are most common in Kata Kolok, and *B* (28.8%; 483/1680), *5* (11.1%; 187/1680) and S (9.6%; 161/1680) in NGT. This, in turn, means that 33 handshapes are distributed over 56.6% (337/595) of the Kata Kolok dataset and 46 over approximately 50.5% (849/1680) of the NGT dataset.

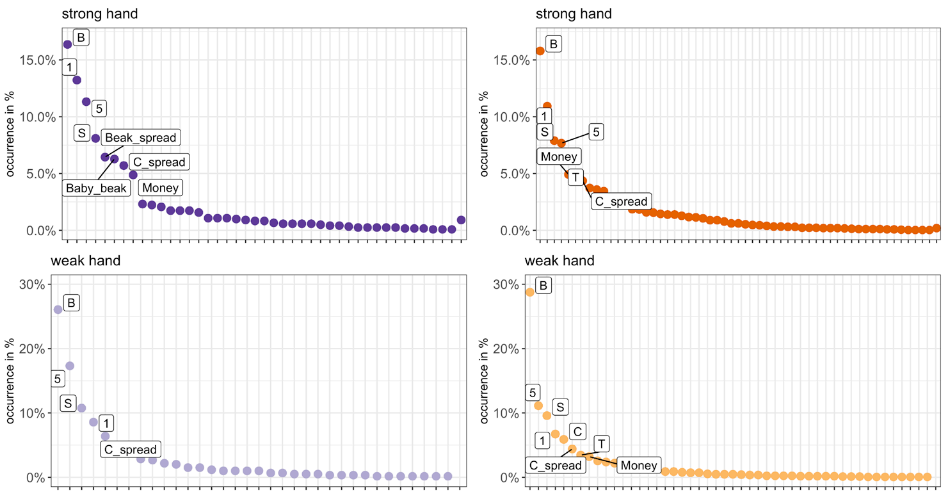

Figure 5-6. Distribution of handshapes in Kata Kolok (left) and NGT (right). Occurrence of a handshape (in percentages) on the y-axis, handshape on the x-axis.

These findings overlap with some existing claims about Kata Kolok's phonology. First, the range of handshapes attested in our study is larger than the primes previously identified by Marsaja (2008). Specifically, our dataset yielded 43 different handshapes while Marsaja identifies 29. Second, our results align partly with Marsaja's (2008) handshape classification. Marsaja classifies the handshapes *B, 5*, and *1* as basic, and, in line with this, they are highly frequent in our dataset. However, other handshapes that are frequent in this study are at odds with previous classifications: Marsaja (2008) classifies *C_spread* as basic handshape while it occurs considerably less often than *B, 5*, and *1* in our data; *Beak_spread* is classified as restricted handshape and *Baby_beak* as regular handshape but both are attested with similar frequencies in this study. Perception experiments may be useful to evaluate possible explanations for these different findings, e.g., a more comprehensive and diverse dataset, or differences in delineating handshape categories.

Moreover, our study reveals crosslinguistic similarities and differences between Kata Kolok and NGT in terms of (i) the size of the handshape inventory, (ii) frequent handshapes are shared crosslinguistically, and (iii) language-specific preferences for handshapes. First, the 43 handshapes attested in the Kata Kolok dataset is higher than previously reported yet smaller than in NGT (n=57). As mentioned previously, these findings may therefore be in line with the existing claim for a smaller inventory in Kata Kolok (Marsaja 2008). Lutzenberger (2018) suggests that this may be related to the fact that NGT but not Kata Kolok integrates alphabet handshapes in the lexicon in the form of initialised signs. Second, the four most frequent handshapes in both datasets (*B, 1, 5, S*) are frequent crosslinguistically (Battison 1978; Rozelle

2003; H. Morgan 2017; Stoianov & Nevins 2017). Rozelle (2003) identifies these four handshapes alongside two additional ones as making up the core of sign language lexicons (~50% of signs). Our data mirror this crosslinguistic trend; these four handshapes account for 42.3% in NGT and for 49% in Kata Kolok. Third, while the distribution of frequent handshapes is similar across both sign languages, the comparison uncovers language-specific preferences (Figure 5-7): the handshape *5* is more frequent than S in Kata Kolok but not in NGT, *Beak_spread* and *Baby_beak* are infrequent in NGT but among the most frequent ones in Kata Kolok, and *T* is very frequent in NGT but rarely used in Kata Kolok. Extrapolating, Kata Kolok appears to prefer handshapes where either all or one finger is selected while many NGT handshapes select several fingers (e.g., *N, V, T, Y,* etc.). In sum, despite great similarity in distribution, handshape inventories differ in size and composition, and possibly also handshape complexity in terms of finger selection.

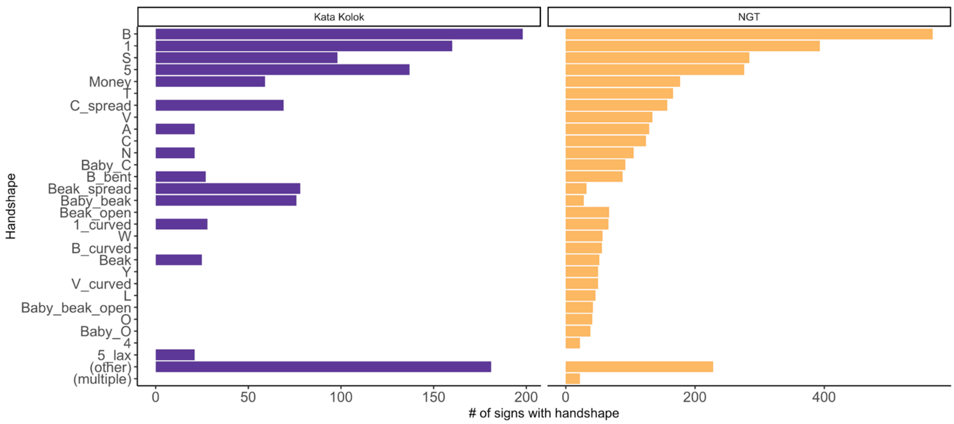

Figure 5-7. Handshapes in Kata Kolok (left) and NGT (right) (handshapes with frequency >20 are collapsed under "other", complex handshapes are collapsed as "multiple"). Handshape name on y-axis, count of signs with this handshape on the x-axis.

5.4.1.2 LOCATIONS

Our Kata Kolok dataset includes 75 and our NGT dataset 82 different 'locations' (Figure 5-8). Two adjustments reduce the number of attested different locations, marginally in Kata Kolok and drastically in NGT: (i) collapsing different locations on *weak hand*, e.g., *weak hand: palm* and *weak hand: thumb* (Kata Kolok: n=63; NGT: n=54) and (ii) summarising multiple locations e.g., *chin to chest* in NGT WONDER (Kata Kolok: n=63; NGT: n=45). The large range of attested locations in Kata Kolok contrasts starkly with the 28 location primes previously reported by Marsaja (2008). Nevertheless, the number of attested locations resembles NGT which suggests the possibility that any difference to the literature may be aggravated by differences in the granularity of coding.

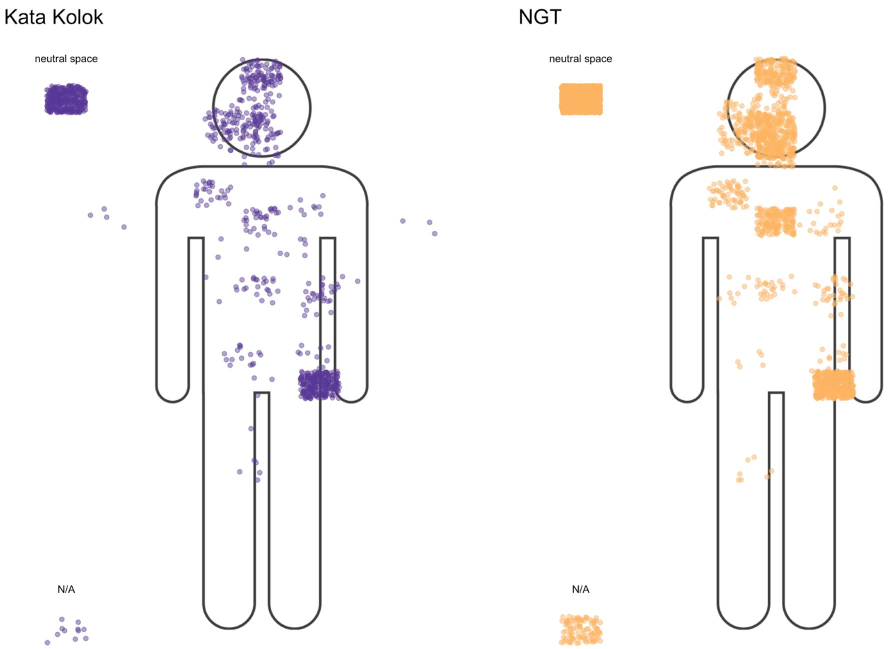

Figure 5-8. Distribution of locations in Kata Kolok (left) and NGT (right).

Similar 'locations' are used most across both datasets (Figure 5-8). Signs in both languages are most commonly produced in *neutral space*, 27.9% (338/1210) of Kata Kolok signs and 48.2% (1732/3597) of NGT signs. In Kata Kolok, the three next most common locations are *mouth* (10.2%; 123/1210), *weak hand: palm* (10.2%117/1210), and *head* (5.6%; 68/1210). All other locations occur to less than 3% of the dataset. In NGT, five additional locations are used in more than 3% of the signs: *weak hand: palm* occurs in 5.8% (209/3597), *chest* in 4.6% (166/3597), *mouth* in 4.1% (148/3597), *chin* in 4% (144/3597), and *head* in 3.8% (138/3597) of signs. The remaining locations are less frequent. In sum, many signs are produced on the *head*, and both datasets include signs at *shoulders*, *arm* and *knee*. Nevertheless, NGT signs are more frequent at centre of the body (*chest, contralateral shoulder*) than Kata Kolok signs which, instead, often include locations at the lower body (*belly, hip, crotch*) or the *arm*. Thus, the size and dispersion of locations appears quite similar across both languages.

Marsaja (2008: 141f.) identifies locations in Kata Kolok and other rural sign languages as unique based on three claims: (i) rare usage in other sign languages (specifically *tongue, teeth, nails,* and *hip*), (ii) wide dispersion due to the use of a larger signing space, and (iii) facial obstruction by placing static signs on the *forehead*. Here, we evaluate each claim in turn. First, almost all locations reported as Kata Kolok-specific are attested in the NGT dataset yet they are more frequent in Kata Kolok. *Tongue, teeth, nails*, and *hip* feature in 2.3% (28/1210; 19 different lemmas) of the Kata Kolok dataset and in 0.3% (10/3597) of the NGT dataset. In Kata Kolok, two signs are produced at *tongue*, nine at *teeth*, two at *nails/thumb*, and 15 at *hip*. In NGT, one sign is produced at *tongue* (TONGUE), none at *teeth*, four at *thumb* (ADAPT, FIT, PT-THUMB, TOADSTOOL), and five at *hip* (DRAWERS, KITCHEN, PANTS, POOR-B, SOLDIER-A). Clearly, these locations are not unique to Kata Kolok but may be more common in Kata Kolok, and maybe also other rural sign languages. Truly exceptional in our dataset are the locations *East* and *West* (cardinal directions); they are unattested in NGT and occur for instance in Kata Kolok signs related to times of the day (e.g., MORNING and EVENING-B; Figure 5-9). Such locations are likely to be found in sign languages that make extensive use of real-world pointing.

MORNING EVENING-B

Figure 5-9. Examples of locations *East* and *West* in the signs MORNING and EVENING-B.

Second, while the dispersion of locations differs only marginally between Kata Kolok and NGT, evidence as to the size of the signing space in the lexicon is limited from our data. The use of real world reference and peripheral locations provide a source for an enlarged signing space (Marsaja 2008; de Vos 2012b). Moreover, locations below the waistline (e.g., INJECTION, OFFSPRING), on the signer's head (e.g., WHALE, CEILING-FAN) or the periphery of the signing space (e.g., EGG, POLICE) may contribute to an enlarged signing space. However, in this study, locations were collapsed as far as possible, e.g., *head* included locations above the head and next to the head, given the lack of evidence from other sign languages that locations are perceived categorically

(Emmorey, McCullough & Brentari 2003). There are two main issues with deriving the dispersion of locations from a purely phonological analysis: in order to assess whether the Kata Kolok signing space is indeed bigger than in NGT, it is necessary to evaluate the effect of discourse and pragmatic strategies on the size of signing (Marsaja 2008; de Vos 2012b), and to apply a precise and granular measure of distance (e.g., Hill et al. 2009; Namboodiripad et al. 2016). Therefore, while it is possible that Kata Kolok locations are indeed more widely dispersed than in NGT, more research is needed in this domain to sharpen the delineation of possible locations.

Third, signs causing "facial obstruction" (Marsaja 2008: 141), i.e., signs with *continuous contact* at *forehead*, are attested to 1.2% (14/1210) in the Kata Kolok data and to 0.3% (9/3597) in the NGT data. This suggests that this type of signs is indeed more frequent in Kata Kolok than in NGT. A more generous analysis (*head* locations with *continuous contact*) corroborates this observation: although not unattested in NGT (2.4%; 87/3597), static signs around the *head* are more common in Kata Kolok (10.5%; 127/1210). Nevertheless, a qualitative study as well as perception data is necessary to assess whether those signs indeed obstruct vision, as previously suggested.

To conclude, the two languages show differences in frequency of specific feature values, e.g., preference of certain 'handshapes' or 'locations'. Nevertheless, striking similarities surface when the languages are compared on equal grounds. While our data supports some of the previous claims (Marsaja 2008; de Vos 2012b), we also note that many features that were claimed to be unique are indeed also attested in NGT.

5.4.2 STUDY 2: REFINING THE KATA KOLOK INVENTORY – CROSSLINGUISTIC REGULARITIES AND USER JUDGMENTS

In the following section, we report results on crosslinguistic regularities, minimal pairs and phonotactic constraints. We also discuss the user judgment (perception and acceptability data) results from Kata Kolok signers.

5.4.2.1 MINIMAL PAIRS

The automated comparisons of the dataset identified 437 minimal pairs in the Kata Kolok dataset. For 83, the members of the pair have the same lemma gloss and were therefore excluded. The final number of minimal pairs in the Kata Kolok dataset is 354. The NGT dataset is not organised around lemma glosses, and, thus, all identified 5,491 minimal pairs are reported here.

In both Kata Kolok and NGT, pairs of signs differing in the handshape of the 'strong hand' are most common (Figure 5-10), amounting to 48.3% (171/354) of the minimal pairs in Kata Kolok and 53.2% (2921/5491) of the minimal pairs in NGT. Although minimal pairs of 'location' are second most frequent in both languages, they are considerably more common in Kata Kolok (22.35%; 79/354) than in NGT (11.4%; 624/5491). While uncommon in Kata Kolok (1;7%; 6/354), NGT has many minimal pairs of 'movement direction' (9.3%; 509/5491) and Kata Kolok (12.2%; 43/354) includes many more minimal pairs of 'relative orientation: location' than NGT (3%; 173/5491) and of 'contact type' (4%; 14/354) than NGT (1.2%; 70/5491). All other features create lexical contrast much less often.

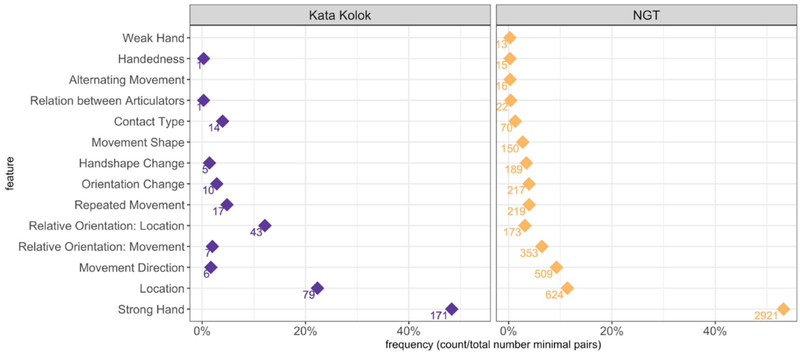

Figure 5-10. Minimal pairs attested in the Kata Kolok (left) and the NGT (right) dataset. Feature on the y-axis, frequency of the feature creating lexical contrast in percentages on x-axis.

Minimal pairs are the most straightforward way to determine lexical contrast and, thus, we can deduce a (preliminary) set of distinctive feature values for Kata Kolok. Minimal pairs include 28 different 'locations', among them *teeth* and *hip*, and 29 'handshapes' ('strong hand'), including all the frequent handshapes (*B, 5, S, 1, Beak_spread, C_spread*). Therefore, the signs STAMP-B and PUMPKIN-A are evidence for the phonemic status of the handshapes *S* and *B* (Figure 5-11A). However, until this point, we have analysed handshapes holistically, disregarding their sub-components ('selected Fingers', 'finger configuration', 'unselected fingers', 'spreading', 'aperture'). A reanalysis of minimal pairs of handshape confirms only 19.3% (33/171) of the original 171 pairs in Kata Kolok and 17.6% (514/2921) of the original pairs in NGT; all other pairs differ in more than one sub-component, e.g., STAMP-B and PUMPKIN-A that differ in selected fingers (*none* vs. *all*), finger configuration (*N/A* vs. *extended*) and spreading (*N/A* vs. *unspread*). In contrast, EASY and INCSENSE differ only in selected fingers (pinky in EASY and index finger in INCENSE), and, thus, persist as minimal pair (Figure 5-11B).

Figure 5-11. Examples of minimal pairs: (A) PUMPKIN-A and STAMP-B: contrast when analysing full handshapes; (B) EASY and INCENSE: contrast when analysing handshape sub-components.

It should be reiterated that the automatic analysis of minimal pairs considers only manual features. However, the presence or absence of nonmanual features frequently creates lexical contrast in Kata Kolok (Figure 5-12). Signs in the minimal triplet QUIET, INCENSE, and DELICIOUS (Figure 5-12A) differ only in 'mouth gesture': *pursed lips* in QUIET, *pursed lips* and *blowing air* in INCENSE, and *pursed lips* and *sucking air* through the open mouth in DELICIOUS. Similarly, the signs FOREIGNER and RHINO are manually identical and differ only in that FOREIGNER is a static sign while RHINO includes a *backwards head tilt* (Figure 5-12B). Different from other sign languages, nonmanuals creating lexical contrast in Kata Kolok are not mouthings but mouth gestures or other nonmanuals.

Figure 5-12. Examples of minimal pairs of nonmanuals. (A) minimal triplet of 'mouth gesture': SILENT (*pursed lips*), INCENSE (*pursed lips* and *blow*), and DELICIOUS (*pursed lips* and *sucking air*); (B) Minimal pair of 'nonmanuals': FOREIGNER (*static*) and RHINO (*backwards head tilt*).

To conclude, both datasets include a substantial number of minimal pairs on diverse manual features. While the results from the NGT are likely overinflated due to coding redundancies, the ones from Kata Kolok are probably underestimated given the role of nonmanuals in creating lexical contrast. Specifically, Kata Kolok appears to rely on diverse nonmanuals for minimal pairs whereas in other sign languages, lexical contrast through nonmanuals is reported to primarily concern mouthing (H. Morgan 2017: 443 for Kenyan Sign Language; Klomp 2021: 116ff for NGT).[28] The examples of (nonmanual) lexical contrast exemplify not only that minimal pairs are helpful to distil the feature inventory of Kata Kolok but also allude to the importance of nonmanuals in the language's phonology that requires systematic investigation in the future. At the same time, this uncovers needed improvement for Global Signbank; in order to accommodate linguistically diverse systems, the description of nonmanual features needs to go beyond mouthings and mouth gestures to include other features of the face, head and body.

5.4.2.2 PHONOTACTIC CONSTRAINTS

In the following, we evaluate whether and to what extent three phonotactic constraints common across other sign languages apply to our datasets: the Selected Finger Constraint, the Dominance Condition and the Symmetry Condition.

The Selected Fingers Constraint applies to signs with handshape change, i.e., 18.3% (221/1210) of the Kata Kolok and 14.5% (528/3597) of the NGT data and states that selected fingers do not change throughout a sign. NGT includes 22 signs with changes between two alphabet handshapes that are exempted from the Selected Fingers Constraint since their handshape change is caused by a written word, e.g., *B* to *A* handshape in BACHELOR. In all other cases, the Selected Fingers Constraint is obeyed; most commonly, signs include *closing, opening* or *bending* the selected fingers. A small paradigm of Kata Kolok signs with numeral incorporation may violate the Selected Fingers Constraint: signs for “months in the future” build a five-step paradigm in which the handshape *Beak_spread* moves forwards while changing into a number handshape between one and five. Thus, in contrast to other signs with numeral incorporation that incorporate a number handshape in the sign, the selected fingers change within this small paradigm.

The Dominance Condition and the Symmetry Condition apply to two-handed signs, i.e., 51.4% (622/1210) of the Kata Kolok and 46.6% (1677/3597) of the NGT

[28] Note that Morgan (2017: 443) refers to the mouth action blowing as mouthing.

dataset. Across both datasets, similar proportions of signs are asymmetric and symmetric, namely 17.4% (210/1210) of Kata Kolok signs and 13% (468/3597) of NGT signs are coded as asymmetric, and 28.3% (343/1210) of Kata Kolok signs and 32.6% (1174/3597) of NGT signs are coded as symmetric. Five Kata Kolok and 79 NGT asymmetric signs appear to violate the Dominance Condition since the 'location' differs from the *weak hand*. In the NGT dataset, most cases appear to be due to coding inconsistencies, as judged by the available videos, and some should not be considered violations, e.g., complex locations such as in DEAL-A that moves *V* handshape from the *chin* to *the weak hand* and signs with location *neutral space* where the weak hand functions as starting or end point (HILL, LESS-B) or both hands move together (e.g., OPPRESSED-A, SUPPORT). Some of the NGT and the five of the Kata Kolok examples may represent true violations; notably, all appear related to iconicity. These signs share the characteristics of asymmetric signs but are articulated at iconically motivated locations; the NGT sign HEARING-HORN traces the shape of the hearing horn while holding it at the *ear* and in the Kata Kolok sign MANGO-E, the handshape *1* brushes over the *S* handshape at the *mouth* as in peeling and eating a mango. Moreover, one Kata Kolok and 13 NGT seem to violate the Symmetry Condition as to being coded as symmetric despite having different handshapes on both hands. From the available videos, all violations in NGT are caused by coding errors, and the one Kata Kolok sign includes interlocked handshapes (*C_spread* and *5*), possibly impacting the shape of the hands.

In addition to these classified signs, 68 Kata Kolok and four NGT signs were marked as "X", i.e., other handedness categories are not applicable. The Kata

Kolok examples include violations of the Dominance Condition and the Symmetry Condition while the NGT signs do not. The most straightforward examples of violations are signs in which both hands move independently regardless of their ‘handshape’ and ‘location’, e.g., MONEY-A or ACCIDENT. Similar to classic asymmetric signs, MONEY-A includes two different handshapes (*S* and *5*) yet *straight contralateral* movement may be executed with both hands simultaneously. Like symmetric signs, both hands share the same handshape and move *straight contralaterally* in ACCIDENT, yet they are not mirror-images of each other (they differ in orientation).

Besides such clear cases, there are three other types of exceptions: (i) numerals, (ii) signs where the weak hand does not fit existing classifications, and (iii) signs where the hand is not the articulator. First, numerals are exceptions in Kata Kolok as well as in other sign languages. For instance, the sign for the number eight has two variants in Kata Kolok, one with two 4 handshapes, and one with the handshapes *5* and *W*. Both variants have no movement and the hands are simply held in space. Such signs deviate from typical two-handed (and indeed also one-handed) signs but do not fundamentally challenge the phonotactic constraints.

Second, the Kata Kolok dataset includes signs that combine two different handshapes but instead of acting as location, the second hand is essential to the sign (Figure 5-13A). For example, the signs BASKETPICKER, LEMONGRASS, and CAMERA-O build on the action of handling a tool; in BASKETPICKER, one hand represents the basket and the other one the hand manipulates the tool; in LEMONGRASS, one hand represents the plant, the other one the knife; in CAMERA-O, one hand represents the camera on the shoulder and the other one sharpening the lens. Clearly, in all those cases, the second hand does not function as location but is fundamental to the structure and iconicity of the sign whose handshape appears underspecified and thus, may vary. Analysing these signs as one-handed signs underspecifies the form of the sign and as two-handed signs, they violate the Dominance Condition. This suggests that it is necessary to extend the notion of the hand as articulator; in these signs, the weak hand is less important than the arm that functions as location and may move as a whole.

Third, we found Kata Kolok signs in which not the hand but another body part acts as articulator. For instance, EXERCISE appears like a classic symmetric two-handed sign where both hands share handshape and (mirrored) movement. However, instead of the hands, the entire arm moves; movement is produced through abducting the upper arm at the shoulder joint. A similar pattern can be observed in one-handed signs: in RELATIVE (Figure 5-13B), the hand remains passive and movement is produced by flexing the shoulder joint; in RHINO (Figure 5-12B), movement stems from a *backwards head tilt*. These examples suggest redefining the articulator in a broader sense.

Lastly, examples like SMALL-C (Figure 5-13B) may challenge the Dominance Constraint. Probably having originated as size-delimitating sign (size-and-shape classifier), one of the hands delimits the other hand (Nyst 2007). For a classic asymmetric two-handed sign, it lacks movement and appears to loosely define the handshape of the delimiting hand.

Figure 5-13. Examples of exceptions in the Kata Kolok lexicon. (A) BASKET-PICKER, LEMONGRASS, and CAMERA-O: second hand is essential to the sign rather than the location; (B) EXERCISE, RELATIVE, and SMALL-C: body part other than the hand acts as articulator.

In sum, while large parts of the lexicon of both languages adhere to the common phonotactic constraints, a small group of Kata Kolok signs differ in that the articulators are not (or not only) the hand(s). This challenges the traditional classification that is based on the hand as articulator. One way to accommodate such signs is to view them as exceptions that may be documented and described by using umbrella features such as the field 'phonology other' in Global Signbank. While this theoretically makes them searchable, this field is excluded from associated statistics such as frequencies or identifying minimal pairs. For this reason, we suggest that revising the notion of articulator would be a more inclusive and possibly more ecological valid way of dealing with diverse sign languages. Specifically, we suggest creating a phonological representation with a larger variety of articulators including the arm and nonmanual features in Global Signbank (we elaborate on this in Section 5.5).

5.4.2.3 PERCEPTION & ACCEPTABILITY DATA

We now turn to the user judgment, i.e., perception and acceptability data, for six pairs of signs elicited from 11 Kata Kolok signers. Four stimuli were manipulated for 'handshape', 'selected fingers' in COW and PRAY, and 'finger configuration' in SHY and GHOST-A, and two for 'location', GHOST-B and FATHER (see Figure 5-4). Overall, target signs were identified successfully virtually without exception. We now report results on each of the stimuli pairs in turn, focusing on the type of manipulation and elicited responses.

Results for handshape manipulations are split: manipulations in 'selected fingers' are rejected categorically while signers vary in whether or not they accept manipulations in 'finger configuration'. First, Kata Kolok signers accept and correctly repeat the tested contrasts in 'finger selection' in two target variants of COW (handshapes *1* vs. *baby_C*) and PRAY (*5* handshape) almost always. Although repeating the stimulus correctly, signers categorically reject manipulations and often offer alternative signs that are similar but not identical to the presented stimulus. For example, in response to the COW-manipulation (*5* handshape), signers frequently suggest GOAT that differs from the stimulus in an extra wrist *flexion* and 'finger orientation', a playful gesture used by children that includes tongue protrusion and wiggling fingers, and one signer refers to the sign WATER-BUFFALO, and for the PRAY-manipulation (*A* handshape), signers suggest INDIA which differs from the stimulus in an extra ulnar flexion. Both the high accuracy of Kata Kolok signers in judging and in repeating prompts is evidence that they discriminate between the four handshapes tested: *1, baby_C, 5*, and *A*.

Second, results are inconclusive about the tested contrasts of 'finger configuration', despite testing the same contrast in both stimuli pairs. Signers accept

GHOST-A (*C_spread* handshape) and SHY (*5* handshape) almost always yet only SHY and not GHOST-A was generally reproduced correctly. One explanation for this is that three variants of SHY exist across the community, the one tested and two which include 'handshape changes' (*bending* or *wiggling*). When repeating the target, signers would often produce one of the other two variants. Strikingly, all signers accept the GHOST-A manipulation and most reject the SHY manipulation. Hence, while GHOST-A is accepted with both *extended* or *curved* fingers, SHY is judged acceptable only with *extended* fingers. While puzzling given that both test the same contrast, we observed that when reproducing the SHY-manipulation, signers tend to delete the *spreading* of the fingers in the stimulus and instead produce a *C* handshape. Based on these results, the status of 'finger configuration' (*curving*), and the handshapes *5* and *C_spread* is unclear.

Results for 'location' manipulations are clear: targets are generally accepted and manipulations rejected. As the only sign, signers often misinterpret GHOST-B (location *cheeks*) as GLASSES, possibly due to the fact that the minimally different GHOST-A was also a prompt. Whenever signers did identify the target, they generally reject the modified 'location' (*cheek bone*). FATHER (location *mouth*) was accepted almost always and reproduced correctly while the manipulation (location *nose*) was never accepted and mostly reproduced correctly. Like for the handshape prompts here above, signers sometimes try to match the manipulation to another similar sign, e.g., STUPID (location *forehead*) for FATHER. The high rate of accepting the target and rejecting the manipulation while reproducing the stimulus correctly suggests that the tested locations (*cheeks, cheek bone, mouth, nose*) are distinctive in Kata Kolok.

Nevertheless, we lack evidence for categorical perception of locations among signers of another sign language (Emmorey et al. 2003); it remains therefore unclear how these judgments interact with different body locations.

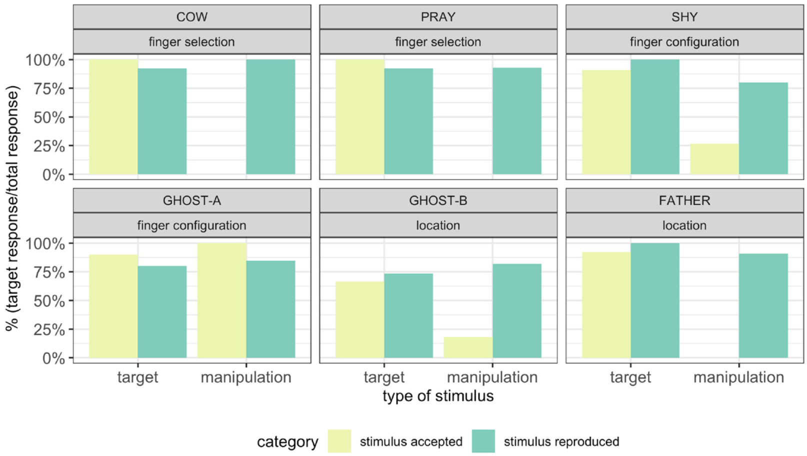

Figure 5-14. User judgment in acceptability and reproduction, averaged across 11 signing participants (ten deaf, one hearing). Response accuracy in percentages on y-axis, stimulus type on the x-axis, grouped by stimulus and type of manipulation.

In sum, we found clear evidence that signers discriminate between phonemic contrasts in 'selected fingers' and 'location' but not in 'finger configuration'. Even though generalisations are limited due to the small number of tested contrasts, our findings indicate that the co-occurrence of particular features and/or feature values (such as 'spreading' and 'curvature') requires further attention. For example, signers judge *curved* versus *extended* fingers as equally acceptable in the case of GHOST-A but often delete *spreading* when reproducing the SHY-manipulation that includes *curved* fingers, and signers differ in whether they reproduce PRAY (*5* handshape) with *spreading* (*5* handshape) or without (*B* handshape). In conclusion, the status of these particular feature values remains to be confirmed. However, the high accuracy in reproducing and accepting targets suggests that Kata Kolok signers have strong metalinguistic awareness about the phonology of their language and these results are therefore considered a proof of concept for similar tasks in the future.

5.5 DISCUSSION & CONCLUSION

In this paper, we set out to examine how diverse sign phonology really is, taking a comparative approach. Any crosslinguistic similarities between two sign languages that are optimally contrastive, like Kata Kolok and NGT, are likely due to convergent evolution and/or language modality. This study represents a novel contribution in at least two regards: (i) our primary focus was Kata Kolok, a rural sign language from the Global South, and (ii) we minimised methodological differences between the two languages by using the same phonologically annotated lexical database.

We performed two studies targeting the feature inventory and regularities in sign phonology. In Study 1, we found (partial) support for existing claims about Kata Kolok phonology as well as great similarity between Kata Kolok and NGT. Specifically, Kata Kolok uses fewer handshapes than NGT, although it is unclear whether this is linked to differences in dataset size, and locations that have been claimed as unique to rural sign languages also occur in NGT, albeit at lower frequencies. Moreover, the distribution of attested feature values shows considerable similarities except in the use of nonmanuals, which is considerably higher in Kata Kolok than in NGT. In addition, we found language-specific preferences, e.g., for specific handshapes.

In Study 2, we found that regularities in Kata Kolok's phonology largely align with - and add to - what has previously been reported for NGT and other sign languages: minimal pairs are attested, and most signs conform to phonotactic constraints. Our Kata Kolok data also contribute new insights since nonmanuals create lexical contrasts and a small group of signs violates the well-known phonotactic constraints. This invites the revision of existing theories to accommodate the diversity across sign languages. Although phonological theories for sign languages have often been developed on the basis of a single sign language, differing in theoretical orientation, it seems to be a common conception among sign linguists that sign phonology is universal. As one would expect on the basis of spoken language typology, phonotactic patterns can be language-specific. Similarly, certain features would be predicted to be important for some languages but not others, again, for signed languages just as for spoken languages. While in Western sign languages, non-manuals play a limited role in phonotactics, for Kata Kolok, they represent a more prominent part of the feature inventory. Lastly, our native signers' grammaticality judgments show that Kata Kolok signers have intuitions about the form of signs, which can help corroborating and refining phonological categories. In sum, this study has revealed both universality as well as language-specific features in sign phonologies.

5.5.1 PRESSURES FOR UNIVERSALS AND SPECIFICS IN SIGN PHONOLOGY

Phonology has long been understood as a core design feature of human language, cf. Hockett's duality of patterning according to which languages have a level of representation at which form is organised without a relation to meaning (Hockett 1960). Indeed, all sign languages that have been studied add evidence to the claim that this also holds for languages in the visual modality.[29] Furthermore, recent comparative work has revealed that crosslinguistically, phonotactic patterns are strikingly similar and even extend to so-called alternate sign languages that are used primarily by hearing signers (Jorgensen et al. 2021). The current study adopts a rigorous comparison employing the same database, coding and analysis to NGT and Kata Kolok and our findings add supporting evidence for universality in sign phonology. This raises the question: what facilitates the great deal of crosslinguistic similarity and diversity?

In the following section, we discuss possible answers to this question. First, we hypothesise that (i) universals are not due to language contact or shared history, and (ii) language-specific patterns arise from a combination of cognitive and articulatory principles summarised as efficiency, the interaction of form and iconicity and features of the ecological niche of a language. Second, we identify ideologies that underlie and possibly constrain the study of sign phonology as evidenced by the 'manual bias' (Puupponen 2019) and suggest that it is necessary to expand existing theories, particularly the notion of the articulator and the role of nonmanual features in the lexicon, in order to accommodate for linguistic diversity.

Efficiency

Efficiency has been proposed as a universal principle in human languages (Levshina & Moran 2021). Specifically, all languages need to balance efforts for production and perception. Similar pressures may lead to shared patterns across the world's languages. For example, spoken languages show an inverse correlation between word frequency and word length (Zipf 1935: Law of Abbreviation; 1949: Principle of Least Effort), i.e., more frequent words are shorter, and word frequency and distribution are inversely correlated, i.e., within a given sample, few high-frequency units make up most of the tokens and many low-frequency units occur only as hapaxes. For sign language lexicons, a Zipfian inverse correlation between frequency and duration exists (Börstell, Hörberg & Östling 2016), i.e., frequent signs are shorter, and an inverse correlation between frequency and distribution (Börstell, Hörberg, et al. 2016; Lepic 2018), has been attested. Therefore, these regularities appear as "a universal feature of language" (Börstell, Hörberg, et al. 2016: 161).

Moreover, it has been suggested that the Zipfian distribution accounts for the crosslinguistic distribution of handshapes (Rozelle 2003; Jorgensen et al. 2021). Few handshapes feature in the majority of the lexicon while most handshapes are used only in few signs (Rozelle 2003). Our results support this observation; eight handshapes account for 72.3% of the Kata Kolok data and seven handshapes for 56.2% of the NGT data (Figure 5-6). Indeed, this principle may even extend to other aspects of signs, e.g., 'locations' are found not to differ fundamentally crosslinguistically, and most signs are located in *neutral space* and the *head* (Rozelle 2003). We suggest that, in line with the arguments of Levshina and Moran (2021), this may reflect efficiency, a guiding principle in shaping universals in sign phonology by

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[29] The only exception to date is ABSL which is reported to show only "kernels" of phonology by its third generation of signers as evidenced by the lack of minimal pairs, frequent violations of phonotactic constraints, and extreme cross-signer variation (Sandler et al. 2011: 4).

balancing efforts within the affordances of the articulatory and cognitive machinery that is shared across all humans.

Iconicity

In addition to efficiency, iconicity is a strong force in shaping and organising sign language lexicons (Perniss et al. 2010) and, according to Channon (2015: 130) "increases the number of marked but non-complex features". Iconicity may be defined as "aspects of form [that] have a contextually instantiated sense of resemblance to aspects of meaning" (Winter 2021) that are afforded by the experiences of an individual (Occhino et al. 2017). In sign languages, iconic form-meaning mappings are created through analogy building; selected aspects of an object are linguistically encoded and thus yield the potential for both crosslinguistic similarities and differences (Taub 2001; Emmorey 2014). For this reason, iconicity has been suggested as one possible explanation for why unrelated sign languages may show form overlap in their lexicon (Börstell et al. 2020).

Another, complementary explanation for crosslinguistic similarities is found in patterned iconicity, i.e., the observation that there are recurrent and systematic iconic mappings between certain forms and certain meanings that are linked to the affordances of the human body (Padden et al. 2013; 2015; Hwang et al. 2017; Hou 2018). In the current study, some of the exceptions to the phonotactic constraints may be related to patterned iconicity; both the Kata Kolok signs LEMONGRASS and BASKET-PICKER (Figure 5-13) have strong iconic foundations in (tool-based) actions. Finally, there is evidence that specific sublexical features in signs and their distribution are linked to semantics (Occhino 2016; Schiefner 2019). For example, two-hands are associated with plurality and certain body locations with specific concepts (Börstell, Lepic & Belsitzman 2016; Östling et al. 2018), and handshapes appear to be distributed in clusters around a limited set of possible meanings (Occhino 2017). Although not the primary focus of this study, it is likely that similarities between NGT and Kata Kolok in the type of signs may be influenced by iconicity. Thus, iconic mappings hold the potential to create both crosslinguistic similarities and differences and growing evidence suggests that crosslinguistic regularities are indeed often founded in iconicity.

Ecology

Languages evolve in their particular ecology and are shaped by sociocultural and environmental factors. This can lead to crosslinguistic similarities and differences in unrelated sign languages. First, experiences of an individual within a sociocultural context affect the kind and form of iconic mappings that may be established (Occhino et al. 2017; Omardeen 2018) which in turn influences the form of signs. Even though not primary interest of this study, our data includes examples where the form of signs reflects the sociocultural practices of their respective communities: signs for tea in NGT and Kata Kolok are iconically motivated, in NGT by steeping a tea bag in a cup and in Kata Kolok by brewing loose leaf tea.

Second, sign phonologies have been shown to be influenced by the gestural environment that sign languages are embedded in and co-evolve with (Pfau & Steinbach 2006; Mesh & Hou 2018; Nyst 2019; Le Guen, Petatillo & Canché 2020).

Similarities in the gestural environment of three West African signing communities have, for example, resulted in using similar handshapes for the depiction of size and shape (Nyst 2019) while the use of different negative co-speech gestures used in Germany (headshake) and Turkey (head tilt) have led to different nonmanual grammatical markers in the respective sign language, namely a headshake in German Sign Language and a head tilt in Turkish Sign Language (Pfau & Steinbach 2006).

Third, cultural practices may be reflected in sign phonologies (Nyst 2012; Jorgensen et al. 2021). Signing while sitting on the ground has been related to a wider proliferation of locations on the body (Nyst 2012), for example in three alternate sign languages of Australia (Jorgensen et al. 2021). The current study refines this claim: our data does not support a wider proliferation of locations in rural sign languages per se, but instead suggest that specific locations are less frequent or underreported in urban sign languages. This may in turn be due to the nature of the data these analyses have traditionally been based on, predominantly situated conversations in case of rural signing varieties, and, predominantly elicited narratives in the case of urban sign languages. While peripheral locations are attested in both datasets they occur more frequently in Kata Kolok despite the smaller size of the dataset. Therefore, our data shows differences in the frequency and prominence of features that may be linked to cultural practices such as sitting on the ground.

Moreover, one of the most striking crosslinguistic differences in this study, the use of nonmanuals, may be explained by the adaptation of linguistic structures to their language ecologies. For the sake of clarity of the argument, we focus on the use of the mouth: mouthing is virtually absent and mouth gestures are frequent in

Kata Kolok (Marsaja 2008; de Vos 2012b; Lutzenberger 2018) while the image is flipped for NGT (Crasborn et al. 2008; Bank 2015). In a metanalysis of 37 different sign languages, Bisnath finds that both rural and urban signing communities use mouthings for similar functions which leads her to conclude that “a difference in language ecology may not result in a difference in linguistic structure” (Bisnath 2020: 9:39’). Taken together with previous observations about mouthings and mouth gestures in both languages (de Vos 2012b; Bank 2015), our findings suggest that while both languages may make use of the same linguistic structures, frequencies and diversity of functions may be sensitive to the language ecology.

We hypothesise that not a single factor but the combination of several aspects of the language ecology affects the distribution of linguistic structures. For example, NGT is in close contact with spoken Dutch and has developed frequent use of mouthing. In the Netherlands, deaf people are literate in written Dutch, literacy has a prestigious status, and the majority of deaf children grows up with hearing Dutch-speaking parents. Kata Kolok on the other hand is in contact with two spoken languages (Bahasa Indonesia and Balinese) and does not use mouthing. The language ecology is quite distinct from that of NGT: literacy skills in Bahasa Indonesia of both deaf and hearing Kata Kolok signers are limited, literacy is only slowly gaining prestige, and Balinese is used outside official settings and many deaf children have signing parents.

Let us add two more examples: Providence Island Sign Language, another rural sign language, is in contact with two spoken languages, the local English lexifier creole and Spanish, and signers combine the frequent use of mouth gestures and mouthings in both surrounding spoken languages (Washabaugh 1986; Omardeen, Mesh & Steinbach 2021). Signers of this language may or may not have basic education, literacy is not an essential skill, and deaf people are likely to grow up and live among hearing family members. BISINDO is in contact with Bahasa Indonesia and local languages. Signers use mouthings mostly in Bahasa Indonesia but also code-switch to mouthings from the local language (e.g., Javanese for signers from Solo) to mark social identity (Palfreyman 2016b) and the amount of mouth gestures varies by region (Suwiryo 2013). Signers were often educated in sign supported Indonesian (SIBI, Indonesian Signed System), have varying degrees of literacy and mostly hearing parents (Palfreyman 2014). All examples show similarities and differences in language ecologies and have evolved different patterns that accommodate their particular communicative needs. Thus, it is likely that several aspects of the language ecology co-evolve linguistic structures.

5.5.2 LIMITATIONS OF DIVERSITY

5.5.2.1 MANUAL BIAS

We have known for a long time that language is multimodal (Enfield 2009; Cooperrider 2019) but research often focuses solemnly on the spoken utterance. Similarly, sign language researchers have long acknowledged that sign languages encompass manual and nonmanual features but phonology and lexicon continue to be studied with a focus on the hands. This is due to two reasons: (i) appropriate ways to code and categorise nonmanuals have started to emerge only very recently (Lackner 2019; Pendzich 2020), and (ii) urban sign languages, the sign languages for which extensive phonological studies exist, have been reported to show little use of lexical nonmanuals except for mouthing, a contact phenomenon where spoken words are usually redundant with the hands (Crasborn et al. 2008). As a result, non-manuals are often omitted from phonological investigation. In the context of sign language emergence, or understudied sign languages for which descriptions are in their infancy, this raises the question: are we are limiting ourselves by a 'manual bias' (Sandler 2018; Puupponen 2019)? In other words, by focusing on the hands, are we ignoring part of the signal space that is available to signers when creating a lexicon?

The manual bias in analyses of sign phonology is a prime example. The current study suggests that nonmanual features are integral to the Kata Kolok lexicon; some nonmanuals, e.g., *biting, spread-lips, blowing,* and *sucking-in-air*, are recurrent through the lexicon, and create lexical contrast (Figure 5-12). Indeed, Washabaugh (1986) reports a similar usage of nonmanuals in Providence Island Sign Language where many signs are co-articulated with nonmanuals, particularly mouth gestures, that have been reported to create lexical contrast, e.g., between COLD and AFRAID (Washabaugh 1986). Our study re-emphasises that if we look outside the small set of historically related languages, to (i) urban settings outside the Global North, and (ii) rural settings, we find that the sample bias creates a blind spot in our analyses that requires further attention (Zeshan & de Vos 2012; Zeshan & Palfreyman 2017; Palfreyman 2019).

As more research is carried out on the phonology of understudied sign languages, we learn more about potential biases in the traditional analyses and may initiate refinement of existing theories. The contribution and recruitment of the body, in particular nonmanuals, may be especially noticeable in early stages of language emergence and/or rural sign languages (Sandler 2018). First, for rural settings, nonmanuals may not be constrained by functions emerging alongside literacy skills, e.g., mouthing (Zeshan 2001; Meir et al. 2010). This allows the recruitment of nonmanuals for other functions. Second, for language emergence contexts, the hands may offer a more extensive and more diverse set of compositional signals than the body and the face which may create an advantage for the latter to be conventionalised quicker and/or to a higher degree (Little, Eryılmaz & de Boer 2017; Zuidema & de Boer 2018). As argued by Sandler (2018), new sign languages may increase gradually in efficiency and complexity with regards to timing, aligning and combining different signals. In sum, by focusing on the hands only, we may risk missing important aspects of language emergence, language change, and linguistic diversity.

Moreover, this study has presented examples in which (i) nonmanuals act as articulator and (ii) the articulator is the whole arm rather than the hand (Figure 5-13). Here, we see the manual bias resurfacing; our classificatory focus on the hands leaves some part of phonology to slip through the cracks. We offered the Kata Kolok examples of RHINO (Figure 5-12) and CAMERA-O (Figure 5-13). When analysing RHINO as a one-handed sign, we miss-classify the movement since the articulator (hand) does not move, it is being moved through the head tilt. Analysing CAMERA-O as one-handed signs leaves out both the relation between the articulators and the source of movement. In both examples, a manual-biased analysis ignores the tight link between form and iconicity of signs. This problem may be tackled by expanding the notion of articulator to include not only the hand but other body parts such as the arm and the head. Having demonstrated these examples for Kata Kolok, we predict to find similar cases in NGT as well. Expanding our infrastructures and theories, can therefore also help enrich the understanding of urban sign languages.

5.5.2.2 IDEOLOGIES

The study of sign phonology is characterised by an ideologically motivated search for similarity aimed at earning the status ‘real language’ (Kusters & Sahasrabudhe 2018; Braithwaite 2020; Hou & Kusters 2020; Kusters et al. 2020) that undermines linguistic diversity (Evans & Levinson 2009). Until now, most urban sign languages have been researched with the privilege of not having to prove their language worthiness as individual languages but only as class of languages (i.e., signed as opposed to spoken languages). This is in stark contrast to rural sign languages which are often judged on a developmental cline of ‘languageness’ (Braithwaite 2020; Kusters et al. 2020).

These ideological undertones surface in analyses of phonology which are commonly based on citation forms, i.e., the hypothesised ‘typical’ articulation of a sign. Lucas and colleagues (Lucas et al. 2003: 27) define a citation form as the form that is “found in sign language dictionaries and taught in sign language classes”. For sign languages where there are no dictionaries or sign languages classes, e.g., rural sign languages, identifying citation forms may be less straightforward, and indeed, distinguishing them from variants is influenced by the judgment, theoretical background, and biases of lexicographers. Thus, the concept of citation forms may not be applicable in the same way to rural signing communities.

Furthermore, prescriptive norms that exist for urban sign languages are tightly intertwined with education. Given that users of rural sign languages often have no or only basic education may allow more flexibility in dealing with ‘typical articulations’. In other words, there may be many equally good ways of expressing the same thing

(Lucas et al. 2003) that are possibly linked to sociolinguistic variables. However, researchers use urban sign languages as a reference and starting point for investigating rural sign languages, leading to claims that lack grounding in language ecologies and that are clouded by expectations shaped by unrelated settings. For example, the fact that signers of Providence Island Sign Language did not apply prescriptive norms led to the conclusion that they lack metalinguistic awareness (Washabaugh 1986). Our perception data suggests that Kata Kolok signers have intuitions about the form of a sign while, at the same time, being aware of variation. In cases of uncertainty as to whether the variant exists or not, signers often suggest a next-best alternative that resembled the stimulus rather than rejecting it categorically. This may indicate a high level of familiarity with existing variation and/or may be linked to cultural politeness norms.

To conclude, language ideologies shape how diverse signing practices are studied and how findings are interpreted (Braithwaite 2020). Sign language research has slipped into a pattern that is recurrent in the field as a whole: using the presence of structures commonly found in majority/prestige/white/European/spoken languages as a measuring stick to designate core 'languageness' while relegating structures that do not match to the periphery of language. The ideal of a Standard Average European Sign Language is not unlike what has previously been described as a bias towards western European languages as the Standard Average European Language (Whorf 1941; Haspelmath 2001).

5.5.2.3 LIMITATIONS OF THIS STUDY

The current study has a few limitations. First, we reported a direct comparison of only two languages and drew parallels to the literature in order to address universals and language-specific patterns in sign phonology. However, this comparison is drawn on equal grounds, using the same method and same measures required for valid crosslinguistic insights (Bickel 2007; Round & Corbett 2020; Haspelmath 2020). In order to corroborate the robustness of patterns when methodological differences are minimal, this comparison could be expanded to include several unrelated sign languages in the future. Our methods provide fertile grounds for such a comparison: the Global Signbank database is expanding with languages from different geographic and socio-demographic profiles all coded in parallel.

Second, this study did not yet analyse handshape in terms of distinctive features, except in the reanalysis of minimal pairs of handshape. This choice was not primarily a coding restriction; in fact, in the infrastructure of Global Signbank, individual handshapes are also represented as feature clusters (see https://signbank.cls.ru.nl/signs/search_handshape/). Instead, we made the conscious decision to not deconstruct handshape to its sub-features, because we first need more research to understand which handshape contrasts are productive and distinctive in the Kata Kolok lexicon. The patterns found for holistic handshapes leads us to expect that the common contrasts (*spreading, bending, curving*, etc.) are used in Kata Kolok as well. Our preliminary results from the user judgments indicate that it is yet to be confirmed whether those features are contrastive or allophonic in all handshapes.

5.5.3 CONCLUDING REMARKS

Taken together the proposed possible explanations for universal and language-specific aspects of sign phonology, we recapitulate the main findings of this study in order to work towards a hypothesis about sign phonology. Our study has revealed many crosslinguistic similarities as well as some differences. First, while we found no support for uniqueness of features, we suggest frequency-based differences brought about by iconicity and/or the language ecology; while feature values such as the *hip* location may be more frequent in Kata Kolok than in NGT they are attested in both datasets. Second, Kata Kolok suggests that more attention to nonmanual patterns can give us better insight in the functioning of sign languages. Third, our findings suggest that the current analyses of sign phonology may be applied to Kata Kolok but there is a major need for enriching our view of what the form of lexical items can look like (cf. Evans & Levinson's argument for focusing more on linguistic diversity in all languages).

Although these were not a particular focus of our studies presented here, Kata Kolok echoes many of the phonological patterns that can be observed across all sign languages: it has both one-handed and two-handed signs; signs are typically monosyllabic in terms of their feature content unless they are compounds; and although there is a richer use of nonmanual properties in the lexicon, the hands realise a large number of distinctive features. In this sense, Kata Kolok resembles other sign languages in any sociolinguistic environment and strongly suggest universal aspects of sign phonology. Thus, we hypothesised that crosslinguistic similarities and differences in sign phonologies are facilitated by a combination of cognitive and environmental factors: specifically, efficiency, iconicity and language ecology limited by ideologically motivated biases. The fact that hierarchical structures and phonological patterns appear more limited in sign languages than in spoken languages (Channon 2015; van der Hulst & van der Kooij 2021) and the Grammar of the Body, the central role of the body for grammar (Sandler 2018), may even generate the hypothesis that crosslinguistic similarity in sign phonology is greater than in spoken phonologies. In order to test this hypothesis empirically, we need large-scale comparisons using the same methodology and balanced samples. In other words, we need to tackle biases in methodology and sampling aiming to adequately represent the diversity of the world's sign languages, too.

ACKNOWLEDGEMENTS

We would like to express our gratitude to all Kata Kolok signers for their joyful participation in this research. Further, we thank your research assistants Ni Made Sumarni, Ni Made Dadi Astini and I Ketut Kanta for their support and collaboration. Finally, we would like to thank Rehana Omardeen, Ellen Ormel, Tashi Bradford, and Aurelia Nana Gassa Gonga for feedback on an earlier draft.

PART TWO

ACQUISITION

CHAPTER SIX

DEVELOPMENT OF SIGN PHONOLOGY IN KATA KOLOK

Chapter adapted from: *Lutzenberger, H., de Vos, C., Fikkert, P., & Crasborn, O. (under review). Development of sign phonology in Kata Kolok.*

6 DEVELOPMENT OF SIGN PHONOLOGY IN KATA KOLOK

ABSTRACT

Much like early speech, early signing is characterised by modifications. In spite of analysing sign language phonology on the feature-level since the 1980s (Sandler 1989), studies on its acquisition exclusively examine ‘handshape’, ‘location’, and ‘movement’. This study is one of teh few to conduct a feature analysis on acquisition data and the first to include a sign language that is acquired in a remote Balinese village with a vibrant community of signers. We analyse longitudinal data of four deaf children from the Kata Kolok Child Signing Corpus. The direct comparison of child productions and adult targets yields three main findings: (i) modifications of handshape features are most frequent in Kata Kolok, which accords with findings crosslinguistically; (ii) modification rates of other features differ from previous studies, possibly due to methodology or Kata Kolok’s phonology; (iii) co-occurrence of feature modifications within a sign can contribute arguments for potential feature interdependencies in the phonotactics of the language. We argue that feature approaches are necessary to understand the full complexity of early signing.

KEYWORDS

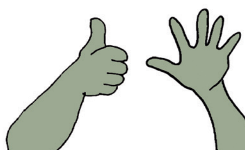
sign phonology; feature analysis; typology; Kata Kolok; axquisition

6.1 INTRODUCTION

Most deaf children in the Western world are born to hearing parents and receive delayed language input in a signed language (Mitchell & Karchmer 2004; Hall 2017). If deaf children have access to fluent signing from birth, they reach linguistic milestones around the same age as their hearing peers (for overviews see e.g., Pichler 2012; Lillo-Martin & Henner 2021). These parallels are particularly notable given that signing children use a very different articulatory apparatus and perceptual channel; signing children have to coordinate two articulators, i.e., two hands, and learn to master a linguistic system in the visual-spatial modality. Despite these differences, signing children, much like hearing children, start out with manual babbling and progress in acquiring sign phonology as their productive lexicon expands (Cheek et al. 2001; Pichler 2012; Lillo-Martin & Henner 2021).

Sign language phonology refers to the sublexical organisation of signs. Initially, signs were described in terms of four parameters: 'handshape', 'location', 'movement', and 'orientation' (Stokoe 1960; Battison 1978). Since the 1980s, upon realising that parameters do not map to single nodes, researchers have turned to a more fine-grained feature analysis of signs for theoretical models of sign phonology (Sandler 1989; Brentari 1998; van der Kooij 2002). For this study, we adopt the *dependency model*, originally developed by van der Hulst (1995) and van der Kooij (2002). This model is based on the idea that the segmental structure of signs unfolds around handshape and place of articulation features.

Signs can be described on the level of features (see Table 6-1 for examples). Signs involve one hand (CANDY or BRIGHT) or two hands that either symmetrically



mirror each other (BIKE) or are asymmetric by using a static non-dominant hand as the place of articulation (BANANA-A). Each hand has a certain configuration, or 'handshape', which specifies selected fingers and their position, and some signs include 'handshape changes' such as *closing* and *opening* of the fingers (BRIGHT). The place of articulation, or 'location', denotes where a sign is produced, i.e., in *space* (BIKE), on the *body* (CANDY) or on the *non-dominant hand* (BANANA-A), and relates to the 'type of contact' between the hand(s) and the body. Movement features capture spatial displacement of the hand(s), describing the 'movement shape' (e.g., *circle* in BIKE vs. *straight* in BANANA-A) and the 'movement direction' (e.g., *downwards* in BANANA vs. *forwards* in BIKE).[30] Nevertheless, movement features are not always applicable (CANDY or BRIGHT). The orientation of the selected fingers is expressed in relation to the movement ('orientation movement') and the location ('orientation location'), and signs may include 'orientation changes' of the palm, e.g., *flexion*, or *supination*. Lastly, 'nonmanual' features describe all those elements of a sign that are produced on the face and body, in particular actions of the mouth such as silent imitations of speech ('mouthings') or speech-unrelated mouth movements ('mouth gestures') (Crasborn et al. 2008); *biting* in CANDY and a *lip smack* in BRIGHT.

In spite of analysing sign language phonology on the feature-level since the late 1980s (Sandler 1989), and evidence that speaking children acquire features or even clusters of features rather than phonemes (Jakobson 1968; N. Smith 1973), research on the acquisition of sign phonology predominately examines the three

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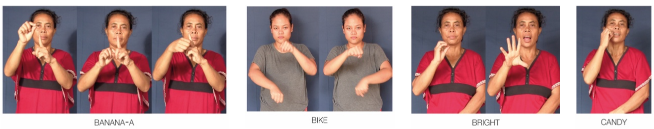
[30] Parameter analyses of signs collapse several different features into the 'movement' parameter: displacement between a location A and a location B is referred to as path movement while changes in handshape or orientation are conflated as hand-internal movement.

parameters 'handshape', 'movement', and 'location' (McIntire 1977; Von Tetzchner 1984; Boyes-Braem 1990; Clibbens & Harris 1993; Siedlecki & Bonvillian 1993; Conlin et al. 2000; Lavoie & Villeneuve 2000; Marentette & Mayberry 2000; Takkinen 2000; Cheek et al. 2001; Karnopp 2002; Meier 2006; G. Morgan et al. 2007; Meier et al. 2008). This has created a methodological and a theoretical gap in our knowledge about sign phonology and its acquisition as well as in the acquisition of signed and spoken phonologies.

Table 6-1. Selected signs and their feature description. Signs from the Kata Kolok dataset in Global Signbank.



hands (handedness)	2 asymmetric	2 symmetric	1	1
handshape	Baby_beak 1	S S	Baby_beak	Baby_spread
handshape change	NA	NA	NA	open
location	non-dominant hand: index finger	neutral space	mouth ipsilateral[31]	neutral space
movement shape	straight	circle	NA	NA
movement direction	downwards	forwards	NA	NA
orientation (location)	palm	palm-down	palm-inwards	palm-forward
orientation (movement)	base	NA	NA	NA
orientation change	NA	NA	NA	NA
contact	continuous	NA	continuous	NA
nonmanuals	NA	NA	bites	lip smack

In this study, we do not only set out to close this gap by adopting a feature approach, we also broaden the typological range of languages studied by focusing

[31] Ipsilateral and contralateral side are specified according to whether the location lies on the same side of the body or crosses the body midline; when the hand crosses the body midline, the location is specified as *contralateral*, else as *ipsilateral*. For example, placing the right hand on the right earlobe is referred to as ipsilateral earlobe, placing the right hand on the left earlobe as *contralateral earlobe*.

on Kata Kolok, the sign language of a Balinese village. Studies on the acquisition of sign phonology have focused on sign languages used in urban contexts, mostly in the West. Here, we study the acquisition of one of the oldest documented sign languages arising in the context of an isolated, rural community (Marsaja 2008; de Vos 2012b).

The contribution of this study is thus two-fold: 1) we apply for the first time the same feature analysis of acquisition data, allowing more direct comparisons of child productions to the target phonological system of adult signers. In doing so, we pave the way for direct comparisons with the acquisition of spoken phonology in the future. 2) By studying Kata Kolok, we broaden our knowledge about the acquisition of sign phonology and enable future crosslinguistic comparisons testing the robustness of acquisition patterns. The paper is structured as follows. First, we recapitulate research on the acquisition of sign phonology and sketch out Kata Kolok and its community. After contextualising the present study and explaining the methodology, we present quantitative and qualitative results of a feature analysis and a sign-level analysis. This paper ends with an elaborate discussion of typological implications of our findings, limitations of the study and avenues for future work.

6.2 L1 ACQUISITION OF SIGN PHONOLOGY

Previous studies have focused on three parameters: ‘handshape’, ‘location’, and ‘movement’ (path movement and hand-internal movement). Various types of evidence suggest that handshape is the most inherently complex parameter (Sandler & Lillo-Martin 2006); handshape is most prone to slips of the hands (Klima & Bellugi 1979; Newkirk et al. 1980; Hohenberger, Happ & Leuninger 2002), the only parameter that is perceived categorically (Emmorey et al. 2003; Best et al. 2010), and handshape is most error-prone in hearing adult L2 signers (Ortega & Morgan 2015). In line with this, children seem to acquire parameters sequentially: they master location before movement and master handshape last (Siedlecki & Bonvillian 1993; Conlin et al. 2000; Marentette & Mayberry 2000; Karnopp 2002; G. Morgan et al. 2007). Nevertheless, inherent complexities of parameters are paired with the child's maturing motor system and developing mental representations in L1 acquisition (Conlin et al. 2000; Meier et al. 2008; Ortega & Morgan 2015). Meier and colleagues (Meier 2006; Meier et al. 2008) argue for robust articulatory effects; movement errors align with general motor development, explaining the use of more proximal than distal joints, movement assimilation and repetition. Although gross motor control may explain the high accuracy of 'location' even in early signing (Siedlecki & Bonvillian 1993; Conlin et al. 2000), Marentette and Mayberry (2000) propose that variation in the mastery of body locations suggests that children construe a body scheme.

Like early speech, early signing is characterised by systematic modifications. Across all parameters, modifications can be summarised as (i) substitutions i.e., replacing one value for another, (ii) additions, i.e., adding a value, and (iii) omissions, i.e., dropping a value.

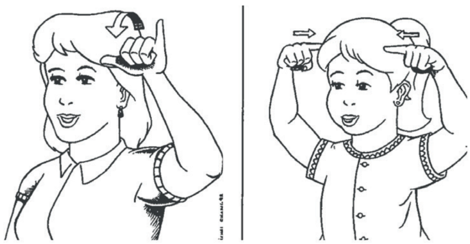
'Handshapes' are often substituted for other handshapes (American Sign Language: Boyes-Braem 1990; Cheek et al. 2001; Marentette & Mayberry 2000; McIntire 1977; Siedlecki & Bonvillian 1997; 1993; British Sign Language: Clibbens & Harris 1993; Brazilian Sign Language: Karnopp 2002; Finnish Sign Language:

Takkinen 2000; Norwegian Sign Language: Von Tetzchner 1984). Specifically, crosslinguistic studies (partly) support predictions derived from a model of handshape acquisition based on articulatory and cognitive constraints according to which easy handshapes such as *1, A*, or *5* are acquired during initial stages and are frequently used to replace more complicated ones such as *Y* or *5m* that are acquired during later stages (Boyes-Braem 1990; Conlin et al. 2000; Marentette & Mayberry 2000). For example, the ASL sign COW in Figure 6-1 includes a substitution and simplification of 'handshape': the child uses *1* while the adult target is produced with a more complex handshape *Y*. In addition, children often drop or add the second hand (Figure 6-1). In asymmetric two-handed signs, children may create symmetry through assimilating 'handshapes' and 'movements' (Siedlecki & Bonvillian 1997; Conlin et al. 2000; Marentette & Mayberry 2000; Takkinen 2000; Cheek et al. 2001).[32] This strategy circumvents having to coordinate two hands independently of each other and may resemble assimilation or reduplication in speech-acquiring children (Fikkert & Levelt 2008).

'Locations' are often substituted for larger locations (G. Morgan et al. 2007), such as the *head* instead of the *temple* in COW (Figure 6-1). Whether location substitutes are bigger and more salient than the adult target, as Marentette and Mayberry (2000) propose, remains to be corroborated. In terms of 'movement', children often enlarge, omit or repeat path movement and omit or substitute hand-internal movement (Meier 2006). For example, substituting bending the wrist in the adult target for the elbow in the child production results in a larger movement (Figure 6-1). Indeed, substitutions

[32] Video examples from Jolanta Lapiak can be found at: https://www.handspeak.com/kid/asl/index.php?id=45.

that enlarge the movement have been linked to a preference for more proximal joints in children (proximalisation; Meier 2006; Meier et al. 2008). Furthermore, modifications of movement size (and speed) and repetition have also been identified as characteristics of child-directed signing (Holzrichter & Meier 2000; Pizer, Meier & Points 2011).



COW

Figure 6-1. Example of a child modification in American Sign Language (ASL) in the sign COW where the adult target sign (left) is a one-handed sign with *Y* handshape produced with a wrist *flexion* at the *temple* and the child modification (right) a two-handed sign with two *1* handshapes produced with a *straight*, *contralateral* movement at the *head* (from Marentette & Mayberry 2000: 84). [Reproduced with permission from Paula Marentette and Rachel Mayberry]

Characteristics beyond these three parameters have remained unexplored. Observations about the role of contact have been made in multiple studies but ‘contact’ has never been studied in detail. Siedlecki and Bonvillian (Siedlecki & Bonvillian 1993; Bonvillian & Siedlecki 1996) notice that many child signs rely on contact, possibly for sensory feedback, Boyes Braem (1990) reports a preference for fingertip contact, whereas Conlin and colleagues (2000) find loss of contact in a small number of signs. In short, evidence about the role of contact is inconclusive due to a lack of investigation. In addition to this, parameters have been studied in isolation with a focus on the number and the type of error and exact substitution patterns. The example provided in Figure 6-1, however, suggests that the child modifies multiple features within the same sign, here ‘handshape’, ‘location’, and ‘movement’. The focus on isolated parameters thus, may have obscured developmental patterns such as potential feature interdependencies and the larger scope of features over phonemes as reported for speech-acquiring children (Fikkert & Levelt 2008).

Summing up, studies have investigated three parameters, ‘handshape’, ‘location’, and ‘movement’, and determined the order of acquisition based on error rates. Child errors are summarised as substitutions, omissions and additions. Studies show that easy handshapes, repeated, deleted or enlarged movements, and larger locations than in the adult target are characteristics of child signing. Handshape acquisition yields crosslinguistic similarities in substitution patterns that may be explained by articulatory and cognitive development; movement and location errors have been strongly linked to immature motor control or/and a developing body scheme. Despite the wealth of studies, our knowledge is limited to a small range of sign languages, most of them used in urban environments throughout the West, particularly ASL and British Sign Language (BSL).

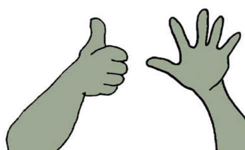
6.3 KATA KOLOK

Kata Kolok is a sign language isolate used in a single farming community of roughly 3,000 inhabitants in rural North-Bali, Indonesia (Marsaja 2008; census data 2019). Sustained hereditary deafness facilitated the emergence of this language six generations ago (Winata et al. 1995; de Vos 2012b). Since its emergence, Kata Kolok has developed into a main language of communication among the villagers without influence from any other signed or spoken language (de Vos 2012b).

As other rural communities in Bali, Bengkala is a tight-knit community whose social structures are dominated by kinship relations in patrilineal tradition (Marsaja 2008). Birth determines the clan membership to one of the ten village clans and women transfer to the husbands' clan through marriage. Within clans, family compounds create shared courtyards where children grow up with age-related peers from their own and adjacent family compounds. Households are often multi-generational and childcare responsibilities are shared with the elderly and older siblings.

Communal living in family compounds leads to a high proportion of hearing signers with various degrees of proficiency (Marsaja 2008). With family members, neighbours, and peers who can sign, deaf children are exposed to a large range of signing interlocutors in all situations of daily life (de Vos 2012c). The received input of both child-directed and overseen Kata Kolok starts immediately after birth and is continued throughout the life. This kind of rich and diverse linguistic environment resembles to some extent how hearing children acquire their first (spoken) language.

Since deafness first occurred in the village, deaf children have been born in all clans (Marsaja 2008). Recently, families with deaf children have relocated to other parts of the island or even abroad due to the changing socio-economic circumstances. Currently, two half-siblings, born 2014 and 2017, are the only deaf child signers of generation VI in the village. Relationships of deaf generation V signers have resulted in a number of hearing children who acquire Kata Kolok from birth as bimodal bilinguals. Together, these hearing and deaf children build a strong peer group with Kata Kolok as their first language.



Research on the structure of Kata Kolok has revealed several typologically unusual features in the lexicon. Most relevant to this study, the range of location features occupies a broader area of space and of the body than in many sign languages and the Kata Kolok lexicon consists of a relatively small set of basic handshapes (Marsaja 2008; de Vos 2012b), similar to other small sign languages emerging in isolated communities.

Concluding, Kata Kolok is a sign language isolate exhibiting typological rarities especially in terms of use the phonological features 'location' and 'handshape'. The community structure leads to a rich and diverse acquisition environment for deaf children. However, the acquisition of Kata Kolok remains to this point almost unexplored (notable exception de Vos 2012c).

6.4 PRESENT STUDY

Although substantial research has been focused on the acquisition of sign phonology, we see three issues in this field that merit an innovative approach. First, research on the phonology of sign languages and on its acquisition appears disjointed: while the former consists of feature analyses since the 1980s, the latter often remains on the investigation of phoneme-like parameters. Although several acquisition studies had initially coded for articulatory dimensions (e.g., Conlin et al. 2000; Marentette & Mayberry 2000), only results for handshape, location, and movement are reported. Second, speaking children show feature dependencies in their acquisition, i.e., the acquisition of certain features often depends on other features (Davis, MacNeilage & Matyear 2002; Fikkert & Levelt 2008), and examples from previous literature suggest deviations in multiple features within a sign (see Figure 6-1). Even though sign features (or parameters) are by necessity expressed simultaneously, studies have investigated them in isolation, potentially obscuring crucial links between different features. Third, studies investigate the phonological acquisition predominately of sign languages used in contexts where most deaf children are born to hearing non-signing parents and grow up in large and loose networks of signers in urban areas (Mitchell & Karchmer 2004; Lillo-Martin & Henner 2021). The acquisition of deaf children growing up tight-knit rural communities with high incidences of deafness is severely understudied.

Therefore, this study addresses the following question: how is early phonology characterised in Kata Kolok? Using longitudinal corpus data from four deaf children acquiring Kata Kolok as a first language, we analyse feature modifications qualitatively and quantitatively and provide insights into the co-occurrence of feature modifications within child productions. For the first time, we adopt the same feature-based approach used for adult data to analyse child signing, bridging the methodological and theoretical gap between sign phonology and its acquisition. Given the limited insights available about the phonology and the acquisition of this language, we focus on how child productions differ from the adult target. At the same time, we examine features both in isolation and within signs in order to uncover feature dependencies as found for spoken languages. Last, we expand the typological range of sign languages under study by investigating acquisition data from Kata Kolok and enable crosslinguistic and cross-modal comparisons in the future.

6.5 METHODS

6.5.1 PARTICIPANTS

This study comprises data from four deaf children (3 female, 1 male) whose only language is Kata Kolok. Parents of all children are deaf, except for CSC whose father is a hearing man from a different village.

The four children are part of two big deaf families in the village and belong to two subsequent generations (Figure 6-2): SS and P3 are generation five signers; CSA and CSC are generation six signers. For all children, most immediate family members are deaf. SS and P3 each have deaf parents and older deaf siblings. SS has been raised in the same house as a hearing sibling and hearing grandparents. All members of P3's household are deaf. Although not in the same household, SS and P3 have been socialised together since birth through their parents' occupational duties. CSA and CSC, nieces of P3, are half-sisters and have been living predominately in their mother's family compound, the same P3 grew up in. All members of the household are deaf, but the family compound is shared with hearing relatives who sign Kata Kolok.

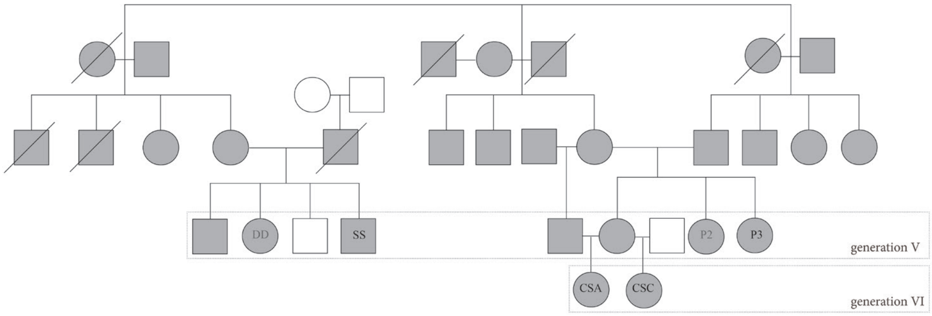


Figure 6-2. Family tree indicating the relation of the four focus children SS, P3, CSA, and CSC and the research assistants DD and P2. Circles stand for female individuals and squares for male individuals. Filled symbols stand for deaf individuals and empty symbols for hearing individuals. Slashes through a symbol indicate that an individual is deceased. Horizontal lines indicate same-level kinship, vertical lines offspring.

6.5.2 DATA

Data for this study comes from the Kata Kolok Child Signing Corpus (KKCSC) for which informed consent was obtained from the parents before the initial recording (de Vos 2016; *Kata Kolok Child Signing Corpus 2021*). The KKCSC comprises longitudinal video recordings of spontaneous interactions between focus children with their environment, including a large range of daily routines and conversational settings with hearing and deaf and adult and peer interlocutors. Given the social structure of the community, conversational settings with a group of mixed interlocutors are more common than one-to-one set-ups with a primary caregiver.

For this study, we focus on early footage of the four deaf children (SS, P3, CSA, CSC). Circumstances of recordings vary from child to child. SS and P3 were initially recorded in 2007 by a hearing research assistant who is a fluent adult signer and member of the village's Deaf Alliance (Marsaja 2008). Recordings of CSA and CSC began in 2014 and 2017 respectively and were administered by deaf relatives of the

focus children (DD and P2, see Figure 6-2). Recordings differ in duration and density: SS and P3 were videotaped monthly for 30-60 minutes while CSA and CSC were videotaped for 4-5 hours each month. Here, we focus on the available data for all children between the age 1;3 and 3;1 years, amounting to 95h 24min of data (SS: 13h 45min; P3: 15h44min; CSA: 19h 38min; CSC: 52h 01min; Figure 6-3).[33]

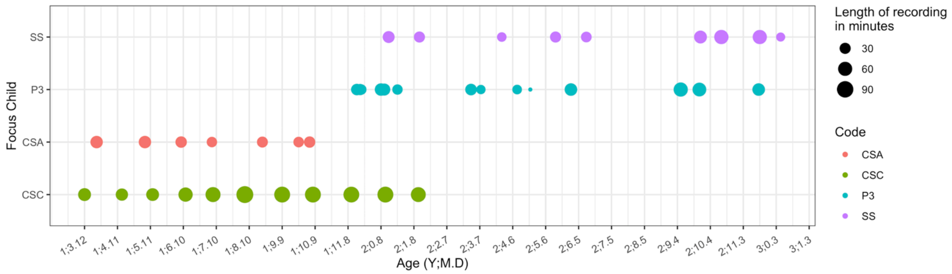


Figure 6-3. Overview of recording sessions of the current sample, illustrating the focus child on the y-axis (also colour-coded) and their age on the x-axis. Dot sizes are adjusted by length of the recording session.

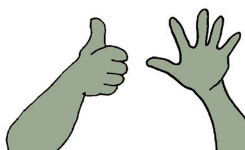
6.5.3 CODING & DATA PREPARATION

All data was annotated using ELAN (*ELAN [Computer software]* 2020). Annotations were made by the first author who acquired language fluency through extensive fieldwork since 2015, and checked with deaf research assistants and deaf family members of the focus children during fieldtrips in 2018 and 2019. Following a baseline coding of communicative interactions (on accelerated speed), we identified child modifications, i.e., child signs that deviate from an adult target, as CV:GLOSS in which CV flags the child production (Child Variant) as modification and GLOSS is a placeholder for the target sign. Target signs were generally identified using the preceding discourse

[33] SS and P3 sometimes feature in the same recordings: these recordings are counted as individual footage for each child, but counted only once for the total sum of data.

context of the video whereby all sign variants registered in Global Signbank qualified as valid target and new entries were added in case no entry was available yet. Each unclear token was checked by the deaf research assistants and we excluded signs if (i) they could not be identified during reviewing the data with a native adult Kata Kolok signer, (ii) they led to disagreement between research assistants and/or the first author, or (iii) an accurate phonological transcription was impossible e.g., due to difficult light conditions, low video quality, or the camera angle. In some instances, children produced bursts of strings of signs over multiple minutes, often with culturally relevant content such as EAT-1 NOT-YET/FINISH or BATHE-1 NOT-YET/FINISH. For the purpose of this study, each instance of a modified production in these bursts was included. The final count of modified child productions was 1,246 tokens.

Signs glossed as CV:GLOSS were reviewed to add a feature-based form description. Our coding scheme is a simplified version of that used for Global Signbank, a lexical database with phonetic description (Crasborn et al. 2018; Lutzenberger 2020) that codes for a total of 19 properties. Of these 19, we selected ten fields: handshape dominant hand (‘Strong hand’), handshape non-dominant hand (‘Weak hand’), ‘handshape change’, ‘location’, ‘movement shape’, ‘movement direction’, ‘contact type’, palm orientation (‘absolute orientation’), ‘orientation change’, and ‘nonmanuals’ (see Appendix 6-A for detailed coding scheme). Note that in Global Signbank, handshapes are not decomposed in sub-features, such as ‘finger selection’ or ‘aperture’, but coded holistically (as a cluster of features represented by a specific handshape). Each property was coded on an independent tier with a semi-colon separating different pieces of information, e.g., movement shape;



movement direction. The pre-existing values for each field in Global Signbank had to be extended occasionally given that child signing may take different forms than adult signing. Absence of a feature received NA coding, i.e., productions without a handshape change were coded NA for this feature. Data were extracted per tier using the multi-layered search function in ELAN with regular expressions (cv:* in tier type Glosses overlapping with .* in the same file in each of the coded tiers).

6.5.4 ANALYSES

In order to bridge the discrepancies between literature on sign phonology and studies on the acquisition of sign phonology, we combine qualitative and quantitative analyses. Note that we focus on child modifications only and do not report adult-like productions.[34] First, we report results from the feature analysis as rate and type of feature modification individually for each coded feature. Second, we provide a case study of movement in order to demonstrate the advantage of the feature analysis as compared to the parameter analysis. Third, we present a sign-level analysis in which we examine co-occurrence of feature modifications. Given that individual variation is commonly high across children (Fikkert & Altvater-Mackensen 2013; Kidd & Donnelly 2020), and that our data includes longitudinal data from four children at different ages, we first report results pooled across all children and then discuss child-specific patterns.

Feature analysis. We re-used infrastructure for adult target signs coded in the

[34] While this does not mean that the children do not produce adult-like sign forms, there are limitations as to how much data could be transcribed. Therefore, we focused on misproductions for this paper.

Kata Kolok dataset in Global Signbank (Crasborn et al. 2020; Lutzenberger 2020). Feature descriptions of all signs documented in the Kata Kolok dataset in Global Signbank were exported and we automatically matched to glosses in our dataset of child modifications. We performed an automated comparison between the relevant features of target signs and the child productions in order to (i) determine whether or not individual features matched the target, i.e., identify modifications, and (ii) classify the modifications as substitution, omission or addition.

Sign-level analysis. This analysis extends the results from the automated comparison used in the feature analysis by exploring all modifications found in each child variant rather than in examining features in isolation. Instead of grouping by coded feature, we locate and then list all the feature mismatches between adult and child production. We report two measures: (i) the number of deviating features across the child productions, and (ii) the specific feature combinations and their frequencies. In addition, we provide a qualitative discussion of multiple feature deviations using selected examples.

6.6 RESULTS

6.6.1 DESCRIPTIVE RESULTS

The 94h36min of annotated data yielded a total of 1,246 child modification tokens of 181 unique sign types. Proportional to the amount of available data, most instances stem from CSC (n=715) and less from CSA (n=254), SS (n=151), and P3 (n=126) (Figure 6-4). Among the 181 types, EAT-1 (n=113), MONEY-1 (n=50), FINISH (n=45), and BAD-SMELL-1 (n=42) are the most frequent, accounting for 20% of the data.

Figure 6-4. Number of tokens per child, indicating the code of the focus child, followed by the total number of attested modifications and the age range covered by the data.

For 127 tokens of 19 types, no unambiguous target sign could be identified. In these cases, the preceding discourse context did not reveal one specific sign variant, e.g., due to camera angle, and multiple different variants are registered in the 1,300 entries [Signbank sample date: July 2021] of the Kata Kolok dataset in Global Signbank, making it impossible to select between many potential target variants. As multiple possible target variants obscure the comparison, these instances are excluded from the results reported here but will be discussed later. The final number of tokens in the analyses is thus 1,119.

6.6.2 FEATURE ANALYSIS

In the following, we report the results of the feature analysis. The automated comparison of child modifications and adult targets yields modification rates per feature (Figure 6-5) and per modification type (substitution, omission, addition; Figure 6-6).

In line with previous studies, most modifications concern ‘handshape’: of the signs in the sample, 71.9% (804/1119) of the child modifications vary in the handshape of the dominant hand and 29.2% (327/1119) in the handshape of the non-dominant hand (Figure 6-5). This lies within the range reported in the literature: 41% in one child acquiring BSL (G. Morgan et al. 2007) to 75% in three children acquiring ASL (Conlin et al. 2000). In our data, handshape modifications are most commonly substitutions but in the non-dominant hand, additions or omissions may occur as well (Figure 6-6). Omitting or adding a second hand has been previously reported in acquisition studies (e.g., Marentette & Mayberry 2000; Pichler 2012) and is also frequent in spontaneous discourse among adult signers (e.g., Kimmelman, Sáfár & Crasborn 2016).

Modifications of 'handshape change' occurred in 18.5% (207/1119) of the data. This may be related to the low rate of signs featuring a handshape change in the lexicon; at present, 16% (209/1305 [Signbank sample date: Oct 2020]) of the signs documented in the Kata Kolok dataset in Global Signbank include a handshape change. Children attempted 23 sign types for which the target includes a handshape change (12.7%; 23/181). Signs with handshape changes may thus be slightly underrepresented in our data. Although this could point towards avoidance strategies, it could also be linked to lexical frequency effects in the input. Rather than substituting the value, child productions tend to add a handshape change where there was none in the target sign or omit a handshape change that is present in the target sign (Figure 6-6). This may indicate that handshape changes may at times be difficult and/or used for ease of articulation, as well as that coordinating target features may be affected by the feature environment on the sign-level, and/or mental representations that may not yet include adult-like contours.

With 46.5% (520/1119) of all tokens containing a modification of ‘location’, our data includes considerably more modifications of this feature than previous studies that find location modifications in 14.9% (Conlin et al. 2000) to 25% (G. Morgan et al. 2007) of their samples. One explanation for this difference may lay in our coding; we did not subdivide body locations and always coded the exact location, for both adults and children. The extended signing space used in Kata Kolok also differs from other studied sign languages and may point to another source of heightened modifications in ‘location’ by children. Further, modifications in location are overwhelmingly substitutions. This is unsurprising given that each sign involving manual activity, by necessity, needs to be articulated somewhere. Additions of location are only possible when the child (i) changes location over the course of the sign or (ii) adds a second hand at a different location, and omissions can only occur when the child omits the manual component of the sign altogether.

In our data, children modify ‘movement direction’ in 48.4% (541/1119) and ‘movement shape’ in 34.6% (387/1119) of the data. Movement shape is most commonly omitted, and added in nearly a quarter of cases, while movement direction is most often substituted. Previous studies report movement modifications in 45% of signs, and an overall lower accuracy for hand-internal than for path movement (Conlin et al. 2000; Cheek et al. 2001; G. Morgan et al. 2007). Due to the theoretical and methodological differences in this study (i.e., parameter vs. feature analysis), the rate of movement modifications cannot be compared straightforwardly to previous studies. Differences are exemplified through a case study in Section 6.6.4.

We found frequent modifications in palm orientation; the children’s productions differed from the adult target in 50.1% (561/1119) of tokens. Modifications were overwhelmingly in the form of substitution. This to be expected as additions of an orientation feature are only possible when a second hand is added and omissions are only possible when the hand is omitted altogether.

Similar to handshape changes, 28.7% (321/1119) of the tokens contained modifications of orientation change. This sample includes 42 sign types (23.2%; 42/181) with an 'orientation change' in the adult target. The Kata Kolok dataset in Global Signbank registers an 'orientation change' in 20.3% (265/1305 [Signbank sample date: Oct 2020]) of entries, suggesting slight over-representation of signs with orientation change in our dataset. As for the type of modification, orientation changes are most frequently omitted although additions and substitutions occur.

We also examined 'contact' and 'nonmanuals', phonological domains that have previously been unexplored. Child-introduced modifications in the type of contact occur in 31% (347/1119) of the sample. Most commonly, children substitute a different contact type and in 35.2% (122/347) of contact modifications, contact is added. Furthermore, the number of modifications in nonmanuals is relatively high (48.5%; 543/1119). In many cases, children appear to omit the nonmanual element present in the adult target but in some cases, children add nonmanuals, possibly to approximate omitted movement features. We will elaborate on this observation further in Section 6.7. Nevertheless, light conditions or the position of the child's face may not always be ideal to judge whether or not nonmanual elements are added, omitted, or modified, and, more crucially, we lack a of systematic investigations in nonmanual features of signs other than mouthings across sign language lexicons.

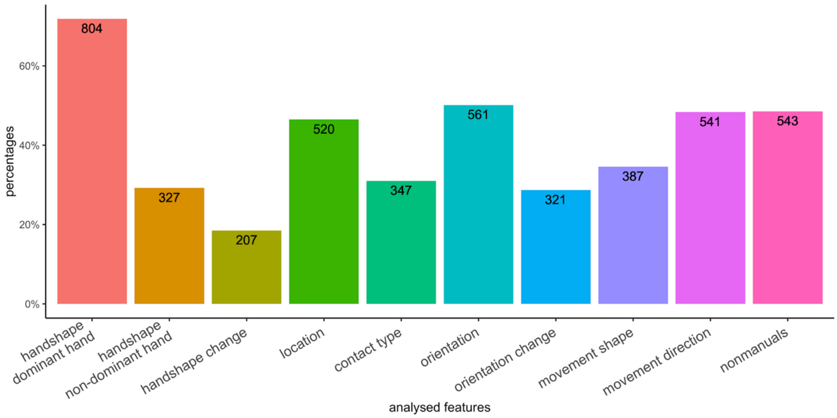


Figure 6-5. Rate of modification per coded feature with amount of modification in the dataset on the y-axis and the feature on the x-axis (also colour-coded).

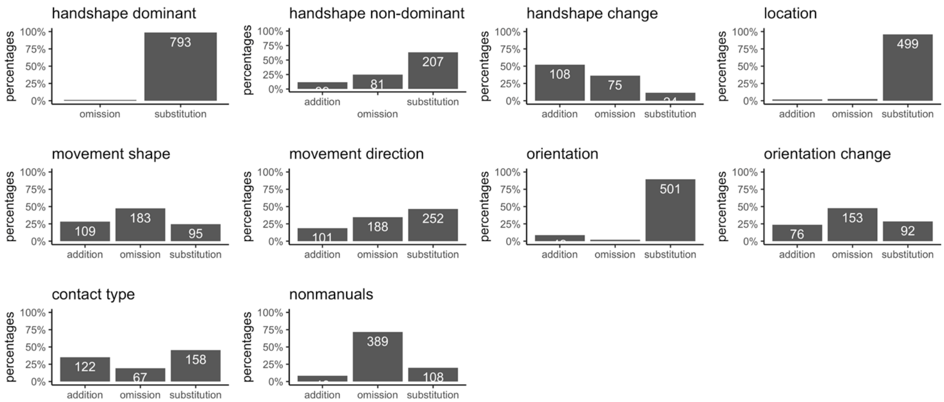


Figure 6-6. Type of modification per coded feature with amount of modification type on the y-axis and type of modification on the x-axis, grouped by feature.

6.6.3 INDIVIDUAL DIFFERENCES ACROSS CHILDREN

Despite the different age ranges from 1;3 to 3;1 years, all four focus children show great similarity as to the rates of modification (Figure 6-7).

Children exhibit similar patterns in ‘handshape’, ‘location’ and ‘orientation’. Handshape modifications are most frequent for all children, followed by modifications of location and orientation. Handshape modifications in the dominant hand range from 59.8% (152/254; CSA) to 71.4% (90/126; P3) and in the non-dominant hand from 20.5% (31/151; SS) to 42% (53/126; P3) and modifying the location occurred in 32.5% (41/126; P3) to 44.1% (112/254; CSA). The ubiquity of handshape modifications may be related to the complexity of this parameter (see Section 6.2). It is however unclear why children of different ages show similarly high rates of presumably easier aspects, particularly location.

Further, it remains unclear whether differences across children are likely to be driven by age or individual differences. Data from CSC and CSA cover earlier ages than data from SS and P3 (Figure 6-3) and thus, higher modification rates are expected for CSC and CSA (at least in particular features). Some results follow these expectations: data from CSC and CSA yield higher modification rates for 'orientation change', 'handshape change' and 'movement direction' than data from SS and P3. This may be related to maturing skills, and to the modification of movement features (see case study in Section 6.6.4). Nevertheless, we do not find considerably lower rates of handshape modifications in the older children. The rate of orientation modifications further challenges age-related explanations; orientation modifications are highest for CSA and P3, two children of different ages. This suggests explanations beyond age, for example feature environment (sign complexity) and input effects.

Last, some differences appear idiosyncratic. P3 modifies handshapes of both the dominant and the non-dominant hand more and location slightly less often than the other children; SS modifies the handshape of the non-dominant hand and handshape changes the least; CSA modifies movement direction and nonmanuals the most. Whether these observations are linked to specific sign types remains to be investigated.

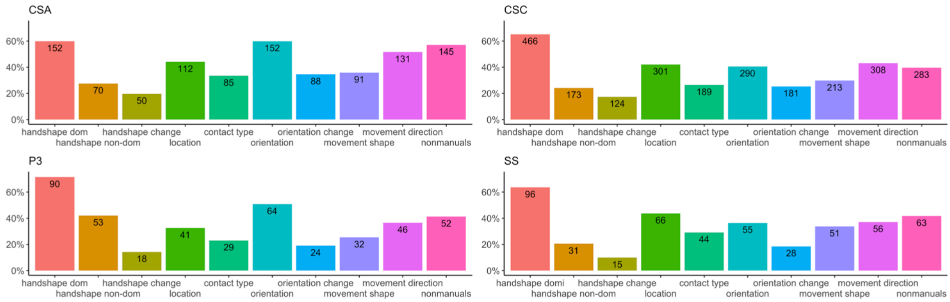


Figure 6-7. Individual differences in feature modifications. Graphs for each focus child, detailing the amount of modification in the dataset on the y-axis and the feature on the x-axis (also colour-coded).

6.6.4 CASE STUDY: MOVEMENT

This section serves to explain fundamental differences of the current analysis to previous studies and demonstrates how to translate parameter results into the feature analysis adopted in this study. As differences between the two approaches surface most strikingly in movement, we focus on the features and parameters that capture this dimension and discuss selected examples.

Modifications can concern simple substitutions where the value of a specific feature is replaced by another one. A modification of this type is shown in Figure 6-8 with the sign BATHE-A produced by CSA at age 1;7 years. The adult target is articulated with a *B* handshape at the *chest* moving *straight up and down*. While the Kata Kolok dataset in Global Signbank registers variation in location, namely a variant produced at the *contralateral arm* (BATHE-B), no variation in movement shape or direction is attested among adult signers. CSA produces the sign with a *B* handshape that is located at the *chest*. Despite matching the target in most features, the child production differs from the adult target in movement direction: *contralateral/ipsilateral (side-to-side)* instead of *up and down* movement. This is analysed as a substitution in a feature- and a parameter-approach.[35]

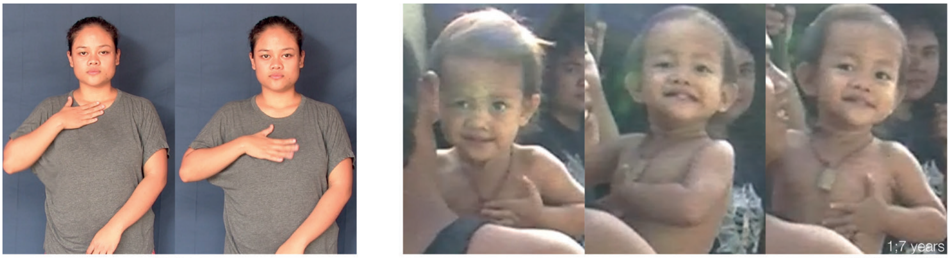


Figure 6-8. BATHE-A. Adult target (left) and child production by CSA at age 1;7 years (right).

Modifications may concern changes across multiple features (Figure 6-9). The sign PAPAYA is produced by repeatedly moving the hand (*C_spread* handshape) from the mouth *straight downwards* (palm facing the signer) while protruding the tongue (Figure 6-9A). CSC's production at age 1;6 years contains a *B* handshape, and a *flexion* of the wrist instead of a *straight downwards* movement. Similarly, the adult target FRY (Figure 6-9B) is a two-handed sign where both hands have a *B* handshape and are positioned perpendicular to each other; the dominant hand moves *forwards and backwards* through wrist *extension* and *flexion*, i.e., an 'orientation change'.

[35] Note that we treat CSA's production here as a child modification of the lexical sign BATHE rather than an instance of productive signing (see Johnston & Schembri 1999 for a discussion of 'frozen' vs. 'productive' lexicon) for the reasons provided above and the fact that boundaries between productive and frozen lexicon is not always clear-cut (Ferrara & Halvorsen 2017).

CSC's production at age 1;6 years is initiated with a single *flexion* of the wrist and adds a *straight downwards* movement of the dominant hand to touch the palm of the non-dominant hand. Both examples provided in Figure 6-9 are classified as substitution in a parameter analysis. The feature analysis however is more nuanced: rather than a substitution, both examples consist of combining a deletion and an addition. In the case of PAPAYA (Figure 6-9A), CSC deletes 'movement shape' and 'movement direction', and introduces an 'orientation change'. In FRY (Figure 6-9B), CSC adds 'movement direction' and 'movement shape' features alongside deleting the target 'orientation change' (after an initial iteration). Clearly, these examples demonstrate that modifications of this type are insufficiently described as substitutions and better understood as a complex array of deletion and/or addition of a particular (set of) feature(s).

Figure 6-9. (A) PAPAYA and (B) FRY. Adult target (left) and child production by CSC at age 1;6 years (right).

6.6.5 SIGN-LEVEL ANALYSIS

In the previous section, we reported modifications of features in isolation. We now turn to the results of the sign-level analysis. We first report the number of features that are modified at the same time, and then frequent combinations of modified features. Nonmanuals are not included in results reported here since we lack insights into cross-signer variation across adult Kata Kolok signers and an adequate coding scheme.

Within a single sign, modifications of more than one feature are the norm (Figure 6-10A; mean=3.59; sd=1.77; range=1-8). Signs with modifications in a single feature only account for 13.4% (150/1119) of the sample. Children most frequently modify three (22.2%; 249/1119), four (17%; 190/1119), or two (16.4%; 184/1119) features at the same time. Comparing the mode for each child (Figure 6-10B), CSA (mean = 3.82; sd =1.77; range =1-8), P3 (mean = 3.51; sd = 1.59; range = 1-7) and CSC (mean = 3.55; sd =1.81; range = 1-8) most frequently modify three features and SS (mean = 3.4; sd = 1.66; range = 1-7) two features within a sign. Clearly, analysing child signing in terms of features in isolation fails to capture the full complexity of child modifications.

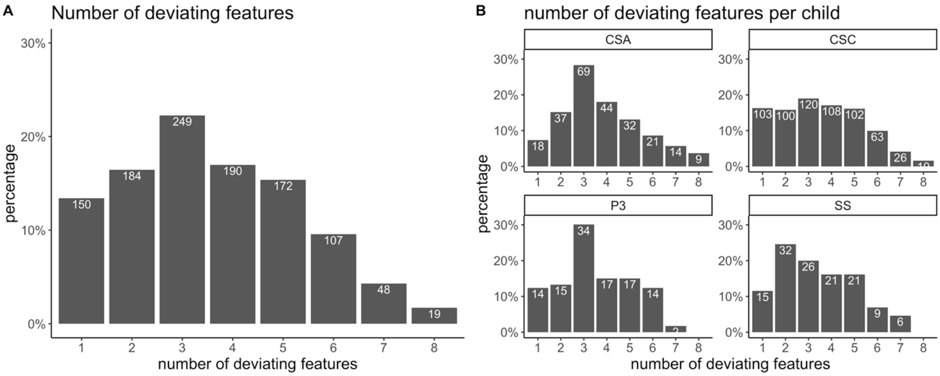


Figure 6-10. Overview of number of modified features within a sign. Occurrence in the dataset in percentages on y-axis and number of deviating features within a sign on the x-axis. (A) Full dataset, pooled across all four children. (B) Individual graphs for each child.

Examining the specific combinations of features reveals that features that showed the highest modification rates in the feature analysis (i.e., ‘handshape’, ‘location’ and ‘palm orientation’) occur frequently as the only modification as well as in combination with other features. Handshape modifications are striking; they occur in 13 out of the 16 most frequent patterns in Figure 6-11. Besides modifying the handshape of the dominant hand (8.2%; 92/1119) as the only modification, the most frequent sign-level modifications are ‘handshape’ of the dominant hand and ‘location’ (3.6%; 40/1119), or ‘handshape’ of the dominant hand, ‘location’ and ‘orientation’ (2.86%; 32/1119) (Figure 6-11). Quantitatively, handshape plays a crucial role in child modifications, both as the only modified feature as well as co-occurring with other feature modifications.

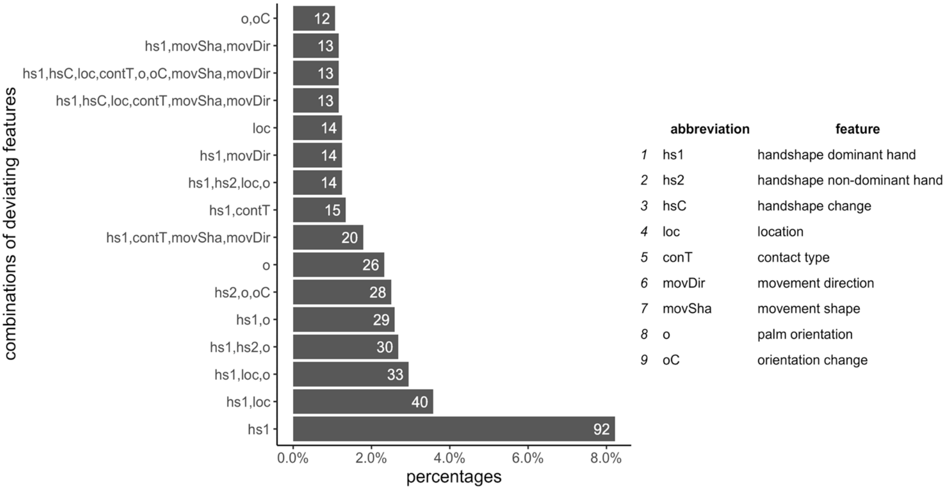
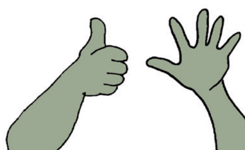


Figure 6-11. Overview of most frequent sign-level modifications. Combination of deviating features within a sign on the y-axis and amount of occurrence in percentages on x-axis. In order to increase readability, this figure summarises the combinations of modified features that are attested in more than 1% of the data.

Qualitatively, this data may suggest that the sign-level environment of features drives child modifications. Consider two examples of the two most frequent types of modifications concerning multiple features: (i) ‘handshape’ (of the dominant hand) and ‘location’ (Figure 6-12), (ii) and ‘handshape’ alongside ‘location’ and ‘orientation’ (Figure 6-13).

Handshape and location differ from the adult target in CSC’s production of COFFEE at age 2;3 years (Figure 6-12). Adult signers articulate COFFEE by executing a *repeated twisting* movement with a *1* handshape at the *temple*. Attested variation concerns ‘handshape’ (*extended* or *curved* index finger) and ‘orientation change’ (*pronation* or *supination*). CSC’s production involves repeated *supination* of the hand with lax extended fingers where the middle finger contacts the *ear*. While CSC’s



orientation and orientation change align with the adult target, CSC's handshape differs from both attested variants used across adult signers in terms of selection of fingers: CSC has all fingers extended in a lax manner and bends the middle finger whereas both adult variants select the index finger. The location in CSC's production, the *ear*, is lower and more peripheral than the *temple*, the canonical location of adult Kata Kolok signers. Although it has been previously suggested that children modify locations to aim for bigger and more salient locations (Marentette & Mayberry 2000), it is unclear whether this explains the current modification; the (inside of the) ear and the temple are similarly sized and there is no obvious increase in salience for this particular sign. However, as pointed out by an anonymous reviewer, there may be a tactile advantage for the *ear* location as compared to the *temple*. Moreover, lowering of sign locations has been attested in discourse across adult signers of different sign languages (Tyrone & Mauk 2010; Russell, Wilkinson & Janzen 2011). It is thus possible that the modifications are triggered by the specific feature environment, i.e., coordinating multiple features at the same time.

Figure 6-12. COFFEE. Adult target (left) and child production by CSC at age 2;3 years (right).

In Figure 6-13, CSC modifies ‘handshape’, ‘location’ and ‘orientation’ of the sign FATHER. Adults produce this sign by placing the *1_curved* handshape between the lips and the nose (*top lip*), radial side of the index finger making contact with the face and palm facing *downwards*. At age 1;6 years, CSC places the *1* handshape at a lower location, namely on the *mouth* rather than above the *top lip*, and modifies the orientation of the palm to face *forwards* instead of *downwards*. Movement features are on target; neither the adult target nor the child sign involve movement components. A crucial aspect of this child production is that all the modifications result in an increased contact area, radial side of curved index at the top lip as compared to the back of extended index and hand on lips. It is possible that modifications are in parts driven by an increase or addition of body contact which may be used for proprioceptive feedback and is also highly prevalent in child directed signing (Holzrichter & Meier 2000; Pizer, Meier, et al. 2011).

FATHER CSC21dec2018

Figure 6-13. FATHER. Adult target (left) and child production by CSC at age 1;6 years (right).

Both examples in Figure 6-12 and Figure 6-13 show child productions that are perceptually fairly similar to the adult target. Nevertheless, the deviations in the child productions go beyond the variation that is attested in adult signers and concern the modification of multiple features. In short, feature modification may result from the need to coordinate different features within a sign, and/or the reliance on specific features, e.g., exploiting contact for proprioception. However, this possibility would have to be investigated further. A future study could explore whether modification patterns of are systematic in pairings of specific feature values, for example a specific handshape and a specific location that are commonly modified simultaneously within the same sign.

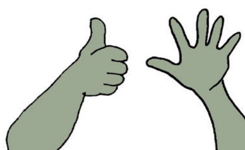
6.7 DISCUSSION

This study is the first to analyse child modifications using the same feature approach for data from adults and children and to add a rural sign language to the languages studied for the acquisition of phonology. We collected child forms from longitudinal data of four deaf children aged 1;3 to 3;1 years who acquire Kata Kolok as their first language and automatically compared the form of child modifications to adult target signs from the lexical database Global Signbank on the basis of ten form features. In comparing our results to previous work on acquisition of sign phonology, this study resulted in three main findings: (i) similar to other languages, handshape modifications are the most frequent, confirming a crosslinguistic pattern observed for urban sign languages; (ii) conversely, modification rates for other features differ from previous studies, which may be due to methodological discrepancies and/or to Kata Kolok's phonology; (iii) we find that many child modifications are complex compositions of multiple modified features on the sign level, a finding made possible by an approach that situates single feature modifications within their larger environment. We argue that a comprehensive feature approach is not only more precise but necessary to understand early signing. Specifically, coding features allows for separating out individual properties of the sign and for exploring the relation between modifications. In short, it provides a more ecologically valid approach to studying child modifications.

6.7.1 TYPOLOGY OF DEVELOPMENTAL PHONOLOGY

Previous studies have consistently found the highest rate of modification in ‘handshape’, followed by ‘movement’ and the least modifications in ‘location’. The feature analysis of this study suggests that this might not be the case for Kata Kolok. We find most modifications in handshape features, followed by orientation and location features and different movement features show different modification rates. In the following, we discuss how our three main findings fit into the typology of the acquisition of sign phonology.

Models of sign phonology suggest featural hierarchies and interdependencies (Sandler 1989; Brentari 1998; van der Kooij 2002). We argue that modification rates in child signing may be linked to the inherent nature of the different features. First, features differ in their absolute frequencies. ‘Handshapes’, ‘locations’, and ‘orientations’ are present in every sign but not all signs express movement features, as exemplified in Table 6-1. This predicts high modification rates for highly frequent features such as ‘handshape’ (as well as ‘orientation’ and ‘location’), which is confirmed in this study. Second, features differ in inventory size. The physiology of the hand allows for independent manipulation of each finger and finger joint,



resulting in a larger range of possible ‘handshape’ values than, for example, ‘orientation’ values. Features with larger inventories are expected to show higher modification rates because more different values need to be learned. Although this study provides tentative evidence for this prediction, the exact size of each feature inventory in Kata Kolok is at this point unclear. Third, feature dependencies may explain rate and type of child modifications. For example, orientation is a result of ‘handshape’ and ‘location’ (Sandler 1989), and, consequently, modifying either ‘handshape’ or ‘location’ may cause an ‘orientation’ modification as a by-product (or the other way round). As shown in Figure 6-11, these three features are often modified together. Unlike changes of handshape and location that may cause a change of orientation, there is no conditional relation between ‘movement shape’ and ‘movement direction’. This indicates that movement aspects may pose different challenges.

Taking these arguments together, high modification rates of ‘handshape’ are expected to be robust crosslinguistically. Nevertheless, we propose that, on top of that, the feature environment may play a crucial role in child modifications. It has previously been highlighted that children simplify handshapes by replacing complex, not-yet-acquired handshapes with easier ones that they have already acquired (Boyes-Braem 1990). The sample in this study yielded 181 sign types, most of which are produced with a small range of easy (basic) handshapes. If indeed children consistently use basic handshapes that they have already learned, we would expect fewer handshape modifications in this sample than in other studies, or at least anticipate older children to show less modifications. This is not the case: we find high rates of handshape modification across all children (Figure 6-7) and similar rates across children from generation five (age range 2;0-3;1 years) and children from generation six (age range 1;3-2;0 years). This suggests that incomplete acquisition of individual handshapes as driven by age may not be the primary explanation of this finding. The high modification rates may instead be related to the challenge of coordinating sign-level complexity. In other words, the difficulty may not only concern articulating a particular set of handshape features but also producing it its particular feature environment.

Our study diverges from previous studies especially in the findings about 'location' and 'movement'. Reasons for this may be methodological and/or typological. This study separates different types of movement based on articulation and thus, different modification rates are expected. Nevertheless, this does not explain the high rate of modifications of location in this study. Locations are coded identically in both the parameter and the feature approach. One of the typologically unusual characteristics of the Kata Kolok lexicon, however, is the use of an extended signing space and unusual locations (Marsaja 2008; de Vos 2012b) (see also Chapter Five; Figure 5-9 for two examples). It is possible that these factors affect the observed rate of modifications. Kata Kolok is the first sign language studied that differs from the ones studied for acquisition of sign phonology, and the first to show considerably higher rates of location modification. To further investigate how typological differences in sign phonologies influence acquisition patterns, a qualitative study of the exact forms and substitution patterns of particular feature values is needed.

Separating movement types uncovers their role in child signing on the level of the sign. Existing literature reports higher accuracy in path movement than in hand-internal movement, suggesting that hand-internal movement is more difficult for children (Marentette & Mayberry 2000; Cheek et al. 2001; G. Morgan et al. 2007). This study finds that hand-internal movement equivalents are not primarily avoided. To the contrary, 'handshape changes' are mostly added and 'orientation changes' are equally often added and substituted, yet omitted in half the cases (Figure 6-6). One pattern is the combination of omissions and additions such as in the case of FRY and PAPAYA in Figure 6-9 where the child omits 'movement shape' and 'movement direction' and adds an 'orientation change' (or the other way round). Another pattern is adding an extra feature without omitting another one. For example, in addition to a wrist *flexion* ('orientation change'), CSC also *bends* her fingers ('handshape change') in the sign NOT-YET (Figure 6-14A) and introduces a *wiggle* of her extended index fingers ('handshape change') in the SIGN-NAME'P1' (Figure 6-14B). Although the handshape change in NOT-YET could potentially be analysed as a movement extension or an articulatory by-product, the addition in SIGN-NAME is unmotivated. This suggests that 'handshape changes' and 'orientation changes' may be used for ease of articulation, modifying the feature environment in a sign.

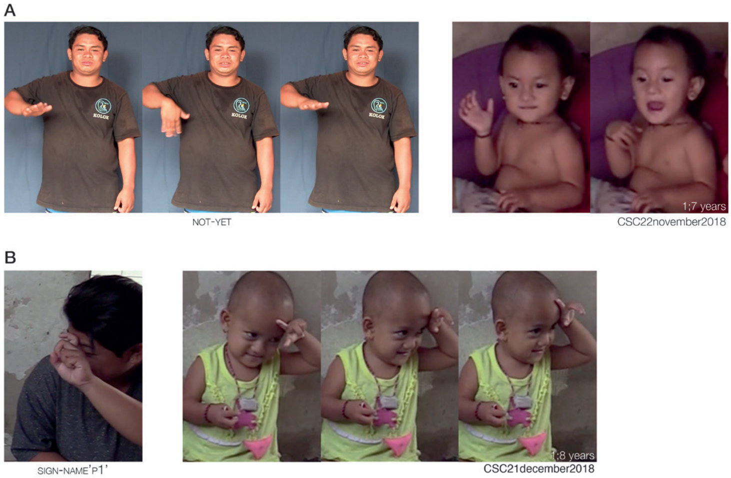


Figure 6-14. NOT-YET and SIGN-NAME'P1'. Examples of handshape change additions in child productions, i.e., instances where children add a handshape change where there is none present in the adult target sign. (A) NOT-YET. Adult target (left) and child production by CSC at age 1;7 years (right). (B) SIGN-NAME'P1'. Adult target (left) and child production by CSC at age 1;8 years (right).

6.7.2 CHALLENGES OF VARIATION

Naturally, there are limitations to this study, in particular the considerable variation across adult signers in the community and particularities of a small data set. This study is based on defining child modifications as deviation from an adult target. Adult Kata Kolok signers, however, use a considerable number of sign variants both on the sign and the formational level (Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020; Lutzenberger et al. 2021) (Chapter Three and Chapter Four). To deal with this, we relied heavily on our knowledge of the community and the language, discussions with the research assistants as well as the Kata Kolok dataset in Global Signbank to decide whether or not child productions are modifications.

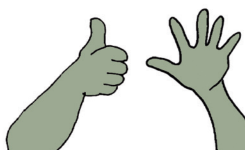
In some cases, the presence of multiple adult targets due to cross-signer variation resulted in exclusion from the analysis (n=127). The village's community-oriented culture and life in intergenerational family compounds leads to interaction with a large number of deaf and hearing interlocutors of different ages from early on. Thus, reliance on the parents' variants is insufficient. Nevertheless, it is unclear how cross-signer variation impacts language input. One possibility to deal with multiple possible target signs is to use the variant that resembles the child variant the closest; another one is to determine the differences between adult variants and then locate overlap between multiple adult variants and the child production; yet another one is to compare the child production to all features of all variants. Although similar issues have also been raised in lexical comparison of sign languages (Börstell et al. 2020), it remains unclear which procedure best addresses this issue.

Another complicating factor is that some signs may be idiosyncratic forms, and there may not be any formal overlap between the child production and documented adult variants. For example, SS produces an exaggerated blink and eyebrow raise to refer to video camera. Multiple signs for camera are used by adult signers, all of them including a manual component and no blink or raised eyebrows. BRIGHT, commonly used to refer to light, sun, television and only occasionally for camera, however, is articulated with a lip smack but without eyebrow raise by adult signers. Another example comes from CSC, who bites her extended index finger to refer ghost or spirit – a form which has no overlap with any attested adult variant. Both the examples of SS and CSC may be idiosyncratic, child-specific conventions or familylects. Familylects, as the name suggests, are commonly used by adults and children within the same family. We did, however, not observe any adult family members producing those signs spontaneously and would therefore argue for child-specific conventions. In the case of CSC's variant, adults may copy CSC or prompt her with this variant in child-directed signing, but in the case of SS's variant, this is completely unattested. For this study, we analysed such signs as extreme modifications of an identifiable target, as confirmed by the research assistant or caregiver. Nevertheless, it would be interesting to explore these signs further as child-specific conventions.

Lastly, some child modifications are dynamic and may change within one token. The production of the sign PAPAYA in Figure 6-10 starts at the *mouth* and the child's hand lowers down to make contact with the protruded tongue, i.e., location changes from the target location to a different location. In other cases, children may start out with a modification and finish their production as an adult target. In this study, we have not considered the length of a child sign as a modification nor have we paid particular attention to repetition. This is due to the fact that it is yet unclear what role repetition plays across adult Kata Kolok signers, thus leaving it an impossible task to study how children deviate from adults. It is, however, possible that examples as detailed above are in line with observations made by Meier and colleagues (Meier 2006; Meier et al. 2008) according to which children often increase the number of movement cycles, resulting in a prolonged sign that may allow time for self-correction.

6.7.3 NEW TERRAIN: CONTACT & NONMANUALS

Children acquiring Kata Kolok seem to frequently modify signs to include *continuous contact*; both adding it where there was no contact before and substituting other types of contact for continuous contact. One reason why children may strive for



increased contact is that it allows for proprioception. Similar to auditory and visual feedback in speech-acquiring children that may facilitate the early acquisition of labials (Boysson-Bardies & Vihman 1991), proprioception may aid sign acquisition. Moreover, contact is frequent in child-directed signing; parents choose sign variants with contact over for example sign variants with handshape changes and often increase sensory feedback by producing signs on the child's body (Holzrichter & Meier 2000; Pizer, Meier, et al. 2011). Finally, increased contact and movement modifications are linked; omitted movement often results in added or prolonged contact. It is possible that increased contact results from movement omissions or that the latter are caused by maximising contact. Nevertheless, contact has received relatively little attention in prior literature. Marentette and Mayberry (2000) note a preference for finger-tip contact; Conlin and colleagues (2000) report loss of contact in child signing; and Bonvillian and Siedlecki (1996: 31) describe perseverance of contact between hands, low omission, frequent addition, and high accuracy of contacting action even in early signing. Future work could explore how proprioception and input effects interact by examining how and where parents devise contact, how children maintain and enlarge contact, and how contact modifications coincide with modifications of other features.

In addition to a proprioceptive advantage for the learner, it is also possible that a preference for contact in child signers is related to a typological feature of Kata Kolok. In a study on name signs, a sub-group of signs attributed to individuals, Lutzenberger (2018) compares Kata Kolok to Sign Language of the Netherlands (NGT) and finds a tendency for continuous contact in Kata Kolok but not in NGT regardless of the area where the sign is produced. The comparison between the NGT and the Kata Kolok datasets in Global Signbank corroborate this observation: the proportion of signs with contact in Kata Kolok is indeed higher than in NGT. For the signs documented in Global Signbank, 47.7% (623/1305; [Signbank sample date: Oct 2020]) of the Kata Kolok signs show a contact value, compared to 36% (1491/4159; [Signbank sample date: Oct 2020]) of the NGT signs. It is thus possible that a proprioceptive advantage for (child) learners is enhanced by typological characteristics of Kata Kolok. It would be interesting to test these two possibilities through intra- and crosslinguistic comparisons of the lexicon and the sample of child modifications. Crosslinguistic similarities in child modifications would point towards a proprioceptive advantage while intra-linguistic similarities between child modifications and lexicon may suggest an effect of divergent phonologies.

Another understudied domain highlighted by our study is that of nonmanual modifications in child signing. With the exception of mouthings, nonmanual elements have been largely neglected in the study of sign language phonology and as a result, underexplored in their acquisition. Here, we highlight three types of nonmanual modifications that may open up future research avenues (Figure 6-15). First, children may omit all manual aspects of the sign and instead, add a characteristic nonmanual behaviour. Previously, such cases may have been analysed as imitations (e.g., Marentette & Mayberry 2000), e.g., the sign WALK-AROUND is replaced with a bodily action of *bopping up and down* (CSA, 1;10 years). Second, children may omit all manual components of the sign and retain only the nonmanual component(s). Such cases may be analysed as extreme reduction that may sometimes also occur

in adult signing (Dively 2001). For example, DIE is produced as the target nonmanual *tongue protrusion* only (CSC, 1;7 years), or FRIGHTENED as a *full body shrug* (CSC, 2;0 years). Third, children may omit a particular feature – primarily movement – and add nonmanuals to replace it (Figure 6-15). These cases may be examples of cross-feature substitution or extreme proximalisation that are particular to child signing and, to our best knowledge, have not been studied. For example, adult signers produce FALL with a *supination* and *arc* movement downwards with the *5* handshape while CSA (1;10 years) maintains a *5* handshape and *bends her body sidewards* (Figure 6-15A). In another example, CSA and CSC respectively introduce a *headshake* to replace the sign's movement. CSA (1;7 years) keeps her hand still and moves her head from side to side for BRUSH-TEETH where adult signers move the *1* handshape in front of the *mouth* repeatedly from side to (Figure 6-15B). CSC (1;11 years) shakes her head in ICE-CREAM instead of moving her hand repeatedly *downwards* as in licking a popsicle (Figure 6-15C). These preliminary observations suggest that children recruit nonmanuals to produce signs that resemble the Gestalt of the adult target. A systematic study of nonmanuals in the acquisition of sign phonology promises important insights into the patterns of child modifications, in particular in sign languages like Kata Kolok for which nonmanuals may play a greater role in the lexicon than in sign languages used in urban contexts (Marsaja 2008; Lutzenberger 2018) (Chapter Five).

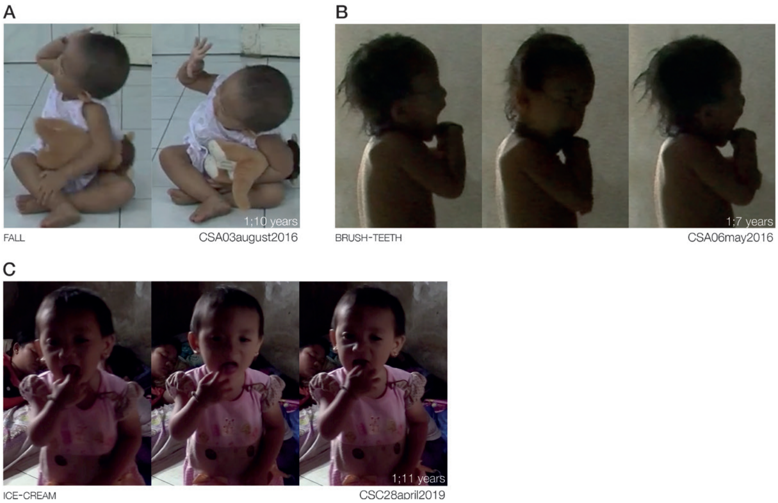


Figure 6-15. Child productions where nonmanuals take over the movement component of the adult target sign. (A) FALL by CSA at age 1;10 years using *body lean* to substitute hand movement and 'orientation change'. (B) BRUSH-TEETH by CSA at age 1;7 years using the *headshake* to substitute hand 'movement'. (C) ICE-CREAM by CSC at age 1;11 years using the *headshake* to substitute hand 'movement'.

6.8 CONCLUSION

This study has addressed two aims: first, closing the gap between research on sign phonology and its acquisition through performing a feature analysis of acquisition data; second, adding to typological diversity of the range of sign languages studied for acquisition both typologically and in terms of acquisition settings. We have shown that a detailed feature and sign-level analysis may help unravel how children modify signs, in particular in regard of separating out features and approaching child productions in their entire complexity. Hereby, this study paves the way for intra-linguistic comparisons between child modifications and adult target signs, as well as comparisons of child modifications across sign languages and even the acquisition of spoken phonologies. Similarities between this study and the previous

literature may suggest shared mechanisms in the acquisition of sign phonology; the high prevalence of handshape modifications across all studies, for example, may be impacted by motor skill and cognitive development as well as, as highlighted in this study, characteristics of the feature inventory, the feature environment and possibly feature dependencies. Crosslinguistic differences may be linked to typological differences in the linguistic structure and the acquisition setting as well as related to methodological differences. Although we do not believe that the differences found in this study are necessarily all Kata Kolok-specific findings, possible comparisons are limited given the novelty of our approach. Follow-up feature-based analyses of child modifications from other sign languages using the same approach across both adult adn child data, however, will provide the chance to disentangle differences induced by differing phonologies from more general differences brought about by the feature analysis. It is clear that there is a need to further explore combinations of features in order to identify which aspects of child signing are indeed shared across sign languages and which aspects are language-specific.

APPENDIX 6-A

tier	coding dimensions	coding values	explanation
main gloss	Gloss of sign	CV:GLOSS	CV indicates a child sign that deviates from the adult target GLOSS indicates the adult target
non-dominant hand		CV:GLOSS	
CV_type	comma-separated list	omission addition substitution body contact assimilation proximalisation	lists aspects where the sign varies
CV_summary	comma-separated list		summary of all relevant tiers
CV_form	free description	any	free description of child form
handshape	RH:handshape; LH:handshape	handshapes available from Global Signbank (addition if needed); else NA	handshape of right and left hand
handshape change	values from Global Signbank	opening closing curving bending spreading unspreading wiggling rubbing NA	describes whether or not there is a handshape change, if so, what
movement	movement direction; movement shape values from Global Signbank	Movement direction: up down Back forwards etc. movement shape: straight circle zigzag arc etc.	describes the (path) movement in two dimensions
location	values from Global Signbank	**head** back of head cheek cheekbone chin ear eye face forehead head (top or side) mouth neck nose temple tongue upper lip	describes place of articulation

		body back belly trunk chest flank shoulder hip **extremities** arm knee leg weak hand: +spec upper arm elbow lower arm wrist **space** neutral space horizontal plane R loc variable	
contact	contact type; contact location	type: brush initial final continuous etc. location: see location NA	describes the type of the contact and where the hands make contact (e.g., in space with each other or with the body)
nonmanual	free description	own words NA	describes use or lack of nonmanuals in the sign
palm orientation	Initial palm position	forwards backwards inwards outwards	describes the initial position of the palm(s)

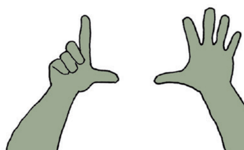
ACKNOWLEDGEMENTS

We thank all Kata Kolok children and their families for their willingness to participate in the KKCSC and to be part of this research. We also thank our research assistants I Ketut Kanta, Ni Made Dadi Astini and Ni Made Sumarni for their dedication and long-term collaboration and Rehana Omardeen for comments on earlier drafts. This research was supported by FWO-NWO under Grant [NWO 326-70-002] "The emergence of phonology within six generations" awarded to Bart de Boer, Paula Fikkert, and Connie de Vos and by NWO under Grant [VENI 275-89-028] "The face in sign language interaction" awarded to Connie de Vos.

CHAPTER SEVEN

MORE THAN LOOKS: EXPLORING METHODOLOGICAL INNOVATIONS FOR EXPERIMENTALLY TESTING PHONOLOGICAL DISCRIMINATION IN THE SIGN LANGUAGE KATA KOLOK

Chapter adapted from: *Lutzenberger, H., Casillas, M., Fikkert, P., Crasborn, O., & de Vos, C. (under review). More than looks: Exploring methodological innovations for experimentally testing phonological discrimination in the sign language Kata Kolok.*



7 MORE THAN LOOKS: EXPLORING METHODOLOGICAL INNOVATIONS FOR EXPERIMENTALLY TESTING PHONOLOGICAL DISCRIMINATION IN THE SIGN LANGUAGE KATA KOLOK

ABSTRACT

The lack of diversity in the language sciences has increasingly been criticized as it holds the potential of producing flawed theories. Research on (i) more geographically diverse language communities and (ii) sign languages allows to corroborate, sharpen, and extend existing theories. The current paper is the first of its kind to combine both of these aspects. Here, we explore methodological adaptations of well-established experimental paradigms in order to study the acquisition of sign phonology in Kata Kolok, a sign language of rural Bali, Indonesia. The first study, a familiarisation paradigm, calls for a mixed-methods approach for data analysis; behavioural measures suggest group-differences that remain obscure when only measuring looking time. The second study pilots a novel tablet-based habituation paradigm; it relies on touch-input instead of looking time which promises modality-neutrality. Both studies suggest limitations of these paradigms due to the ecology of sign languages and the sociocultural characteristics of the sample. Alongside methodological innovations of stimuli design, procedure and data analysis, this paper evaluates and discusses the complexity and effectiveness of dual adaptations (i.e., adapting a technique from spoken language to signing participants and adapting a method designed for participants from a WEIRD community to participants from an understudied non-WEIRD community) in order to further advance and diversify the field.

KEYWORDS

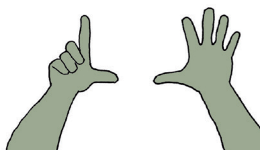
methodology; Kata Kolok; field-adaptation; modality-adaptation

7.1 INTRODUCTION

As more and more of the world's languages are being documented, we get a peek into how diverse acquisition settings may be. This has led to questioning some fundamental assumptions about how children are socialised with language, which have emerged from a tradition of data collection and experimentation focused on the Global North (Western Europe and North America). For example, while child-directed speech has long been considered fundamental for language learning, research has shown that in communities where child-directed speech is rare, children learn mostly from overheard speech (e.g., Cristia et al. 2019; Casillas et al. 2020b; 2020a).

In addition to broadening the geographical scope of languages under investigation, the advent of sign language linguistics has paved the way for exploring how children acquire visuospatial languages. While acquisition studies are still rare, psycholinguistic research has developed significantly through adapting existing methods uncovering fundamental commonalities and differences in how specific phenomena manifest in different language modalities (spoken vs. signed). For instance, joint attention is achieved through speaking while focusing on an object in speech settings whereas sign settings require coordinated switches of visual attention between object and interlocutor within the same modality (Lieberman et al. 2014).

Despite being a relatively modern field, sign language linguistics has still fallen prey to traditional biases of linguistic research; most of what we know is based on sign languages used in Global North (Lillo-Martin & Henner 2021). The dual pressure of adapting methods to the visuospatial modality and to contexts that are not



Western, Educated, Industrialized, Rich and Democratic (WEIRD) (Henrich, Heine & Norenzayan 2010b) has constrained taking experiments to signing communities in diverse settings. In this study, we present two exploratory studies focusing on the acquisition of sign phonology in a small Balinese village. The aim of this paper is two-fold: (i) we explore adaptations of two paradigms that are well-established with speaking children to signing children, and (ii) we expand the typological range by investigating child signers of Kata Kolok, a sign language that originated in a rural enclave in Bali due to sustained hereditary deafness.

Data collection for these studies was carried out during two fieldtrips in 2018. Testing sign language acquisition experimentally in this community is unique and time-sensitive; after 10 years of no children born to deaf parents, eight children were born since 2014. Given that experiments to investigate phonological acquisition typically target young children it was critical to implement an experiment rather quickly. We thus planned two pilot studies, one high-tech and one low-tech, testing whether we can detect children's ability to discriminate minimal phonological contrasts in sign stimuli. The first study was a tablet-based habituation paradigm. Technical problems constrained data collection with this method, and it was therefore treated as an initial pilot. Second, we designed a simpler familiarisation experiment using a laptop, which we carried out with a larger sample.

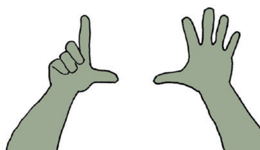
In this paper, we first report the completed, lower-tech study with the laptop (Study 1). We then elucidate how the tablet-experiment (Study 2) may provide interesting avenues for further development. In this vein, we identify challenges, in the hopes that our considerations of how these could be addressed adequately can contribute to future methodological innovations in both field-based and sign-acquisition experiments.

7.2 EXPERIMENTAL METHODS IN NON-TYPICAL CONTEXTS

Many of the widespread and foundational experimental paradigms and measures of language processing assume a hearing participant using a spoken language and theories of psycholinguistics emerged from a limited set of languages that are socioculturally similar. As existing paradigms cannot be straightforwardly extended to signing participants or diverse communities, there is the potential for critical gaps in psycholinguistic theories. In the following, we review methodological adaptations to (i) non-WEIRD communities, and (ii) the visuospatial language modality, specifically in the context of studying the acquisition of sign phonology, and introduce the Kata Kolok community.

7.2.1 FIELD-ADAPTATIONS: EXPERIMENTS ON ACQUISITION IN NON-WEIRD CONTEXTS

As linguists problematise the focus on WEIRD languages for drawing conclusions about languages, and their acquisition, the wealth and diversity of adaptations needed for existing paradigms in diverse settings becomes evident. Adaptations include matching stimuli to the language, creating instructions for populations in which experimental setups are unusual, ensuring that participants and collaborators understand the task, as well as more practical adaptations to the experimental environment, technical equipment, recruitment strategies, etc.



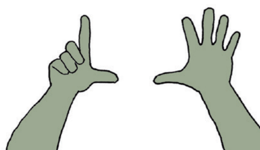
Research in diverse settings shows that methodological, technical and design adaptations vary from community to community. Sarvasy and colleagues (in preparation) validated the effectiveness of (mobile) eye-tracking for investigating clause-planning in Nungon, a small Papuan language in rural Papua New Guinea (PNG). Studying the same language community, Tuninetti and colleagues (in preparation) explore the use of mobile electroencephalography (EEG) to measure brain responses (P600 and N400 effects) to different types of syntactic violations. Mulak and colleagues (under review) discuss difficulties with running two well-established word learning paradigms (fast-mapping and cross-situational word learning) with adult participants from rural PNG; only after major adaptations, fast-mapping but not cross-situational word learning was administered successfully. Similarly, Frost and Casillas (2021) made major changes to stimuli, instructions, and the number of practice items in a statistical learning experiment with speakers of Yélî Dnye used on Rossel Island (PNG).

Adaptations may be community-specific. Cristia and colleagues (2020) discuss challenges in eliciting non-word repetitions from individual child speakers of Tsimane' (Bolivia). Their initial design using sound playback failed, leading them to design a group game with children and adults in which a Tsimane' research assistants acted as a model for the other participants. They also adjusted stimuli gradually while in the field to increase their naturalness and allowed group-size to vary flexibly between three and nine participants according the availability of participants. In another community, child speakers of Yélî Dnye (PNG) responded positively to a more traditional design using playback (Cristia & Casillas under review). Stimuli items were adapted to Yélî

Dnye using native speakers as sounding board for appropriateness and suitability, and distributed across children to maximise the number of trials.

In addition to the experimental design, adaptations to the testing environment and/or experimental protocols are often necessary. In remote communities with unstable or non-existent electricity, equipment needs to be mobile, connected to backup batteries or solar-powered (Frost & Casillas 2021; Sarvasy et al. in preparation). Instead of a lab-environment, data collection may vary in location and setup, e.g., visiting participants' housesand using portable devices such as tablets or laptops may be beneficial (Frost & Casillas 2021; Cristia & Casillas under review). Informed consent may be obtained verbally (Cristia et al. 2020), participant compensation may vary (Cristia et al. 2020; Frost & Casillas 2021), and personal details of participants such as age, years of schooling, literacy skills often are rough estimates (Cristia et al. 2020). Most importantly, comfort of the participants (and caregivers) with participation and with the presence of the researcher, often a foreigner, may lead to adjustments e.g., the non-ideal use or placement of equipment (Cristia & Casillas under review).

While these studies are still few in number, it seems clear that adaptations are intricate and multifaceted and vary from community to community and task to task. More and more studies of non-WEIRD communities allow us to explore and corroborate the generalisability of existing paradigms and the claims and theories made about language (acquisition).



7.2.2 MODALITY-ADAPTATIONS: EXPERIMENTS ON THE ACQUISITION OF SIGN PHONOLOGY

Sign language research has often concentrated on proving their status as fully-fledged languages, or on testing linguistic universals, instead of focusing on diversity (McBurney 2012). Like spoken languages, sign languages show phonology (e.g., van der Kooij 2002). Signs are organized sublexically in features (e.g., ‘handshape’, ‘location’, ‘movement direction’, ‘movement shape’ etc.) and feature contrasts may lead to minimal pairs of signs where two signs share all but one feature (Figure 7-1), e.g., the Kata Kolok signs PRAY-D and SHY-A differ only in ‘location’ (*forehead* in PRAY-D; *chin* in SHY-A; Figure 7-1A) and THINK and PRAY-D only in ‘handshape’ (extended index in THINK; flat handshape in PRAY; Figure 7 1B).

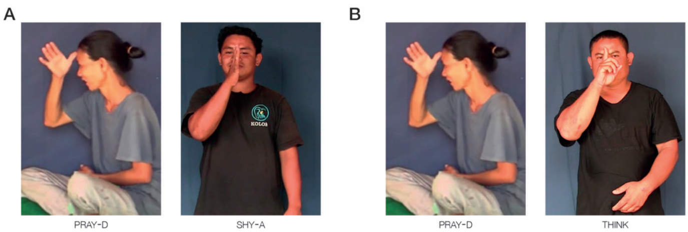


Figure 7-1. Minimal pairs in Kata Kolok: (A) PRAY-D and SHY-A contrast in location; (B) PRAY-D and THINK contrast in handshape.

Experiments studying the acquisition of sign phonology by children are rare. Most studies have adapted one of two paradigms used with speaking children targeting the ability to discriminate between linguistic contrasts: the habituation paradigm (Fennell, Groot & Hagoort 2017) and the preferential looking paradigm (Golinkoff et al. 2017). The habituation paradigm exposes participants (usually infants) repeatedly to the same stimulus until their interest, measured in looking time, sucking time or heart rate, decreases. Then, they are exposed to a novel stimulus which, upon discrimination, is expected to elicit higher interest than the familiar one (novelty effect or dishabituation). The preferential looking paradigm capitalises on looking time differences between two visual stimuli that are presented simultaneously; increased interest to one of them is interpreted as a preference.

Using a habituation paradigm, Carroll & Gibson (1986; habituation-dishabituation task) and Schley (1991; habituation-recovery task) showed that ASL-naïve infants are sensitive to movement contrasts of ASL signs. Carroll and Gibson (1986) exposed 4-months-olds to minimal pairs of movement in ASL and found that infants differentiated global and single movement contrasts, but this was not the case for all movement dimensions. Schley (1991) disentangled movement type and semantic context by testing hearing infants (aged 3;6 months) without ASL exposure on aspectual (in Schley, 1991 "inflectional") movement manipulations of the ASL sign LOOK-AT. After three tokens of a movement type, infants looked longer to a novel movement type than to a new member from the same category. Wilbourn & Casasola (2007) habituated ASL-naïve infants (aged 4 months and 10 months) on the ASL sign FINISH and then tested whether they detected manipulations on single parameters. Infants detected manipulations of location and nonmanual markers but not handshape or movement.

Using a preferential looking paradigm, Krentz and Corina (2008) presented hearing infants without ASL exposure (aged 6 months and 10 months) with short clips of ASL narratives and non-linguistic pantomime on two different screens.

Younger but not older participants looked longer at ASL stimuli, i.e., preferred language over pantomime. With the same paradigm, Blau (2019) explores whether American infants (deaf, hearing signers, hearing non-signers) prefer one of two unknown sign languages (German Sign Language and Russian Sign Language) or a natural and a non-natural sign language (ASL and Signed Exact English).

Palmer and colleagues combine both paradigms. In their study, stimuli were pictures of ASL-handshapes from a continuum that adult native ASL signers perceive categorically (Baker et al. 2005), presented in pairs of either identical or different tokens from the same category. ASL-naïve infants prefer ASL handshapes only before 1;0 year (Baker et al. 2006) but this preference persists after 1;0 year for hearing infants with ASL exposure (Palmer Baker et al. 2012).

Mann and colleagues (2010) adapted a non-word repetition task of 40 nonsense signs with 91 deaf children who acquire BSL (aged 3-11 years) and 46 hearing non-signing children (aged 6-11 years). They found that phonological complexity (‘handshape’ and ‘movement’) impacts sign production in all children but deaf children gradually recruit their knowledge of British Sign Language (BSL).

Besides a range of different paradigms, the types of stimuli vary across studies. Krentz and Corina (2008) and Blau (2019) used naturalistic narratives; Mann and colleagues (2010) and Wilbourn and Casasola (2007) used video recordings of a signer producing isolated (nonsense) signs; Carroll and Gibson (1986) used cropped videos that only show the hand of the signer in front of the torso; Palmer and colleagues (Baker et al. 2006; Palmer Baker et al. 2012) showed pictures of the hand only.

In sum, experiments studying the acquisition of sign phonology are somewhat scarce, and are largely based on ASL-stimuli, mostly administered to ASL-naïve children, or hearing bimodal bilinguals of English and ASL (exceptions Mann et al. 2010; Blau 2019). These studies thus target the loss of sensitivity to signed phonemic contrasts rather than the acquisition of sign phonology in signing children.

7.2.3 KATA KOLOK

The sign language Kata Kolok arose due to high levels of congenital deafness in a Balinese village of ~3,000 (Friedman et al. 1995; Winata et al. 1995). Today, 33 permanent residents are deaf (Lutzenberger in press). Since its emergence, Kata Kolok has become entrenched in the village's culture and linguistic landscape (Marsaja 2008; de Vos 2012b).

Like other traditional Balinese villages, this community has strong kinship ties. Clan membership, regulated through a patrilineal system, organises the village geographically and socially (Covarrubias 1937; Marsaja 2008). Within clans, villagers live in family compounds: arrays of multigenerational households. This social structure distributes childcare among members of the nuclear family and relatives within the same family compound.

The tight-knit community structure also leads to a high percentage of hearing signers. This creates a rich and diverse linguistic environment for deaf (and hearing) children who learn Kata Kolok from birth. After a decade without child births, eight babies were born into deaf households between 2014 and 2018. With at least one deaf parent, two deaf and six hearing children learn Kata Kolok as (one of) their primary language(s).

An in-depth study of Kata Kolok phonology is ongoing. However, the lexicon shows typological peculiarities. Kata Kolok signs use locations that are reportedly unusual in other sign languages, e.g., the *hip*, the *teeth*, or the *tongue* (Marsaja 2008; de Vos 2012b). In addition, the handshape inventory is small and includes many basic handshapes (Marsaja 2008; de Vos 2012b; Lutzenberger 2018; Lutzenberger et al. 2019). Variation in sign form is attested within the community (Lutzenberger et al. 2021), and appears to be governed by factors such as hearing-status and gender (Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020).

In sum, Kata Kolok has emerged as a sign language isolate, and is integral to the community's social and linguistic landscape. Alongside deaf signers, many hearing signers provide a language model for children who acquire Kata Kolok from birth. The Kata Kolok lexicon shows cross-signer variation, a tendency for unusual locations and a handful of frequently used handshapes, whose phonetic or phonemic status is yet to be determined.

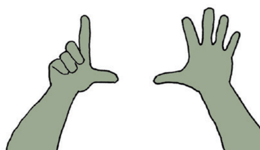
7.3 STUDY 1: LOW-TECH VISUAL FAMILIARISATION PARADIGM IN THE FIELD

For Study 1, we conducted a low-tech visual familiarisation experiment in the field. Visual familiarisation differs from visual habituation in two ways: (i) children are exposed to the same stimulus for a fixed number of showings, and (ii) instead of novelty effects, a preference for the familiar stimulus (familiarity effect) is common as well (Oakes 2010; Fennell et al. 2017). We predicted differences between signing and non-signing controls in their ability to discriminate between minimal handshape contrasts in Kata Kolok due to Kata Kolok exposure: we expected sensitivity to handshape contrasts, thus a longer looking time for novel stimuli, in signing than in non-signing children.

7.3.1 METHODS

7.3.1.1 PARTICIPANTS

As we are primarily interested in the acquisition of Kata Kolok phonology, we exhaustively sampled the community for young children who had at least one deaf primary caregiver, and could thus be considered to learn Kata Kolok natively. The resulting *signing* group consisted of eight native Kata Kolok signers between the ages of 0;4-4;4 years; two deaf monolinguals and six hearing bimodal bilinguals (spoken Balinese and Kata Kolok). In addition, we tested age-matched *non-signing* children who were recruited by two main criteria; (i) the closest match in registered birth date to one of the signing children and (ii) belonging to families with very limited or no signing skills. Note that we did not find an age-match for one signing child (CSR) and in cases where the non-signing participant was very fussy, we double-matched signing children, resulting in more non-signing than signing children. Signing children were recruited directly by the first author who is familiar with the deaf villagers and has been conducting mid- to long-term data collection on these sign-acquiring children (*Kata Kolok Child Signing Corpus* 2021). Non-signing children were identified and recruited with help of a local hearing signing research assistant through the use of the local nurse's registry. For all children, age is provided in full months. Whenever the experiment had to be completed across two separate



sessions and the children's age in months differed in the two sessions, their age in months is provided as the median; this was the case for CSS and CNSW. Find an overview of the sample in Table 7-1.

Table 7-1. Overview of participants.

***signing* group**					***non-signing* group**		
participant	**age** (months)	**hearing status**	**gender**	**deaf caregiver**	**participant**	**age** (months)	**Gender**
CSA	49	deaf	female	two deaf parents	CNSA	49	female
					CSNAII	52	female
CSR	45	hearing	female	grandfather deaf	-	-	-
CSHM	32	hearing	male	deaf grandparents	CNSM	31	female
CSD	23	hearing	female	one deaf parent	CNSD	22	male
CSS	18.5	hearing	male	two deaf parents	CNSS	19	male
					CNSSII	19	male
CSC	18	deaf	female	one deaf parent	CNSC	18	female
CSW	18	hearing	male	two deaf parents	CNSW	17.5	male
CST	4	hearing	female	two deaf parents	CNST	4	female

7.3.1.2 STIMULI

The stimuli consist of videos of an animated monkey producing Kata Kolok signs and nonsense signs. We opted for a non-human character to counteract the tendency of adult Kata Kolok signers to focus fully on identifying people whenever pictured. A monkey is ideal for two reasons: (i) they are found natively in Bali, and are thus culturally appropriate, and (ii) their anatomy is similar to a human, allowing the animated character to sign naturally. The skeleton of the monkey was designed by Jeroen Derks (Max Planck Institute for Psycholinguistics, Nijmegen) and the animations of each stimulus video were made by the first author using the animation software MAYA Autodesk (version 2018).[36, 37]

Signs consist of a preparatory phase, the stroke, and a retraction phase (Kita, van Gijn & van der Hulst 1998) with peak informativeness at the stroke (Figure 7-2). We animated stimuli in three equally long phases where the stroke of the sign was initiated at the 24th frame and released at the 48th frame. Videos were rendered in high quality at 24 frames per second and edited in Adobe Premiere to video clips of 02:26:00 seconds, showing one complete sign cycle. All stimulus videos show the monkey's full body from a frontal perspective (Figure 7-2).

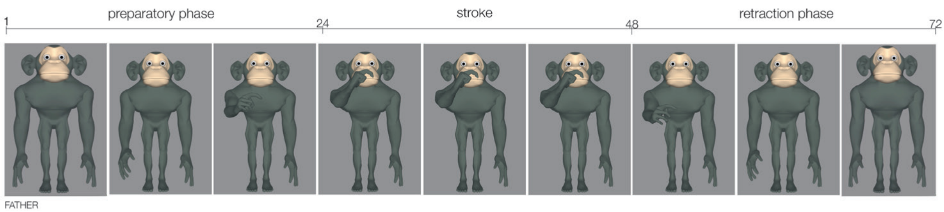


Figure 7-2. Example of animated stimulus sign FATHER, indicating the preparatory phase, the stroke and the retraction phase of the sign as well as the relevant frames.

Stimuli were selected based on familiarity and form. We judged these by (i) the Kata Kolok dataset in Global Signbank (Lutzenberger 2020), based on elicited and spontaneous data from deaf adults, (ii) field-observations, and (iii) language fluency of two of the authors (HL and CdV). Specifically, familiarity was assessed based on frequency in the input and early production by children. All chosen signs,

[36] https://www.autodesk.com/products/maya/overview?term=1-YEAR&support=null.

[37] Source code, materials and stimuli can be found on the Open Science Framework (https://osf.io/w62tm/?view_only=5bbe57e3068a4d9995d267d9073c1224).

except COW, were one-handed signs with frequent handshapes where handshape frequency was based on the lexical database. The sign COW is a two-handed sign and was used as practice item throughout the experiment. We selected the following signs: COW, FATHER, GRANDPARENT, MOTHER, PRAY, STAY, THIRSTY, BATHE, CRY, DOG, RAIN, SHY.

Stimuli were animated in pairs: a target production and a mispronunciation. Handshape was selected for manipulation, since adults have shown categorical perception in this parameter in ASL (Baker et al. 2005), and it is often considered the most contrastive property of the sign (Johnston & Schembri 1999). We manipulated either 'finger selection' or 'finger configuration' (i.e., *curvature*) while all other form aspects of the sign were kept identical. We consider manipulations in finger configuration (BATHE, CRY, DOG, SHY) perceptually more subtle than 'finger selection' (FATHER, GRANDPARENT, MOTHER, PRAY). Given the large age range among our participants, signs were arranged in two blocks: easy (finger selection) and hard (finger configuration) (Figure 7-3; full stimuli list in Appendix 7-A).

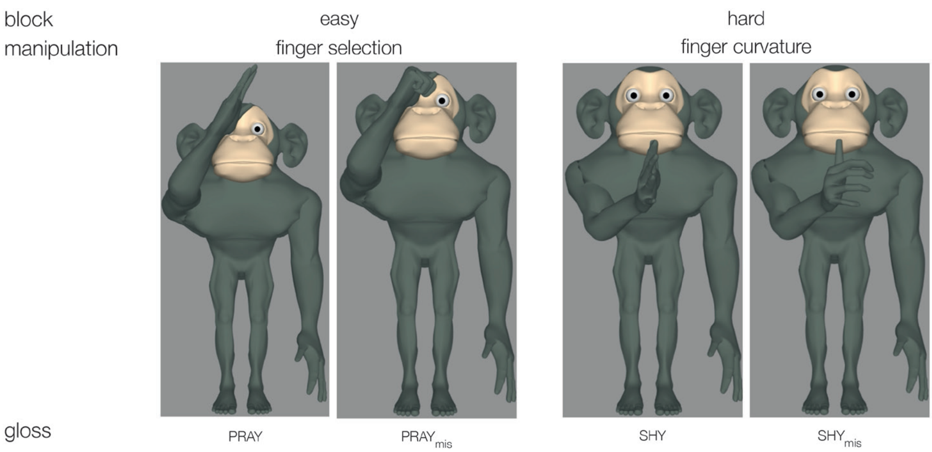


Figure 7-3. Example of pairs of stimuli: PRAY and PRAY$_{mis}$ and SHY and SHY$_{mis}$.

Prior to the experiment, all stimuli were piloted with three deaf adult native Kata Kolok signers in order to assess their recognisability, clarity and whether they were known to young children. We eliminated three signs (THIRSTY, STAY, RAIN) since they were not correctly identified.

Lastly, we created four different filler animations using Apple Keynote. We designed and animated prototypes of balloons, confetti, fish, and monkeys, crossing the screen vertically or horizontally at different speeds.

7.3.1.3 PROCEDURE

Parental consent was obtained before the experiment and after explaining the goal and the procedure. For deaf parents, the first author provided the explanations in Kata Kolok, and for hearing parents, a hearing research assistant communicated the information in Balinese and translated questions. After the experiment, children were offered a soap bubble tube or a stamp as reward. Accompanying caregivers were compensated with the equivalent of a day's salary.

The experiment was presented on a MacBook Pro (13.3 inch). The laptop was placed on a 40 cm high stool in a quiet room at a house under construction at the edge of the village. As recreating a completely isolated lab setting would be impossible in this community, we tried to minimize distractions as much as possible. Children sat on the floor or their caregiver's lap, facing the laptop. Caregivers were instructed not to respond to the stimulus or disturb the child, however, they were allowed to encourage the child to continue watching the screen and to interact with the child if inquired. The first author conducted all experiments, interacting directly with the children. No other people were in the room. Each session was videotaped with three cameras: (i) the front laptop camera recorded the child's face and eye movements, (ii) one Canon Legria HF G26 camera behind the laptop recorded a frontal view of the child and (iii) another Canon Legria HF G26 camera behind the child recorded the screen of the laptop and child-caregiver interactions.

Children were tested in a visual familiarisation paradigm. All children started with a practice trial, showing COW and COW_{mis} repeatedly in semi-random order, to familiarise the child with the experiment. Experimental trials consisted of a familiarisation phase showing the same stimulus five times and a test phase consisting of a novel and the familiar stimulus (Figure 7-4). The experiment relied on a low-tech solution; the experimenter directed a slideshow using the forwards key on the laptop. We used three types of screens: (i) black screen with a blinking attention-getter in the centre, (ii) stimulus video, (iii) filler animation. Each stimulus was preceded by an attention getter to direct the child's gaze to where the stimulus would appear. Once the child's gaze fixated on the attention getter, a stimulus was shown on loop for as long as the child looked at the screen. When the child averted their gaze, the experimenter proceeded to the next attention getter. Each completed test phase was followed by a filler animation. Filler animations lasted 30 seconds.

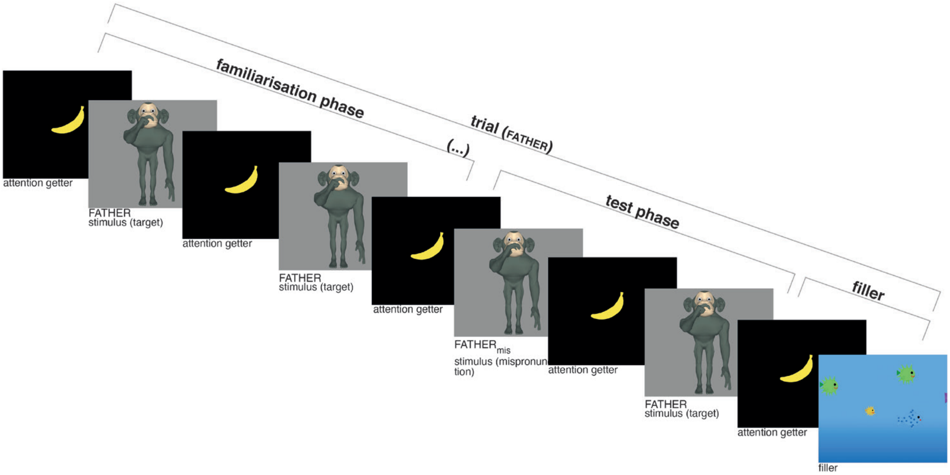


Figure 7-4. Example of the procedure, detailing the phase and the stimulus type.

Each child watched as many trials as possible. We counterbalanced (i) the order, and (ii) whether children were familiarised with the target or the mispronunciation. Given the age range of our participants, the order of stimuli was randomised within blocks; each child started with the easy block and only afterwards proceeded to the hard block.

When the child got too fussy to continue, the experiment was paused and the child played with soap bubbles until they were ready to continue. In order to obtain the maximal amount of data from each participant, we allowed the data collection to be distributed over two visits.

7.3.1.4 ANNOTATION

The first author annotated all data in ELAN (*ELAN [Computer software*] 2020) (Figure 7-5). We annotated each trial (e.g., father) for the phase (familiarisation vs.

test) and the presented stimulus (target vs. mispronunciation). We also annotated sign cycles and strokes. Looking time was coded (i) tolerantly where looks with off-screen glances of less than one second are allowed between fixation periods, and (ii) conservatively where each continuous fixation was annotated. We excluded looks where the child saw less than half of the stroke of the sign. In addition, we coded for three types of behavioural measures:

(1) **Attention**. Attention concerns a rating of how distracted children were from the task. We gave scores from 1 (fully attentive) to 5 (fully distracted) for each stimulus showing and each trial.

(2) **Hand activity**. We rated how actively children engaged their hands during each stimulus showing using a mixed scoring of Likert scale (1-5) and categorical for gestures and signs. A mixed scoring was necessary to disentangle communicative hand movements, i.e., signs and gestures, from unrelated ones, e.g., nose-picking or beat gestures. For the sake of simplicity, this measure includes communicative responses that are nonmanual such as expressing negation through a headshake.

(3) **Eye contact**. We coded whether the child made eye contact with an interlocutor at the end of a stimulus presentation (categorical variable).

We used multiple systematic searches in ELAN via the function Multiple Layer Search to export data (Figure 7-5) and performed analyses in R (R Core Team 2019).[38]

[38] Analysis files can be found on the Open Science Framework (https://osf.io/w62tm/?view_only=5bbe57e3068a4d-9995d267d9073c1224).

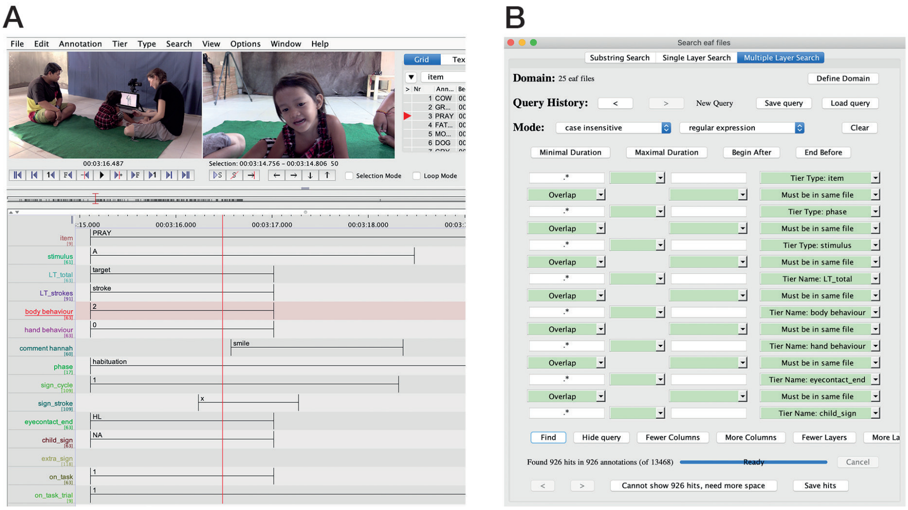
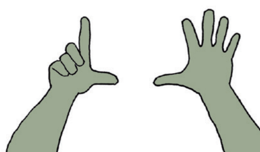


Figure 7-5. Example of (A) ELAN file and (B) Multiple Layer Search query used for data export.

7.3.1.5 ANALYSIS

This study takes a mixed-methods approach. First, we test the hypothesis that only signing children discriminate between the target and the mispronunciation with a mixed-effects model, using R (R Core Team 2019) and the lme4 package and the lmer() function (Bates et al. 2015). We chose mixed effects modelling over ANOVA as it deals better with few(er) data and (more) variation. We log transformed looking time to reduce the positive skew of the data (Winter 2019). The model tests whether group (signing vs. non-signing) predicts looking time to stimulus (target vs. mispronunciation) by phase (familiarisation vs. test), with random intercepts for participants, item, and block (easy vs. hard). Second, the heterogeneity and small size of the sample warrant additional qualitative analyses. We hypothesize that language skills in Kata Kolok affect behaviour. Thus, we analyse the three behavioural measures: attention, eye contact, and hand activity.



7.4 FINDINGS

Data annotation yielded 989 looks, of which 25.7% were excluded due to seeing less than half the stroke (n=210) or an incomplete test phase (n=44). The remaining 751 looks, 370 looks from non-signing and 395 looks from signing children, entered the analyses.

7.4.1 LOOKING TIME

The two groups do not show great differences in their looking behaviour ($mean_{signing} = 8.41$; $sd_{signing} = 0.7$; $mean_{non\text{-}signing} = 8.44$; $sd_{non\text{-}signing} = 0.79$) (Figure 7-6). In the easy block, both groups looked longer during the familiarisation than the test phase. In the hard block, the signing group looked marginally longer to stimuli in the test phase. Indeed, the model (lmer($LookingTime_{log}$ ~ group*phase*stimulus + block + (1|participant) + (1|item)) did not reveal any significant differences.[39]

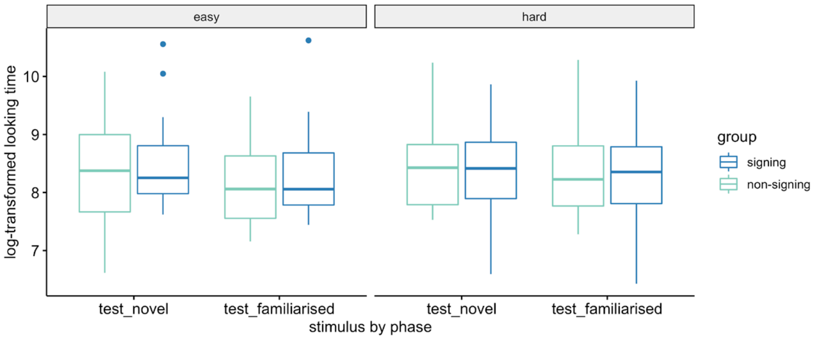


Figure 7-6. No effect of looking time (log-transformed) by group, stimulus by phase, and block, showing looking time on the y-axis and stimulus type by phase on the x-axis.

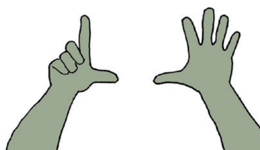
[39] Note that any statistical analysis should be interpreted with caution, given the variation and size of our sample. Inferential statistics are generally used to extrapolate from samples to the population. While we consider the signing group as (exhaustive) sample, it may be considered as population, in which case the means represent true population means and linear mixed-effects models would no longer be applicable.

7.4.2 BEHAVIOURAL MEASURES

7.4.2.1 ATTENTION

Our attention measure yields two main observations: (i) attention span, and (ii) attention level. The signing children showed a longer attention span than the non-signing children (Figure 7-7). With two exceptions (CST and CSW), all signing children completed all eight trials. CST, a four-month-old infant, completed six trials and for CSW, a hearing child of deaf parents, we had to interrupt the final trial at the final stimulus due to fussiness. The non-signing children were much less likely to finish the experiment. Three children (CNSAII, CNSC, CNSM) completed all eight, one child (CNSA) completed seven, four children (CNSD, CNSS, CNST, CNSW) completed six, and one child (CNSSII) completed only four trials. In short, the signing children upheld their interest longer than the non-signing children.

The signing children were more attentive than the non-signing children (Figure 7-7). Although most children (except CNSS) got more distracted with time, distraction levels of the signing children were generally lower (mean = 2.03; range = 1-4; sd = 0.89) than of the non-signing children (mean = 2.54; range = 1-5; sd = 1.27). The two deaf children showed the lowest levels of distraction: CSA (aged 49 months) was very focused during the entire experiment and CSC (aged 18 months) maintains moderate distraction starting mid-experiment.



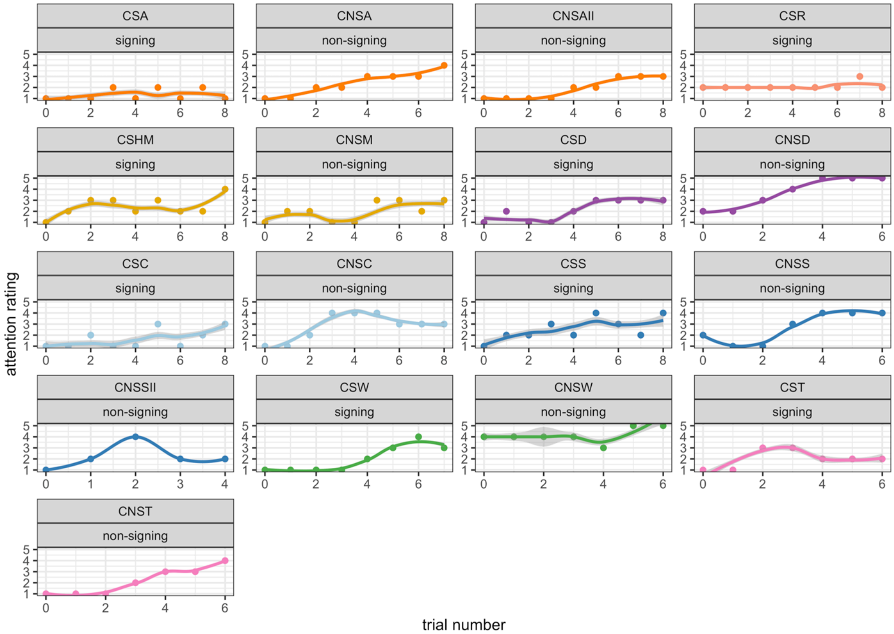


Figure 7-7. Attention measure per trial across the full experiment (eight trials) for each participant, showing the different levels of the attention measure on the y-axis and the trial number on the x-axis. Age-matched children are displayed using the same colour.

In sum, the two groups of children differed in their attention. While the signing children were very attentive to the task throughout the experiment, the non-signing children became distracted more quickly. In addition, the signing children showed high attention to the experiment suggesting that they engaged with the stimuli, while repetitiveness may have contributed to fatigue and the rapid decline in attention among the non-signing children.

7.4.2.2 EYE CONTACT

Eye contact was coded as a categorical variable with three levels (no eye contact, eye contact with experimenter and eye contact with caregiver). Here, we report rate and timing of eye contact. Experimenter and caregiver were collapsed to an "interlocutor".

The signing children established eye contact with an interlocutor more often than the non-signing children (Figure 7-8A). The signing children looked to an interlocutor in 37.1% (143/385) of cases whereas the non-signing children did so only in 18.3% (65/355). Nevertheless, individual variation is high: two non-signing children (CNSSII and CNSD) established eye contact more often than their non-signing peers; two signing children (CSHM and CSD) did so less often than the other hearing signing children, and the high rate of eye contact of deaf signing children (57.8%; 67/116) is driven by CSA, who has the highest rate of eye contact overall (Figure 7-8B).

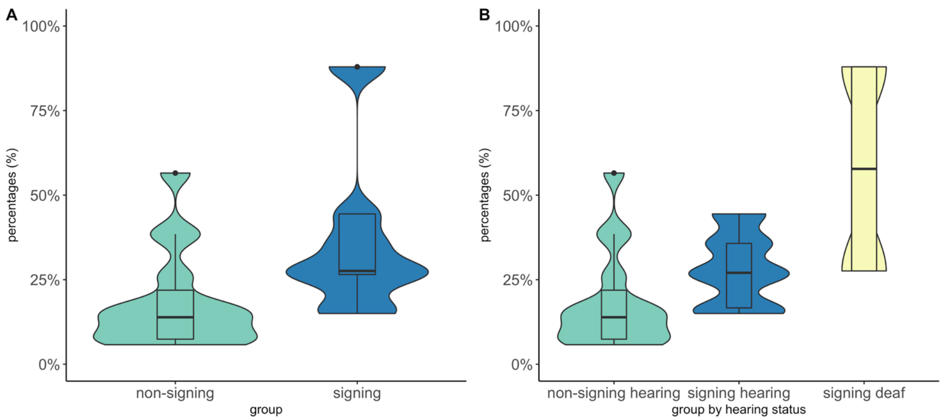
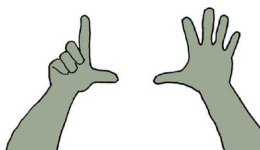


Figure 7-8. Prominence of eye contact with an interlocutor per group, (A) showing signing vs. non-signing children, and (B) separating out the signing children by hearing status vs. non-signing children.

Among the signing children, eye contact patterns appeared to be driven by phase (practice vs. familiarisation vs. test; Figure 7-9). All children established eye contact with the interlocutor most frequently during the practice trials, i.e., at the



beginning of the experiment. Nevertheless, patterns of eye contact among the non-signing children suggest natural decrease in attention over time. The signing children, however, establish eye contact most frequently in the test phase. Thus, for them, establishing eye contact may be linked to detecting differences.

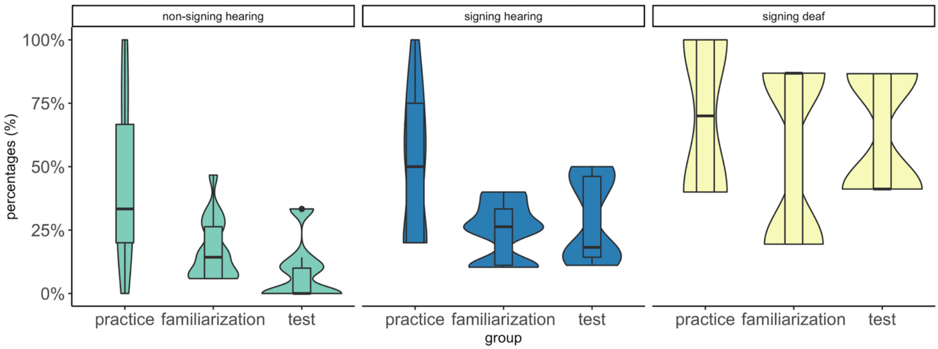


Figure 7-9. Eye contact by phase, group and stimulus type. The graph shows the percentage of eye contact on the y-axis and the phase on the x-axis, grouped by signing vs. non-signing children and hearing status.

In sum, eye contact is more common among the signing children, especially the two deaf children. While eye contact may be a proxy for attention in the non-signing children, it appears to be indicative of recognition of a novel stimulus among the signing children.

7.4.2.3 HAND ACTIVITY

Hand activity was scored on mixed scale (scale 1-5 and categorical). Here, we focus only on the categorical coding, i.e., any communicative (nonmanual) signs or gestures.

Groups differ in the type of hand engagement: no hand activity, parental manipulation, and signs/gestures. First, no manual activity is most common among all groups (non-signing: 93%, 330/355; signing: 89%, 343/385). Second, one third of the non-signing children and none of the signing children experience parental manipulations; although instructed not to interfere, caregivers reached for their children's arms and hands to move them playfully or to imitate the stimulus. Third, 4/9 non-signing children, 3/6 hearing signing children, and 2/2 deaf signing children used signs/gestures during or immediately following a stimulus presentation. As this occurs most often during the practice phase (9.3%, 4/43) and rarely during the test phase (3.8%, 3/80) for the non-signing children, hand engagement likely is a proxy for interest. In the signing children, hand engagement occurs never during the practice phase and most often during the test phase (17.5%; 17/97). While the signing children who are hearing show less hand activity than their deaf peers, this behaviour may reflect discrimination that is not captured in the looking time measure.

Furthermore, the form of hand activity differs. The non-signing children may point to the screen. The signing children show a range of different responses including child productions, i.e., incomplete imitation (Figure 7-10A), pointing to the screen (Figure 7 10B), direct responses (Figure 7-10C), and full repetitions (Figure 7-10D).

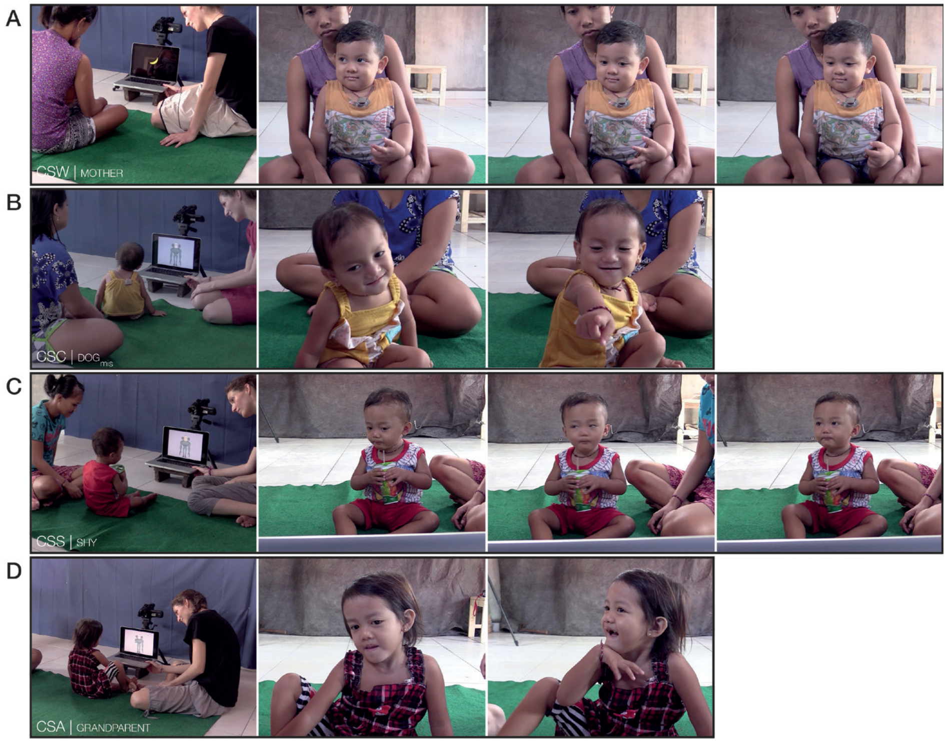


Figure 7-10. Examples of responses of different signing children. (A) Lax manual activity overlapping with the stimulus sign MOTHER by CSW. (B) Non-manual marking (*headtilt, smile*) followed by pointing sign to the screen by CSC to the stimulus DOG_{mis}. (C) Direct response to the stimulus (headshake) by CSS to the stimulus SHY. (D) Full repetition of the stimulus by CSA to the stimulus GRANDPARENT.

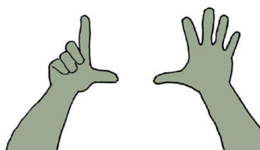
Repetitions or imitations of stimuli are sometimes cases of child productions. The form of CSW's lax manual activity and the stimulus sign MOTHER overlap (Figure 7-10A). MOTHER is produced by moving the flat handshape repeatedly up and down with constant contact at the ipsilateral chest. CSW repeatedly flexes wrist and fingers while the hand rests on the lap, which could represent a child production of the sign MOTHER.

Pointing signs may be used alongside other (nonmanual) cues. During the third showing of the stimulus DOG_{mis} during the familiarisation phase, CSC first tilts her head, smiles and then points to the screen (Figure 7-10B). CSC's behaviour incrementally increases, starting with nonmanual marking (head tilt and smile) followed by a pointing sign to the screen. CSC's behaviour is modality-appropriate and communicative; upon detecting something, she establishes the fundamentals of joint attention needed to discuss something.

The communicative aspect of the example in Figure 7-10C is of a different kind: CSS has been familiarised with SHY$_{mis}$ and upon encountering the target sign SHY, he directly responds to the stimulus as in a conversation; he negates the sign SHY by shaking his head, interpreting it as if the monkey asks him whether he feels shy. Rather than engaging with an adult interlocutor, CSS treats the monkey as a communication partner.

CSA combines communicative behaviour with perceptual and productive skills. Throughout the entire experiment, CSA repeats most stimuli (correctly). As pictured in Figure 7-10D for GRANDPARENT, she observes the stimulus for one (or few) sign cycles, establishes eye contact with the experimenter, smiles and then repeats the sign. This behaviour occurs for target signs and manipulated signs. Clearly, CSA is able to perceptually discriminate and productively repeat both targets and mispronunciations.

In short, the groups differ in their hand activity. Hand activity of the non-signing children appears incidental but among the signing children, different types of hand behaviour may be communicatively motivated interactions that are based on differentiating stimuli.



7.4.3 DISCUSSION STUDY 1

We presented signing children and age-matched non-signing peers with animated sign stimuli using a visual familiarisation paradigm. Children were familiarised and tested on Kata Kolok target signs and handshape manipulations. We found no differences between groups in looking time, i.e., no evidence for discrimination of the stimuli. Behavioural measures (attention, eye contact, hand activity) indicate that the signing children discriminate stimuli. Nevertheless, Study 1 included multiple innovations, making it difficult to pinpoint the factors that may have obscured looking time differences. Here, we discuss how some of the sample characteristics and the adaptation of the paradigm may explain the lack of group-differences in looking time.

Traditionally, populations are sampled for group-internal homogeneity on various levels; in comparison, our sample is relatively heterogeneous. Our single inclusion criterion was that children acquired Kata Kolok as a first language, resulting in a large age range, and both deaf and hearing children. While habituation or familiarisation studies typically test infants between 0-14 months, our participants are between 0;4 and 4;0 years old. The sociolinguistic setting also presented some difficulty for selecting the control group. Given that we sampled non-signing participants from the same village, we cannot exclude the possibility that these children have acquired some familiarity with signing and/or culturally entrenched iconicity merely by being part of the community. Although testing infants from another village could corroborate whether the current control group indeed was naïve to Kata Kolok, we believe that heterogeneity of the sample and issues related to the paradigm are more likely to account for the observed variation.

It is possible that the paradigm is not well suited for signed stimuli and signing populations. There are at least two fundamental challenges: (i) sign phases vary in informativeness, and (ii) eye contact plays a central role in signed communication. First, sign stimuli unfold sequentially (Figure 7-2). Thus, informativeness of a look varies alongside timing not duration; looks during the preparatory phase are less informative than looks that coincide with the stroke. We presented children with looping videos of isolated signs where all three phases were equally long, and excluded looks that cover less than half the stroke (21%; 210/989). Evidence from adult signers suggests that signers make predictions about the sign already before seeing the stroke (Hosemann et al. 2013). Thus, applying a less rigid criterion may allow for retaining more datapoints in future studies. Second, the paradigm builds on sustained eye gaze which may clash with the sociolinguistic ecology of signed communication. The gaze behaviour of sign-exposed infants aged 5-14 months mirrors adult signers; they focus on the signer's face (Bosworth & Stone 2021). Furthermore, deaf children triangulate joint attention through communicative switches of visual attention (Lieberman et al. 2014) and show enhanced gaze following patterns as early as 7-20 months (Brooks, Singleton & Meltzoff 2020). Crucially, Brooks and colleagues' (2020: 5) older participants exhibited checking-in behaviour, i.e., shifts in visual attention from the stimulus to the experimenter – the same observation we made with our signing, and particularly deaf, participants. Instead of marking decreasing interest, shorter looks among the signing participants may thus be caused by switching visual attention, i.e., modality-appropriate communicative behaviour.

7.5 STUDY 2: PILOT TABLET-BASED HABITUATION EXPERIMENT

7.5.1 DESIGN & PROCEDURE

As explained previously, we initially also designed and piloted a new method to collect looking time equivalents with a tablet-based task. Aiming to circumvent some problems described above, this tablet-based experiment registers touch input to measure interest (i.e., replacing screen-look duration with screen-touch duration). By providing a more direct measure, it opens up interesting avenues that warrant further exploration.

The design is modelled on core ideas of the habituation paradigm using a Samsung SM-T713 tablet. The application was written by Peter Withers (Max Planck Institute for Psycholinguistics, Nijmegen) as an Android application available through the Google Play Store.[40] Touch input (and, if needed, touch area) initiates playback of a stimulus for the touch duration. Data is saved automatically on the memory card and can be uploaded to a server using an internet connection. In addition, sessions were videotaped using a Canon Legria HF G26 camera. While the pilot version relied on controlling stimuli manually using a magicsee R1 Bluetooth remote controller, we planned to automatically calculate habituation based on a habituation criterion of 50% with a sliding window of three trials in the final version.

The experimental phase consists of a pre-stimulus screen and a stimulus screen (Figure 7-11). We used simple games available on the Google Play Store

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[40] Source available on the Open Science Framework: https://osf.io/w62tm/?view_only=5bbe57e3068a4d-9995d267d9073c1224.

as filler activities after completed trials. Stimuli were of the same kind as in Study 1 except that we manipulated 'handshape' or 'location' of six Kata Kolok signs. We piloted the stimuli with 15 adult signers, and the experiment with 11 children with Kata Kolok exposure. Note that all signing children from Study 1 and five older children, four hearing with deaf relatives and one deaf, participated in this pilot.

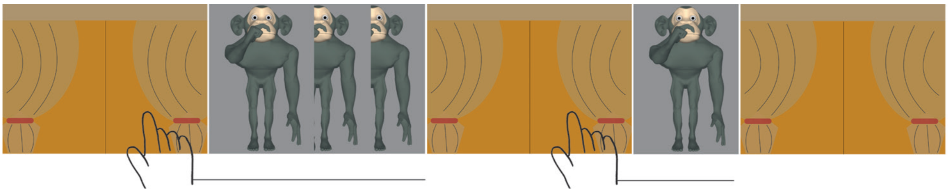
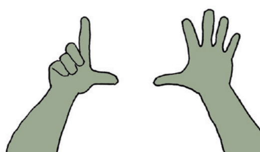


Figure 7-11. Example of tablet-based interaction, illustrating how touch input initiates changes of screens from the default (curtains) to the stimulus screen (monkey animation) until touch is released.

7.5.2 LESSONS LEARNED

The following evaluates the advantages and disadvantages of the pilot and formulates concrete recommendations for improving and expanding this work in the future. We focus on methodological choices of the device, setting, procedure, screens and stimuli, and the measure.

Device. Tablets are portable, intuitive, and changes can be implemented remotely. First, tablets are portable which expedites field-experiments, e.g., through bringing the device to the participants' house (Frost & Casillas 2021). Second, navigating tablets is very intuitive, even for young children (Lytle, Garcia-Sierra & Kuhl 2018) and participants with low technical literacy (Frost & Casillas 2021). Third, Google Play Store updates allow for implementing changes remotely. While extensive piloting is needed to minimise bugs, experiments may be piloted and



conducted during the same field trip (e.g., Cristia et al. 2020; Frost & Casillas 2021). Nevertheless, building and maintaining the infrastructure for tablet-experiments requires substantial time investment and technical expertise.

Setting. We visited children's homes and placed the tablet on the floor in front of the children. To optimise touch data, children were prevented from picking up or leaning on the tablet. We recommend affixing the tablet to some surface so that it displays at a 45-degree angle and using a bigger sized screen. In our case, we recorded how children interacted with the tablet using an external camera on a tripod, which compromises the naturalistic setting. Using the tablet's internal camera instead would avoid adding experimental equipment but requires piloting to check whether it captures sufficient detail.

Screens & stimuli. Unlike Study 1, the pre-stimulus screen was a curtain that opens to both sides. Curtains invited children to swipe over the screen which counteracts continued touch input. Instead, we recommend a static icon in the right bottom corner of the screen as an icon mid-screen may risk children covering the stimulus with their own hand. The stimuli proved to be well-suited for young children, and for eliciting judgments from older children and adults. Similar to Study 1, however, issues related to using signed stimuli persisted; sign phases vary in informativeness, and touch behaviour does not guarantee interest as shorter touches may result from decreasing interest or shifts in visual attention.

Procedure. The experiment is so simple that even the youngest participants could navigate it independently, which may help to overcome larger ranges in participant age like in our Study 1. However, children of different ages pose different challenges in interpreting the touch data: young children are generally curious, yet some children get overly excited and produce staccato touches which often resulted in software issues during experiment playback. Older children showed a lower tolerance for the repetitiveness and easily got bored. More interactive tasks, e.g., sorting tasks, may maintain their attention and cooperation.

7.6 GENERAL DISCUSSION & CONCLUSION

This paper explores how to adapt traditional paradigms to signing children growing up in a non-WEIRD community. Using visual familiarisation (Study 1) and visual habituation (Study 2), we investigated options to detect whether signing children discriminate between minimally different stimuli. We focused on two groups: children acquiring Kata Kolok natively and age-matched controls without Kata Kolok exposure. Study 1 suggests that behavioural measures but not looking time capture group differences. Study 2 proposes that touch-input improves but does not circumvent all issues with existing paradigms. Specifically, heavy reliance on sustained eye gaze to the stimulus as a measure may be inappropriate for signing participants.

In the following section, we address implications of the dual adaptation in these studies, (i) adapting a technique from spoken language to signing participants and (ii) adapting a technique designed for participants from WEIRD communities to participants from an understudied non-WEIRD community. Adaptations to the field setting centre around the experimental design and procedure. Previous elicitations with adult Kata Kolok signers revealed a strong focus on identifying people, places and events, as a result, we animated stimuli rather than using a real signer. Given that lab-like conditions are impossible, we arranged a relatively quiet room to collect data (Study 1), or designed a portable experiment that can be brought to the home of participants (Study 2). Modality-adaptations concern the stimuli and experimental setup. We animated actual Kata Kolok signs and created nonsense signs through careful manipulation of a single property (handshape); we opted to systematically animate three equally long phases of one-handed signs to balance visual saliency of signs; stimuli were presented as looping videos; we recorded each session with three cameras to capture behaviour from different angles.

Experiments with signing populations face a common challenge: samples are often small and diverse since the pool of participants is limited and heterogeneous (Lieberman & Mayberry 2015; Morford, Nicodemus & Wilkinson 2015). In the Global North, deafness occurs in 0.1% of the population (CDC 2020) and most deaf children experience language deprivation (Hall 2017; Hall et al. 2017); only 5-10%, or less (Costello, Fernández & Landa 2008), are born to deaf parents who can provide immediate input in a sign language (Mitchell & Karchmer 2004; Lillo-Martin & Henner 2021). For this reason, much experimental research has focused on hearing or deaf participants of deaf parents, or on different ages of sign acquisition (Morford et al. 2015).

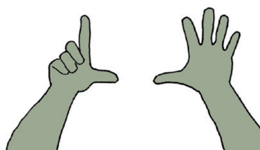
This challenge is aggravated in our case. We sampled from a much smaller pool of participants than available in other signing populations. In order to include all children who fulfil the sampling criteria, we compromised on homogeneity of age, hearing status, and language input. Specifically, the eight signing children are 0;4 to 4;0 years old, include bimodal bilinguals (hearing signing) and monolinguals (deaf signing), and their language input may vary alongside their family members' hearing status and signing fluency (Place & Hoff 2016; Unsworth et al. 2019). In communities where exhaustive sampling is possible, heterogeneity is ubiquitous given the small population.

Heterogeneous samples influence the experimental design, data collection and data analysis. First, tasks need to be simple in order to accommodate a large age range as well as varying degrees of educational levels and literacy skills. Second, a small sample requires us to maximise data from individual participants (see also Cristia et al. 2020). This can be done during data collection by extending testing sessions over multiple days to avoid fatigue, like in Study 1, by repeating the experiment at several occasions, or by developing incremental experimental designs that can be conducted longitudinally. Third, one needs to be selective in homogeneity and deal flexibly with heterogeneity (see also Cristia et al. 2020). Cristia and colleagues (2020: 7) argue that we need to "move away from statistical significance as the main criterion for judging noteworthiness and towards contextualised reading of the size of effects". Statistical analyses need to be interpreted and generalisations made with caution due to the sample characteristics. Here, we focused on a mixed-method approach that allows us to use the available data in versatile and multifaceted ways.

Sign language acquisition in non-WEIRD settings is severely understudied (exceptions de Vos 2012c; Hou 2016; Lutzenberger et al. under review) (Chapter Six) and the use of experimental approaches in this context is unprecedented. Both our studies implement methodological innovations (Morford et al. 2015): Study 1 relies on a more traditional experimental design but takes a mixed methods approach for data analysis. Study 2 presents a novel technique that is more modality-neutral. Both studies use novel stimuli of isolated (nonsense) signs that also opened up avenues for future research into acceptability judgments with adult Kata Kolok signers. Given the wealth of issues discussed in this paper, one may question the value of such experimental approaches. We argue that studies like this reveal systematic biases in experimental traditions. Particularly, rigorously requiring homogeneous samples as a grouping requirement favours WEIRD communities, and pushes communities with more heterogenous characteristics to the outskirts of experimental inquiry. Experimental and analytical designs must be flexible enough to incorporate these communities, or else we will find ourselves limited to learning and drawing conclusions from a small, homogenous group of languages and cultures (Jaeger & Norcliffe 2009; Kidd et al. 2020). This allows for fundamental biases to manifest in psycholinguistic theories. While enriching the diversity of languages experimentally studied in acquisition creates new challenges, ultimately when these challenges are faced, they will undoubtedly advance the field.

APPENDIX 7-A: DETAILED OVERVIEW OF STIMULI

block	sign gloss	ID gloss in Global Signbank	stimulus			
			target		mispronunciation	
practice	COW	COW-B	L		5	
easy (finger selection)	FATHER	FATHER	1_Curved		C_Spread	
	GRANDPARENT	GRANDPARENT-B	5		1	
	MOTHER	MOTHER-A	5		1	
	PRAY	PRAY-D	5		A	
hard (finger configuration)	BATHE	BATHE-A	5		C_Spread	
	CRY	CRY-A	B		C_Spread	
	DOG	DOG	C_Spread		5	
	SHY	SHY-A	5		C_Spread	



ADDITIONAL MATERIALS

All materials can be found on the Open Science Framework (https://osf.io/w62tm/?view_only=5bbe57e3068a4d9995d267d9073c1224).

ACKNOWLEDGEMENTS

We would like to express our gratitude to all participants and their parents for their joyful participation in this research. Further, we thank our research assistants Ni Made Sumarni and I Ketut Kanta for their support and collaboration.

CHAPTER EIGHT

GENERAL DISCUSSION

8 GENERAL DISCUSSION

The goal of this dissertation was to explore the following three questions:

i) What characterises variation in Kata Kolok phonology?

ii) How does Kata Kolok phonology fit into a broader typological landscape?

iii) How is the phonological system acquired by children?

I examine Kata Kolok with respect to crosslinguistic and within-language variation, as defined in Chapter One; the analysis of phonology among adult signers of Kata Kolok includes a crosslinguistic approach (Chapter Five), and the study of within-language variation (Chapter Three and Chapter Four); the analysis of how Kata Kolok phonology is acquired contributes primarily crosslinguistic insights (Chapter Six and Chapter Seven), looking at both production (Chapter Six) and perception (Chapter SevenChapter Six).

8.1 OVERVIEW OF CHAPTERS

The five experimental studies (Chapter Three through Chapter Seven) in this dissertation combine advancements in the understanding of variation and of the acquisition of sign phonology with methodological innovation. By taking an in-depth look at Kata Kolok, this dissertation expands the typological scope of sign languages under study in both the domains of phonology and its acquisition.

Chapter Three and **Chapter Four** contribute to answering the first question as to what characterises variation in Kata Kolok.

Chapter Three charted variation at the level of the lexicon (sign production). In this study, I investigated whether sociolinguistic differences between our participants such as age, gender or whether or not they are deaf, influence the signs they produce in an elicitation task. In order to analyse the data appropriately, I used two variation measures that do not require us to determine one variant as the default and others as a deviation thereof. First, entropy measures variation in a set, i.e., it quantifies differences between participants based on any of the sociolinguistic variables considered. I found that this measure fails to capture qualitative differences between stimuli such as cases where groups of people used more or less specific sign variants. Second, I measured the lexical distances between the lexicons of participants, such that participants who produced more of the same signs have a shorter distance from each other than participants with little lexical overlap. This analysis suggested that, overall, the lexicons of deaf participants are more similar to each other than for hearing participants. There was no evidence for different lexical choices according to age. Alongside applying novel methodology to analyse variation in a micro-community sign language, this study is the first to contribute evidence of sociolinguistic variation in the Kata Kolok lexicon.

Chapter Four charted variation across the form of signs. Here, I was interested in what variation is attested when taking only the participants whose lexicon appears more similar in Chapter Three, i.e., the deaf participants. Combining methods previously used for sign comparisons, I developed a new measure (variation index) that quantifies variation in sign variants with the same iconic motivation based on the number of variants and their phonetic distance from each other. I

used token frequency and signer frequency as a weight to identify how frequent and how widespread sign variants are across the sample. Taking all relevant signs into account, I demonstrated that different stimuli elicit different numbers of iconic motivations, and form variation may appear in different degrees at different levels. Crucially, token frequency strongly impacted how much variation may be attested, i.e., variants that are produced only few times have less chance to show variation than variants that are produced often. This suggests a cautious interpretation of previous findings based on limited datasets such as picture elicitation tasks that are commonly used in studies on sign language emergence. Weighting the variation index by token frequency and signer frequency, revealed, in many cases, specific variants that are particularly frequent or widespread across the sample (dominant variants). The comprehensive analysis of variation in this study uncovered limitations in existing methodologies and showed that not all signs differ to the same extent, including variation in highly uniform signs and minimal variation in highly variable signs. I argued that variation does not equal the absence of conventionalisation and that especially in micro-community sign languages, taking variation into account may be key to understanding patterns of language emergence.

Chapter Five examined the second research question by investigating how diverse sign phonologies are when taking a comparative approach in which methodological differences are minimised. I created a dataset of ~1,300 phonologically annotated Kata Kolok signs in the lexical database Global Signbank. Using the same infrastructure, I compared the inventory and regularities of Kata Kolok's phonology to Sign Language of the Netherlands (NGT), a representative example of a large sign language that is maximally different from Kata Kolok in many major typological domains (e.g., sociolinguistic setting, acquisition patterns). I carried out two sub-studies: first, I examined the inventory of the Kata Kolok dataset as compared to NGT, and tested whether existing claims about the phonology of Kata Kolok are corroborated with the current datasets. Second, I examined phonological regularities (minimal pairs, phonotactic constraints) in both languages to test their suitability in both datasets. Finally, I evaluated user judgements from Kata Kolok signers to refine the phoneme inventory of Kata Kolok. I found both crosslinguistic similarities in the inventory and common phonotactic regularities, suggesting that similar pressures have shaped both languages. Differences surface as language-specific preferences, possibly indicating that the same pressures may have different weight in different signing communities. I proposed that a combination of cognitive and environmental pressures (efficiency, iconicity, sociocultural and environmental factors alongside historic relatedness and language contact) shape sign phonologies, and possibly yield a higher degree of crosslinguistic similarity across sign languages than attested for spoken languages.

Chapter Six and **Chapter Seven** investigated how Kata Kolok phonology is acquired by children.

Chapter Six focused on how early productions of signs of four deaf children who acquire Kata Kolok from birth differ from their input. I annotated and analysed ~95 hours of longitudinal data for child productions that deviate from their adult targets. I applied the same fine-grained feature-level coding as used for adults in the lexical database Global Signbank (Chapter Four and Chapter Five)

and used an automatic comparison to categorise modification patterns such as substitutions, omissions, and additions. By comparing the results to the literature, crosslinguistically robst and language-specific patterns emerge. Children acquiring Kata Kolok produced most deviations in terms of handshape, corroborating crosslinguistic findings. The Kata Kolok data, however, suggests differences in the other features: location features deviated more often than in previous acquisition studies, and different movement features were often omitted or substituted at different rates. In addition, nonmanual features and contact features were used to substitute other features. Besides contributing primary data from child signers of a non-WEIRD sign language, and the step towards a fine-grained analysis that parallels the analysis of adult sign phonology as well as spoken (child) phonologies, this study also discovered that child productions are often complex signs in which not only one feature varies but in which deviations in multiple features co-occur in the same sign. This study paves the way for comprehensive crosslinguistic comparisons in the future exploring variation in child signing.

Chapter Seven explored the challenge of adapting experimental approaches to studying the early acquisition of phonology to (i) signing participants and (ii) a non-WEIRD context. In this study, I reported two novel methodologies: I used two established paradigms in spoken language phonology (familiarisation paradigm & habituation paradigm) and conducted two studies with child signers of Kata Kolok and hearing non-signing controls, i.e., hearing children who do not know any Kata Kolok. In the first study, I adapted a traditional habituation paradigm and complement the traditional looking time analysis with additional behavioural measures to investigate whether group-differences can be detected. I did not find the expected difference in looking time between children with and without Kata Kolok exposure, suggesting that signing children did not discriminate between two minimally different stimuli. An additional analysis of the children's behaviour, however, indicated group-differences in (i) attention to the task, (ii) use of eye gaze, and (iii) communicative behaviour during the task. In the second study, I piloted a new way of measuring attention; it relies on touch-input instead of looking time which promises modality-neutrality. Both studies revealed challenges that are shared by other researchers, some of which are related to adapting an experiment that was administered successfully with a WEIRD population to a non-WEIRD population, and others to adapting a task designed for hearing, speaking children to a signing population. Alongside methodological innovations of stimuli design, procedure and data analysis, Chapter Seven evaluates and discusses the complexity and effectiveness of dual adaptations in order to further advance and diversify the field.

Taken together, this dissertation has yielded four main results:

1) Kata Kolok's phonology and its acquisition largely mirror other sign languages which suggests shared mechanisms and pressures alongside similar affordances of the language modality.
2) At the same time, Kata Kolok's phonology and its acquisition by deaf children also show language-specific patterns; this may suggest that there are also pressures at play that are particular to the language ecology.
3) The study of variation in sign languages, and the measuring of it, is a prime

example of underlying theoretical and methodological biases that need re-visiting in order to accommodate such linguistic diversity.

4) Addressing and closing methodological disparities between studies of different sign languages is necessary to reduce biases in analyses in order to arrive at valid crosslinguistic comparisons.

In the remainder of this dissertation, I discuss the implications of these main findings in the broader context of the field and illuminate both methodological and theoretical considerations emerging from this dissertation. Specifically, I review the impact of fundamental biases in (sign) language research such as the focus on a small sample of the world's languages, the relation of social structure and linguistic structure, and the acquisition of languages within the social context in which they are used. Finally, I elucidate methodological contributions and challenges of this dissertation and lay out potential future avenues of research stemming from this research.

8.2 LANGUAGES ARE USED IN THEIR ENVIRONMENT

Languages persist through "the repeated cycle of learning and use" (K. Smith 2020: 692). This implies that languages are shaped by the social environment in which they are acquired and used, an idea that has been explored in detail in different sub-fields. For example, linguistic typologists argue that cultural evolution drives linguistic diversity (Thompson et al. 2016; Zeshan & Palfreyman 2017; K. Smith 2020), evolutionary linguists argue that social environment drives linguistic structure (Lupyan & Dale 2010; Dale & Lupyan 2012; Raviv 2020), and sociolinguists argue that social factors drive language use and how linguistic structures are varied and changed (Labov 1994; Trudgill 2011; Bayley et al. 2015). Indeed, Givón (1989: 289) argues that a "communicative system never rises in a sociocultural vacuum". In the following section, I will discuss the evidence that is available in the literature and that emerges from this dissertation as to the extent to which linguistic ecologies shape languages.

8.2.1 SOCIAL STRUCTURE SHAPES LINGUISTIC STRUCTURE

Social environments shape linguistic structure. Specifically, it has been suggested that languages used by small communities "tend to have smaller phonological inventories, longer words and greater morphological complexity than languages spoken in larger communities" (Nettle 2012: 1835).

Evidence in morphology appears robust: several studies find that community size is inversely correlated with morphological complexity. A large crosslinguistic study suggests that large languages have simpler morphologies than smaller languages (Lupyan & Dale 2010). Furthermore, experimental evidence from artificial languages suggests that languages created by small communities show less systematicity, which in turn, makes them less transparent and harder to acquire (Raviv, Meyer & Lev-Ari 2019). In short, both Lupyan and Dale (2010) and Raviv and colleagues (2019) provide evidence that languages of smaller communities are more complex in the sense that they show more irregularities, are less transparent, and are less predictable.

For phonology, however, evidence is inconclusive. In spoken phonology, the correlation between community size (population size) and size of the phoneme inventory is highly debated. While many researchers have found a positive correlation between these two variables (Hay & Bauer 2007; Atkinson 2011; Wichmann, Rama & Holman 2011; Fenk-Oczlon & Pilz 2021), others fail to replicate this correlation at all (Donohue & Nichols 2011; Moran, McCloy & Wright 2012), and Nettle (1998) even notes an inverse correlation. Moran and colleagues (2012), using the largest typological sample to date that is also balanced for genealogical relatedness, find no correlation between population size and size of the phoneme inventory. This aligns with researchers who argue that there is no sensible explanation as to why such a correlation should even exist (e.g., Bybee 2011). Indeed, some researchers show that correlations of this type are generally false positives, i.e., every "two variables (that) evolve through time (…) will almost always look highly correlated even if they are not related in any substantial sense" (Koplenig & Müller-Spitzer 2016: 2), unless the model appropriately corrects for the structure of temporal data. More nuanced predictions about phoneme inventories, such as Trudgill (2004; 2011), note that community size is just one factor among others that affects inventory size and the presence of the other major factors including language contact, network structure, and communally shared knowledge are oftentimes difficult to disentangle.

In sign phonology, researchers have often anecdotally mentioned that micro-community sign languages have smaller phoneme inventories than macro-community sign languages (Washabaugh 1986; Nyst 2007; Meir et al. 2010; Bauer 2014; de Vos & Pfau 2015). However, phoneme inventories have never been studied with a broad typological sample of unrelated sign languages but instead as case studies of individual languages. In fact, no previous studies have conducted a controlled comparison between a macro- and micro-community sign language like the one presented in Chapter Five. In this study, I found only partial support that the phoneme inventory of the macro-community sign language NGT is larger than that of the micro-community sign language Kata Kolok. Although fewer phonemes are attested in the Kata Kolok dataset than in the NGT dataset, in most features, the differences are small and may well be an artefact of the size difference of the datasets. Given this observation, it is possible that the stark differences in inventory size mentioned in the existing sign language literature may be caused by diverging methodological approaches. Having laid the infrastructure for such crosslinguistic comparisons in this dissertation, more comparative studies are needed to corroborate typological differences. In short, it is unclear (i) whether there are true size differences between the phoneme inventories of macro- and micro-community sign languages, and (ii) should they exist, whether these would be linked to community size or other sociolinguistic factors, such as population size, network structure, language contact, stability of the community, and communally shared knowledge, as suggested by Trudgill (2004). Sign languages provide an excellent case study for testing the relevance of these predictors since micro-community sign languages have fewer users than macro-communities and differ, for instance, in network structure, and contact situation (Zeshan & de Vos 2012).

Correlations between language structure and ecology are often connected to the composition of the language community, particularly the number of adult L2

language users. Lupyan and Dale (Lupyan & Dale 2010; Dale & Lupyan 2012) argue that languages with more users have simpler morphologies because it makes them easier to learn by the many L2 speakers in these communities. While some studies provide support for this hypothesis (e.g., Winter & Bentz 2013), recent typological and experimental studies suggest that community size but not the proportion of L2 speakers affects complex morphology. For example, across 2,000 languages, community size but not number of L2 speakers correlates with morphological complexity (Koplenig 2019). Furthermore, Raviv and colleagues find that while artificial languages emerging in larger communities are more systematic there is no added learnability benefit for L2 speakers (Raviv et al. 2019; Raviv, de Heer Kloots & Meyer 2021). Potential links between population size and size of phoneme inventory are, in the spoken language literature, explained with differences in input variability (Nettle 2012; Lev-Ari & Shao 2017), varying rates of language change influencing loss and persistence of phonological distinctions (Nettle 1998; Trudgill 2004), and the role of learning processes among adult and child learners (Nettle 2012). Regarding this last explanation, Nyst (2007: 209) proposes that the high number of adult L2 signers of Adamorobe Sign Language, a micro-community sign language of a Ghanaian village, may influence the small handshape inventory. Hearing L2 signers show a high degree of lax articulation which may lead to more variability. Relatedly, in the spoken language literature, a high number of adult learners is sometimes argued to promote simplification, i.e., loss of phonological contrasts (Trudgill 2004). In this dissertation, I did not analyse the production of hearing signers phonetically. However, I found that (i) hearing and deaf signers of Kata Kolok differ in their lexical choices (Chapter Three), and that (ii) the phoneme inventories of Kata Kolok and NGT differ only marginally in size (Chapter Five). It is possible that articulation differs between hearing and deaf signers, like their lexical preferences, but that, in spite of this, and unlike for Adamorobe Sign Language, this has not led to a small phoneme inventory in Kata Kolok. Therefore, follow up studies are needed to empirically test these connections.

What appears to remain undiscussed in the literature in both spoken and sign languages is the relation of the phoneme inventory and the size of the lexicon. A larger phoneme inventory naturally increases the possibility for different words (Nettle 2012). Similar to duality of patterning arising from an expanding signal space (de Boer, Sandler & Kirby 2012), it seems plausible that the phoneme inventory increases in tandem with – or in response to – the lexicon growing. Indeed, some evidence supports this idea: preliminary data shows that vocabulary expands alongside sound inventories over time (Moran & Verkerk 2018), that word length and syllable complexity are inversely correlated with phoneme inventory size, i.e., words are shorter and syllables simpler when phoneme inventories are larger (Nettle 2012; Fenk-Oczlon & Pilz 2021), and that rates of change differ in differently sized communities with languages with more users having higher rates of gaining and lower rates of losing words than languages with fewer users (Bromham et al. 2015; Greenhill et al. 2018). Taken together, this suggests that larger languages have larger phoneme inventories and larger vocabularies.

Based on 80 years of sign language research, lexicons of sign languages appear to be smaller than lexicons of spoken languages (Onno Crasborn, personal

communication). Further, researchers have suggested the lexicon of micro-community sign languages shows high cross-signer variation; the small community size, frequent interactions between community members, and affordances of the language modality weaken pressures for lexical convergence (Washabaugh, Woodward & DeSantis 1978; de Vos 2011; Meir et al. 2012). On a sublexical level, this may affect the differentiation of specific phonological contrasts, as suggested by Sandler and colleagues (2011). Given the evidence from spoken languages above, it seems possible that both the lexicon and the phoneme inventory continue to grow as the language ages. All sign languages are considered to be substantially younger than spoken languages and some micro-community sign languages are particularly young, which could explain smaller vocabularies and test hypotheses about the relationship between lexicon size, phoneme inventory, population size, etc.

To summarise, different social factors have been related to the size of phoneme inventories in spoken languages, primarily, community size, and tested across large typological samples. Sign languages have never been included in these comparisons nor do there exist controlled and representative typological studies assessing phoneme inventories systematically across sign languages; all references to size of phoneme inventories and lexicons in sign languages are anecdotal and/or based on case studies. Given the diversity sign languages bring to typology, it is worthwhile to include sign languages in crosslinguistic comparisons that target typological patterns and language evolution. The findings of this dissertation provide another data point for the debate among linguists, testing their claims against another type of community which is underrepresented in these cross-cultural studies.

8.2.1.1 CULTURAL, SOCIAL, AND ENVIRONMENTAL FACTORS AFFECT VARIATION

Instead of seeking an explanation exclusively in community size, let us consider how social and environmental factors affect variation in a broader sense. Trudgill (2004; 2011) suggests that phoneme inventories are influenced not only by community size but also by network structure, language contact, stability of the community, and communally shared knowledge.

While typological and sociolinguistic research has demonstrated the effect of social and environmental variables on variation for decades, variation in micro-community sign languages has been attributed to 'immaturity' (Brentari & Coppola 2013). Specifically, comparing micro-community sign languages to macro-community sign languages of the Global North, variation is often explained by the relative youth (Israel & Sandler 2009; Sandler et al. 2011) or the social structure (Meir et al. 2012) of the former. It seems clear that the framing of immaturity when studying micro-community sign languages is rooted in ideological biases (Braithwaite 2020). Ultimately, treating the presence of variation as immaturity in micro-community sign languages and as richness in macro-community sign languages does not do justice to representing linguistic diversity appropriately. Indeed, as remarked by Evans and Levinson (2009), the biased representation of linguistic diversity among sign languages reflects the situation for small languages more generally.

First, it has been critiqued that the established binary classifications and typologies of sign languages seriously obscure the widespread variation in socio-demographic profiles of micro-community sign languages (Nyst 2008; Green

2014; Hou 2018; Reed 2019; Hou & de Vos 2021). The ‘deaf village’ has become the prototypical example of a micro-community sign language. Sign languages like Kata Kolok used in Bengkala and Adamorobe Sign Language used in a Ghanaian village are thus often-cited prime examples whereas other situations fall in the ‘grey area’ of classifications (Nyst 2008). In fact there is tremendous diversity in micro-community sign languages, including (i) sign languages that emerged not in a village but on an island such as Providence Island Sign Language on Providencia (Washabaugh 1986) or Miyakubo Sign Language on Ehime-Oshima Island (Yano & Matsuoka 2018), (ii) sign languages that stretch over several villages such as San Juan Quiahije Chatino Sign Language that is used in two villages in Oaxaca, Mexico (Hou 2016), or Yucatec Mayan Sign Languages used in multiple villages in Yucatán, Mexcio (Safar 2020), (iii) or sign languages that emerge within a single extended family such Mardin Sign Language in Turkey (Dikyuva 2012) or Language des Signes de Bouakako in Côte d’Ivoire (Tano 2016). Categorisation is determined primarily by establishing the difference to large well-studied national sign languages in the Global North. This is problematic as it evokes the false impression that micro-community sign languages represent a homogenous type of languages and hereby downplays the linguistic diversity that exists across sign languages.

8.2.1.2 SMALL GROUPS ARE HOMOGENEOUS AND HETEROGENEOUS

Small communities are often assumed to represent an homogeneous community due to their small size (e.g., Wray & Grace 2007; Trudgill 2011). Some have even suggested a link between community size and social heterogeneity; the larger the community, the more heterogeneous it becomes due to an increase in subcultures (Wilson 1986). This may be one reason underlying the desire to differentiate between micro- and macro-community sign languages.

However, classifying small communities as homogeneous is reductive since it obscures the fact that small communities include subcultures. Take the example of small-scale multilingualism: villages in regions such as Casamance, Senegal, and Lower Fungom, Cameroon, for instance, are associated with one spoken language but villagers are multilingual in up to ten languages (Di Carlo 2016; Lüpke 2016). I argue that while there may be aspects of high (cultural) homogeneity among community members of micro-community sign languages, small groups should not be misconceived as lacking heterogeneity. This heterogeneity then may influence linguistic choices, such as in the case of sign multilingualism among young but not old Kata Kolok signers. The tendency to classify small groups as homogeneous is ideologically motivated (Lüpke 2016) and may be alleviated through applying the concept of communities of practice (Wenger 1998) which highlights that "different sets of members will share different and only partly overlapping practices that shape their linguistic interactions" (Lüpke 2016: 61). Thus, similar to large groups, small groups may display both homogeneity and heterogeneity.

Let us demonstrate how homo- and heterogeneity manifest in the Kata Kolok community with the example of three deaf siblings PI, PA, and PU. All three were born and raised by deaf parents (MR and TR biological parents; raised primarily by MR and DA). PI is the firstborn son. He married KE, another deaf villager of hearing parents,

and raised one deaf son SB. As male offspring, PI remains member of his birth clan Ceblong. Recently, PI and KE moved to the village outskirts since SB founded his own family in their original family compound with a deaf woman from another village. PI works primarily locally, in agriculture and in raising livestock. PA is the second born son. He first married MG, another deaf villager of hearing parents and with a deaf sibling, with whom he had one deaf son JU. He then married RES, the only deaf in a hearing family from outside the village, with whom he had a daughter. As male offspring, PA continued to live in their original family compound with both MG and RES, both children, JU's own family with his deaf wife, originally from another village, and his mother MR. PA sometimes works locally or on construction sites elsewhere. PU is the last-born daughter. PU was first married to a deaf man from a different village with whom she had two sons, and then then married SD, another deaf villager with multi-generational deafness. As female offspring, PU relocated to SD's family compound in the clan Tihing. With SD, she had three deaf daughters, two of whom have married, moved to their husbands' villages and had children of their own. PU stays at home and performs childcare, household and family duties because of a leg injury that prevents her from taking on outside work.

Clearly, the three siblings share crucial aspects of their sociodemographic profile (summarised in Figure 8-1): they are born in the same village, are deaf, have deaf parents, share (some of their) experiences when growing up, they are all Hindu and follow the religious traditions and ceremonies, all still live in the village, have married deaf partners and have deaf children who, in turn, have married deaf spouses and have become parents. Nevertheless, they also differ critically their sociodemographic profiles. Birth order and gender play a role: as the lastborn son, PA is expected to care for the elderly parents; being a woman, PU has transferred clans and family compounds upon marriage, while PA and PI remained in their birth clans; PU has daily religious obligations including preparing and attending ceremonies whereas PA and PI are responsible for preparing graves for the deceased. Moreover, other factors determine social grounds: PA lives in the original compound with his family in the centre of the village, PI lives in a more remote part of the village, and PU in her spouse's family compound. PU has married into a deaf family whereas PI and PA's spouses have hearing families. PU does not work while PI works primarily locally and PA periodically works elsewhere. Last but not least, individual personalities may affect how their preferred variants diffuse through the community: PU has a leadership character, PI is very hardworking, and PA likes to socialise.

Figure 8-1. Visualisation of overlapping characteristics of three Kata Kolok signers, the deaf siblings PI, PA, and PU. Filled bars indicate sharedness, empty bars no overlap, and graded bars partial overlap.

This example demonstrates that, similar to any other community, community members in Bengkala share some aspects of their lives and differ on others. In that sense, they can be seen as members of different and only partly overlapping communities of practice. Differences and similarities in life experience may function as social variables that may influence social interaction and linguistic structures, including lexical preferences such as suggested in Chapter Three.

8.2.1.3 VARIATION IS A MATTER OF SCALE AND INTERSECTIONALITY

Common social variables such as age, gender, ethnicity and region may exert different influences on language use given a community's ecological niche. Community size, for example, may influence the scale of social factors and impact their relation to each other; small communities have, for example, often also a tight-knit network structure (Wray & Grace 2007; Trudgill 2011). Instead of neglecting social factors, it is crucial to adapt both the measuring stick and the measuring unit to the given ecological niche.

Appropriate scaling of social factors is critical to approach variation in small communities. In Bengkala, examining variation by region (as is done in British Sign Language for example in Stamp et al. 2014; 2015; Stamp 2016) is not informative as almost all members are from the same geographical location. Nevertheless, it is possible that clan membership (as tested in Chapter Three), family compound or location in the South or North part of the village are more relevant correlates of the traditional variable. Indeed, the question of scale is not particular to micro-communities. In a recent study on school-based variation in South African Sign Language, van Niekerk and colleagues (2021) found that comparing two schools in the same city resulted in similar variation as comparing two schools in different regions. This demonstrates that it is crucial (i) to adapt the scale of social variables to reflect the sociolinguistic niche, and (ii) for the researcher, to understand thoroughly what represents an appropriate variable prior to designing sociolinguistic studies.

Social factors are intersectional and a small community size may enhance their interrelatedness. While a small community size theoretically enables all villagers to interact with each other, interaction patterns often are also shaped by social factors (Lüpke 2016). In Bengkala, I have observed through my fieldwork that factors influencing who interacts with whom and to what extent include for example gender, family compound, clan membership, occupation, and age. Specifically, women are generally less mobile and spend more time in the family compound while men have a larger sphere of movement (Marsaja 2008). Moreover, gender may interact with age and other social factors: elderly women often stay in the compound and share household and childcare tasks while elderly men often socialise close to but outside the family compound; elderly childless men or women may live by themselves or with their relatives but rely on the support of their relatives.

While we know that social factors often co-vary and intersect, this understanding has not yet been applied in the study of micro-community sign languages. In Chapter Three, we have made a first attempt to adjust the scale of social variables, however, their intersectionality remains a challenge for current analyses. Also in macro-communities, social factors are tightly interwoven. For

example, socioeconomic class and ethnicity are prominent correlates in language acquisition studies with children in the US (e.g., Rowe et al. 2016). While the tight-knit network structure in micro-communities may even increase the collinearity of factors, more sensitive tools are needed to match the appropriate scale of social variables. Extended lexical distance matrices as in Mudd and colleagues (2021), visualisation methods like Multi-Dimensional-Scaling (MDS) used in Chapter Three and hierarchical clustering used in Mudd and colleagues (in prep.) are more exploratory methods which could help better understand the relationships between these sociolinguistic factors. Overall, recalibrating the scale of social factors and exploring their intersectionality promises a more comprehensive and ecologically valid approach to studying language in use in micro-communities.

In sum, I argue for a more nuanced and dynamic understanding of communities and their social networks regardless of their size. Rather than classifying languages or communities as a whole, contextualising usage events of language may help to disentangle social and environmental factors that are at play and uncover the appropriate scale of social variables. This could be done e.g., by combining detailed ethnographic and experimental methods, similar to Reed's analysis of sign networks (Reed 2021). With these efforts, the study of variation within micro-community sign languages promises groundbreaking contributions to linguistic typology, language emergence and language variation and change.

8.3 LANGUAGES ARE ACQUIRED IN THEIR ENVIRONMENT

Turning to the second half of the repeated cycle of language use and language learning (K. Smith 2020), I now address language acquisition. Our state of knowledge about the acquisition of cross- and within-language variation remains heavily influenced by a tradition of focus on WEIRD spoken languages. A major contribution of this dissertation to the study of (sign) language development is the data on the acquisition of Kata Kolok using both longitudinal (Chapter Six) and experimental (Chapter Seven) data.

8.3.1 LANGUAGES ARE LEARNED IN ECOLOGICAL NICHES

Children are born and immediately start to acquire the language they are exposed to – regardless of which of the world's 7,000+ languages they set out to learn. Research has shown, however, that acquisition settings are shaped by large differences in interactional patterns between adults and children (Lieven 1994; Stoll 2016; Blom & Soderstrom 2020). Despite this, crosslinguistic and typological research on language acquisition is still scarce. Stoll (2015) estimates that maximally 2% of the world's languages have been included in acquisition research, with a heavy bias towards WEIRD languages from the Global North (see also Kidd et al. 2020). Ensuring the continuation of longitudinal Kata Kolok data collection in the future is therefore vital.

The study of how children exposed to Kata Kolok acquire sign phonology has revealed fundamental similarities yet important differences with other sign

languages. Similar to children who natively acquire macro-community sign languages from the Global North, early child productions in Kata Kolok are characterised by modifications, particularly in handshape (Chapter Six). This strongly suggests shared learning mechanisms, guided by maturing motoric and cognitive abilities as argued previously (e.g., Marentette & Mayberry 2000; Meier 2006; G. Morgan 2014). Overlap between sign phonologies, such as those discussed in Chapter Five, may help to explain great similarities between phonology acquisition of different sign languages. Furthermore, as noted in Chapter Six, the nature of the feature and the simultaneous use of features may affect the rate of modifications across languages. That is to say, the overall complexity of manual signs may increase the chance for errors, merely probabilistically.

Nevertheless, two findings from children acquiring Kata Kolok in Chapter Six may make it necessary to re-evaluate what governs early signing: (i) the rate of handshape modifications is high despite many target signs including basic handshapes, and (ii) handshape modifications persist over time (here, 1;3 to 3;1 years). If mastery of basic handshapes would come early in acquisition, as reported in the literature, it is unclear why our dataset nonetheless includes so many modifications in basic handshapes. Further, if basic handshapes were acquired early, one would have expected less handshape errors in the older children in our sample but no age-related differences were found. As ease of acquisition alone cannot sufficiently explain our findings, I hypothesise that sign complexity also influences child modifications. Children in our sample often modify multiple features within a sign; this occurred regardless of whether or not basic handshapes are used.

This may suggest that in combination with ease of acquisition of individual feature (values), child modifications may be shaped by the interplay between mastery of individual feature values simultaneously, i.e., coordinating different features at the same time (also suggested by de Vos 2012c). To test this hypothesis, more research is needed into the complexity of child modifications in Kata Kolok, and other sign languages. Specifically, more research needs to address questions such as whether modifications in certain features are correlated with modifications in other features and whether there are feature values that are commonly modified together.

This dissertation also provides support for the claim that differences in the acquisition setting may influence acquisition patterns (Stoll 2015). Children acquiring Kata Kolok are faced with lexical and form-based variation in the input that is linked to sociolinguistic factors such as hearing status (Chapter Six and Chapter Seven). In Chapter Six, I adopted a conservative approach in which target signs of children were identified directly from the visible input in the recording (i.e., the adult's production). However, this may not do justice to the real input variation that children actually experience. Taking the example of hearing status, children receive input from both hearing and deaf signers on a daily basis, and therefore are exposed the lexical differences between hearing and deaf adult signers and the form variation that is attested across different deaf signers.

This input variation in Kata Kolok may be quite different from other acquisition settings under study. Studies on the acquisition of sign phonology in macro-community sign languages investigate three groups: (i) deaf children of deaf parents (e.g., McIntire 1977; Bonvillian & Siedlecki 1996; Siedlecki & Bonvillian

1997; Conlin et al. 2000; Takkinen 2000; Cheek et al. 2001; Karnopp 2002; 2008; G. Morgan 2006; G. Morgan et al. 2007), (ii) deaf children of hearing parents (Von Tetzchner 1984), or (iii) hearing children of deaf parents (Siedlecki & Bonvillian 1993; 1997; Bonvillian & Siedlecki 1996; Marentette & Mayberry 2000). Data is commonly based on dyadic or triadic interactions of the focus child with their deaf parent and/or the deaf researcher, representing the default interactional format in the Global North. Thus, young children in the Global North receive input from their deaf parents, maybe some signing relatives and possibly other deaf adults from the extended family; crucially, however, input from many diverse signers is unlikely to be received on a daily basis. In Bengkala, the social organisation results in very different typical interaction settings. Family compounds and intergenerational households make linguistic input in Kata Kolok available from diverse signers at any time and starting from birth. One may argue that input for children learning Kata Kolok is more diverse in terms of number and profile of interlocutors than for deaf children in the Global North.

Naturally, the question arises how children deal with variation in the input. On the one hand, input from a larger range of speakers boosts the acquisition of phonological categories (Seidl et al. 2014). If it is true that children acquiring Kata Kolok are exposed to more interlocutors, they should be predicted to master phonological categories more rapidly than deaf children from the Global North. On the other hand, children mirror variation in their input and acquire the social contexts governing variation only gradually (Johnson & White 2020). This would predict that, even though children acquiring Kata Kolok may have more interlocutors, their language production will reflect the linguistic repertoire of their primary interlocutors. This is what we found for most cases in Chapter Six, suggesting that child modifications can be related to variants in their input. However, Chapter Six includes a handful of child modifications with multiple possible target variants. These may provide an excellent case study where a detailed social network analysis could help narrowing down which variants are available to the child in which social contexts.

At the same time, language experiences that are embedded in cultural practices impact early language skills and interactional behaviour (Schieffelin & Ochs 1984). As is similar for speaking children (Mayor & Plunkett 2011; Braginsky et al. 2019; Caselli, Pyers & Lieberman 2021; Frank et al. 2021), the early vocabulary of children acquiring Kata Kolok contains common objects, animals and social routines that are embedded in the cultural context. Take the early-appearing signs such as BATHE, PRAY, GHOST, FINISH, and NOT-YET (Chapter Six): daily routines revolve around religion (PRAY), the sign GHOST is used to scare children from something they should not do, and phrases such as EAT FINISH or BATHE FINISH are common conversation openers across the community and important signs in early infant-caregiver interactions. Moreover, Chapter Seven uncovered differences in visual attention that may be related to different language experiences; while deaf children maintain high visual attention throughout the task, the attention span of hearing bimodal bilingual children is shorter than that of deaf children, and hearing children without any sign exposure quickly get distracted.

These observations have implications for interpreting the existing literature on the acquisition of sign phonology. First, the study of how children acquire

non-WEIRD sign languages contributes important insights into our understanding of sign language acquisition. Second, by basing our understanding of acquisition and our design of experimental approaches on Western cultures where child-caregiver interactions are most common, we may develop tools that are less appropriate to those who are from cultures with more one-to-many or many-to-many interactions. Third, methods and analyses need to be fine-tuned to capture core aspects of the language ecology, especially since they are bound to shape the input of children. To conclude, I argue that expanding the typological range of languages studied is not only essential to corroborating (psycho-)linguistic theories but also to appropriately reflect diversity in language acquisition settings.

8.3.2 LANGUAGES EMERGE IN ECOLOGICAL NICHES

It is long established that vertical language transmission is crucial for language vitality (Aoki & Feldman 1991). A recent agent-based model however suggests that different types of language transmission act favourably on language persistence (Mudd, de Vos & de Boer 2020b). However, the role of child acquisition in language variation and in language emergence is yet to be systematically explored.

It has been claimed that children are crucial for the emergence of a language (R. Senghas, Senghas & Pyers 2005). In the case of Nicaraguan Sign Language, homesigners from different parts of the country were brought to a newly established deaf school in the capital Managua. As deaf students attended and passed through the school, a sign language emerged and underwent rapid changes. Researchers found that later cohorts show considerably more complex structures than their input, i.e., the previous cohorts (Pyers et al. 2010 for spatial language; Kocab, Senghas & Snedeker 2016 for temporal language). This is in line with experimental evidence from artificial languages where children are found to regularise variation in linguistic input (Hudson Kam & Newport 2005). Even though it is not the primary focus of this dissertation, our data provides no evidence that children acquiring Kata Kolok regularise their input. The vast majority of child modifications in Chapter Six could be related to variants used by adult signers in the immediately preceding discourse context. Rather than minimising variation, children appear to mirror the variation they experience in their input (Stöhr 2018 for a similar finding with bilingual children).

Interestingly, this fits with observations from the literature on language change. While it has been argued that children are the main drivers of language change (e.g., Hróarsdóttir 2004; Lightfoot 2010), research increasingly uncovers discontinuities between child errors and change patterns (e.g., Foulkes & Vihman 2015; Blythe & Croft 2021). While children can contribute to language change (Roberts 1999), language users become increasingly involved in language change only after childhood (Foulkes & Vihman 2015; Baxter & Croft 2016; Blythe & Croft 2021) and innovations by young adults, in particularly young women, are most likely to diffuse through the community (Bybee 2010; Schmid 2020). This dissertation adds evidence to the limited impact innovations of children have on the community-level. In Chapter Six, I identified some child-specific conventions, i.e., signs innovated by the child and used with relatives in child-directed signing. Crucially, these signs did not diffuse through the wider signing community, thus did not initiate change. These signs contrast with “familylects” (Sandler et al. 2011: 526), or family based lexical

variation, observed in signers of Al-Sayyid Bedouin Sign Language (Sandler et al. 2011), Yucatec Mayan Sign Language (Safar et al. 2018; Safar 2021), San Juan Quiahije Chatino Sign Language (Hou 2016), and Amami Island Sign Language (Osugi et al. 1999). Unlike family signs that occur primarily in child-directed signing, familylects represent family-wide usage of certain signs so that productions are more similar within than across families and may manifest in language change. Note that based on the data from Chapter Three (Mudd, Lutzenberger, de Vos, Fikkert, et al. 2020), there is no robust evidence for familylects in Kata Kolok.

One possible reason why I did not find that children are driving linguistic change like in Nicaraguan Sign Language may lie in the fundamental differences in their ecological niches and emergence scenarios. In Nicaragua, deaf children were brought together at school age and developed the language in a school-based community with peers of similar ages. Children's language acquisition begins at school around age 4-5 years (Senghas 2005) and primary interlocutors are other pupils with whom they spend the most time (Gagne, Senghas & Coppola 2019). In Bengkala, deaf children grow up in their families where they receive input from a large number of diverse interlocutors from birth. Their primary interlocutors will, at least at the start, be determined through social factors such as kinship, family compound, clan, and possibly later also school. Thus, there are two key differences between the Kata Kolok situation and the Nicaraguan Sign Language situation: (i) Kata Kolok child learners have an early onset of language input while Nicaraguan Sign Language child learners have a delayed onset, and (ii) Kata Kolok child learners have a variety of conversational partners who encompass a large range of sociolinguistic characteristics while Nicaraguan Sign Language learners have restricted set of school-age peers. The very different ecological niches in which each language exists presents children acquiring Nicaraguan Sign Language and children acquiring Kata Kolok with fundamentally different types of social learning.

Another reason to explain the difference between the findings in this dissertation and what has been suggested for Nicaraguan Sign Language may lie in time depth; the research on Nicaraguan Sign Language focuses on the first three cohorts while the child data from Kata Kolok used in this dissertation stem from generation five and generation six. It is thus possible that the impact of child learners on linguistic structure is the highest in the earliest stages of language emergence and wanes as the language gets older. Indeed, this is supported by data from Zinacantec Family Homesign (“Z”), a signing system that centres around three deaf people in Mexico where regularisation is higher among younger siblings as compared to older siblings (German 2019; 2021; Haviland 2020).

In sum, language input may vary greatly in different language ecologies. Differences in the social environment and ecological niche may create different pressures with respect to the rate, the extent and the kind of changes that linguistic structure may undergo. In different settings, the role of children with respect to language change may differ: while the production data of children acquiring Kata Kolok appears to reflect the diversity in their input, children acquiring Nicaraguan Sign Language may regularise their input, maybe due to the different composition of the signers who provide input and/or the age of the language.

8.4 METHODOLOGICAL CONTRIBUTIONS & CHALLENGES

This dissertation includes a large amount of innovative methodology, with each chapter adapting and combining methodological traditions of different fields. I have presented studies that include both adapting existing methods (Chapter Five, Chapter Three, Chapter Seven) and innovating new methods (Chapter Five, Chapter Four, Chapter Six, Chapter Seven). Methodological innovation, however, does not come without challenges. In the following, I discuss methodological challenges, shortcomings and potential solutions.

8.4.1 METHODOLOGICAL INNOVATION

The enormous structural and sociocultural diversity in the world's languages has been obscured by a bias towards studying WEIRD languages. Sign language linguistics is no different: after 60+ years of sign language research, non-WEIRD sign languages remain systematically understudied. This has led to creating methods, approaches and theories based on a small sample of the world's languages that share major aspects of their demographics. This dissertation is dedicated to studying Kata Kolok, a non-WEIRD sign language, and, as such, makes a substantial contribution to alleviating this systematic bias.

Throughout the dissertation, I have paid particular attention to adapting – and advancing – methodologies and analyses to the language community while, ensuring – and increasing –- comparability with other languages. When creating a Kata Kolok dataset (Chapter Five), I used Signbank, the same lexical database infrastructure that exists for many macro-community sign languages (BSL SignBank: Fenlon et al. 2014; Software: Cassidy et al. 2018; Asian Signbank: Centre for Sign Linguistics and Deaf Studies 2018; NGT dataset in Global Signbank: Crasborn et al. 2019; Libras Signbank: Rossi Stumpf et al. 2020; ASL Signbank: Hochgesang et al. 2021), and used the same phonological coding as in Global Signbank, a collection of diverse sign language lexicons (Crasborn et al. 2020). This approach allowed me to conduct the crosslinguistic comparison on equal grounds presented in Chapter Five. In addition, all datasets in Global Signbank, including the Kata Kolok dataset, are accessible, paving the way for crosslinguistic studies in the future. I also pioneered in collecting, annotating, and utilising substantial data from the Kata Kolok Child Signing Corpus (*Kata Kolok Child Signing Corpus* 2021), a longitudinal corpus of hearing and deaf children acquiring Kata Kolok. Previous studies on the acquisition of sign phonology generally rely on less naturalistic data or parental report. In addition to providing the first ever study of the acquisition of a non-WEIRD sign phonology, the data made available through this project allows for future comparisons with corpora documenting the acquisition of macro-community sign languages such as the IPROSLA corpus for children acquiring NGT (van den Bogaerde et al. 2011). This allows for testing of the robustness of our approaches and theories about how children acquire sign phonology of a non-WEIRD sign language (Chapter Six). Finally, in Chapter Seven, I tested how methods developed for WEIRD spoken languages can be used successfully for testing phonological discrimination in a non-WEIRD sign language; hence a dual adaptation of methods to (i) the visual spatial modality and (ii) a non-WEIRD context. This study presents

the first step of conducting experiments with child participants acquiring a non-WEIRD sign language.

The studies in this dissertation also apply new analytical approaches to the study of variation and acquisition in micro-community sign languages. Lexical distances (Chapter Three) and the variation index (Chapter Four) increase the ecological validity of exploring within-language variation; the lexical distance matrix circumvents having to decide on one standard form and instead allows investigating how similar the lexicon of different participants is to each other, and the variation index takes into account different aspects of the sign as well as token frequency and signer frequency to show how widespread variants are across the sample. The analysis of features in child modifications (Chapter Six) capitalises on state-of-the-art understandings of sign phonology and, is the first study to ever investigate how children acquire the phonology of a non-Western micro-community sign language (Chapter Six). Using the same method across data from adults and children allows us to directly compare both systems. Complementing the traditional analysis of looking time with behavioural measures in Chapter Seven exemplifies the need for mixed-methods approaches. Finally, the experimental explorations of phonological perception in adults and children (Chapter Five and Chapter Seven) adds to the range of methods and analyses that may be adapted to small and heterogeneous samples to corroborate findings from production or spontaneous data with a mixed-methods approach.

The work in this dissertation highlights the need for broadening methodological range and the importance of adapting methods to ecologies, including flexibility in recruiting alternative approaches to experimental design, data collection and data analysis. Pioneering in these different methods with Kata Kolok can represent a feedback loop; knowing about how new or existing methods work with a micro-community sign language can also license researchers working on macro-community sign languages or spoken languages to take new insights into consideration in their experimental designs and analyses.

8.4.2 SAMPLING

Decades of sign language research have demonstrated that the pool of possible participants for linguistic research in most (if not all) signing communities is both small and heterogeneous (Morford et al. 2015). In macro-community sign languages, this is reflected primarily by large differences in age of acquisition (Costello et al. 2008; Morford et al. 2015). While the age of acquisition may be more stable in certain micro-communities, e.g., for many children in Bengkala, heterogeneity is further accentuated in micro-community sign languages; communities are even smaller and sampling is often affected by practical limitations (Nyst 2008; 2015; Omardeen 2021). In the context of this dissertation, the question of who and how to sample has become central.

Traditionally, sign language research has oversampled native signers, i.e., deaf people with deaf parents who acquire a sign language from birth (Fenlon & Wilkinson 2015; Morford et al. 2015; de Vos et al. in press). This is at odds with the fact that most deaf people (90-95%) are born to hearing parents (Mitchell & Karchmer 2004). In some signing communities like in the Basque country of Spain

(Costello et al. 2008) or in Mali (Nyst 2008), the concept of native signer even is misleading since all deaf people are ‘late learners’. Corpora of macro-community sign languages often exclude signers who are hearing or not profoundly deaf and focus on diversity in region and age (Schembri & Cormier submitted; but see Greene 2013), e.g., the Corpus NGT includes deaf signers with early signing exposure from six different regions across the Netherlands (Crasborn & Zwitserlood 2008), and the DGS Corpus sampled signers from 12 different regions across Germany (Prillwitz et al. 2008). Corpora of micro-community sign languages often also include hearing members of the signing community (e.g., de Vos 2016; Hou 2018; Omardeen 2021; Safar 2021).

The small size of micro-community sign languages may evoke the impression of a scenario in which we can sample exhaustively. In Chapter Seven, I demonstrate that exhaustive sampling is possible only at a specific point in time and under certain conditions; I included all young children who learn Kata Kolok as a first language. As in any other setting, it remains extremely difficult to estimate the size and the scope of the signing community (Nonaka 2009). Furthermore, delineating a signing community is often highly political (Johnston 2004; Mckee 2017; Palfreyman & Schembri in press); this is also the case in micro-community sign languages.

In the context of this dissertation, I decided to focus more on deaf than on hearing signers. Most of the data in this dissertation stems from deaf signers (Chapter Four through Chapter Six). Nevertheless, hearing signers are included both in Chapter Three to examine sociolinguistic variation, and in Chapter Seven, where children are sampled on the basis of Kata Kolok exposure rather than hearing status. Furthermore, selected hearing signers participated in some of the other tasks, e.g., HKK and HWI are teachers and were therefore included while eliciting school-related vocabulary.

Focusing on deaf signers was primarily a practical decision. One reason for this is that deaf signers vary in the form of signs but variation is greater among hearing signers (Chapter Three). Additionally, Nyst (2007) observes lax articulation as a hallmark of hearing signers of Adamorobe Sign Language. Thus, focusing on deaf signers reduces some of the potential variables influencing variation. Second, acquisition in a micro-community sign language is a fleeting opportunity and thus, warrants, and even requires, immediate action. Two deaf members of the community were toddlers at the time of starting this PhD project which allowed me to document and interact with them in their language acquisition setting. Nonetheless, these decisions have implications for the generalisations that can be drawn from the studies in this dissertation. Hearing signers constitute the numeric majority of the signing community in Bengkala (Marsaja 2008; de Vos 2012b), which makes them part of a representative sample that seeks to capture a cross-section of the community. Unlike deaf villagers, however, their primary mode of communication is not Kata Kolok, a fact that may explain differences found across deaf and hearing participants for example in their lexical choices (Chapter Three). For example, Chapter Three elucidates examples where hearing signers tend to choose more general and deaf signers more specific signs. Based on my knowledge of the language (and the community) as I acquired it, I believe that this dissertation has cross-sampled the community sufficiently for a balanced and representative account of Kata Kolok.

Nevertheless, more research is needed to explore how different sociolinguistic profiles shape Kata Kolok variation.

In Chapter Three, I have argued that lexical differences in deaf and hearing participants may be caused by specificity; in some cases, deaf signers provided more specific signs than hearing signers whose signs were more general. Chapter Four shows that among deaf participants, different concepts vary in how much variation is attested and how widespread variants are; I suggest to consider the distribution of sign variants alongside sociolinguistic variables, for example by implementing the variation index developed in Chapter Four into the lexical distance measure used in Chapter Three. This would allow us to separate out forms that differ from a dominant shared convention and forms that are one of many existing variants for a concept for which there is no dominant convention. For example, when a signer produces a variant different than the dominant variant DOG-1A for *dog*, this may be considered a greater deviation from the shared convention than when a signer produces one of the many variants elicited to refer to *dragonfruit*, for which there is no dominant variant.

The profiles of individual signers may also affect the observed variation in a language (Chapter Three, Chapter Four). Statistically, increasing the number of participants performing the same task will eventually result in a decrease of observed variation; it is more likely that two signers each produce a different sign for a given concept than 16 signers each producing a different sign. However, in cases like the present where samples generally remain too small to reach this effect, it may be possible that increasing the sample size also increases variation through including a broad sample of synonyms that exists across the population, or due to low conventionalisation. The resulting difficulty is that signers may know and use several variants but only produce one or they may use one variant in spontaneous signing but produce many in an elicitation task. One solution for this could be to sample the same signers at every testing occasion, another one to repeat the same task multiple times, or yet another one to combine production with perception data, as operationalised in this dissertation (Chapter Five).

In sum, studies on macro- and micro-community sign languages face similar challenges since smaller communities include fewer people while at the same time encompassing social diversity. Taking this observation to our advantage, we may develop new methods for micro-communities and then adapt them to macro-communities. Having carefully examined a complex microcosm allows to then scale methods up to a macro-community which is just a bigger microcosm with similar types of variation, just grouped by different variables.

8.4.3 FEATURE CODING

Soon after the groundbreaking discovery of sign phonology in the 60s (Stokoe 1960), distinctive feature analysis has been advanced and widely accepted to understand sign phonology. Similar to how it has been applied in spoken phonology, feature coding allows to describe the abstract representation of signs as precisely as possible. Nevertheless, it is used consistently only by phonologists. Psycholinguists, lexicographers and sociolinguists whose main interest is to distinguish two forms from each other to allow for pairwise comparisons, often instead use the coarser

parameter coding or continuously switch between a fine-level and a coarse-level description. For example, Fenlon and colleagues (2015) determine the difference between lexical and phonological variants in terms of the number of deviating parameters; minimal pairs are typically categorised according to parameters (H. Morgan 2017). The practical reasons for these methodological choices are compelling; parameter coding is less time-consuming, and differences may be more visually salient than on the feature level. However, this comes at the cost of aggravating the gap between the study of different sign languages and makes appropriate crosslinguistic comparisons impossible. Most studies on the acquisition of phonology have not used feature coding (except Cheek et al. 2001; Karnopp 2002; Wong 2008; Pan & Tang 2017) despite its use to analyse adult phonology, and thus, the fields remain somewhat disassociated.

Applying feature coding to all studies (except Chapter Three that focuses on the lexicon) is a major methodological advancement of this dissertation that allows for appropriate within- and across-language comparisons. First, I have used feature coding for annotating Kata Kolok signs in the dataset in Global Signbank (Chapter Five), facilitating a comprehensive study of Kata Kolok phonology and crosslinguistic comparisons to data coded in the same framework. The comparison with NGT shows that crosslinguistic differences are limited when methodological differences are minimised. Second, I have used the same feature coding to quantify the form variation that exists across the community (Chapter Four). Taking into account the full range of features and feature values allows for a comprehensive variation measure that can be applied to different languages and data types, lending itself to crosslinguistic comparisons (see Börstell et al. 2020 for an example). Third, the number of studies analysing child signing with a feature coding is slowly growing (Chapter Six). This method does not only allow for robust comparisons to adult signing, it also reveals that, with a more fine-grained approach, the typical order of acquisition of sign phonology may be questioned and that modifications occur most frequently in clusters. Last, I have used the feature coding to manipulate individual features of experimental stimuli to test whether this elicits discrimination among signing children and acceptability judgments from signing adults (Chapter Seven, Chapter Five). This allows us not only to directly feed in variants from the child's input but also to control and test isolated contrasts using a similar method to what is commonly used with hearing children acquiring a spoken language. Taken together, all studies invite crosslinguistic comparisons with future data from other sign languages, for example, those in Global Signbank (incl. BISINDO, Langue des signes de Belgique francophone (French Belgian Sign Language), Norsk teiknspråk (Norwegian Sign Language), and Zaban Eshareh Irani (Iranian Sign Language)).

Despite the benefits of feature coding, applying it throughout all studies has not come without challenges. I decided to rely on existing infrastructure to implement the Kata Kolok dataset into Global Signbank. That is to say, feature contrasts were derived from the phonology of NGT and adding and deleting feature values was negotiated with Onno Crasborn, the curator of Global Signbank, on a case-to-case basis. The advantage of this is that we maintain maximal comparability and ensure minimal methodological deviations. One challenge is the potential of overgeneralising phonological contrasts and thus, inflating typological differences, such as the

contrastiveness of the handshapes *B* and *5*, the role of thumb extension or location contrasts such as *cheekbone* and *cheek*. One way of dealing with this is to scale-up perception experiments such as reported in Chapter Five. Targeted perception data can help to disentangle whether specific contrasts, such as *spreading* that differentiates the handshapes *B* and *5*, are indeed contrastive and thus gradually refine the phoneme inventory of Kata Kolok. While not ideal, starting out with the NGT infrastructure was a necessary practical decision; it is a nearly impossible task to create a sophisticated database suitable for crosslinguistic comparisons from scratch, given methodological challenges related to capturing variation, sampling as well as ideological biases in the study of sign phonology. Importantly, however, a database remains a living organism that needs lifelong extension and refinement.

8.5 FUTURE DIRECTIONS

In addition to its contributions to the study of variation, both across- and within-language, this dissertation opens up many different avenues for future research.

8.5.1 ACQUISITION

Our focus on variation across adults and acquisition has brought up major questions about the input that children receive. There are two relevant domains: who signs (what) to children, and how do they modify their signs?

First, who signs (what) to children? Chapter Four and Chapter Five provide a comprehensive study of variation in Kata Kolok phonology which allows us to extrapolate the language input that is available to children acquiring Kata Kolok. We sampled a substantial part of the deaf population and a small proportion of hearing signers in the immediate networks of deaf signers on a range of topics of daily life. This sampling is quite extensive in terms of showing the variation that exists within the community and therefore what the children are in theory exposed to.

However, we lack a detailed study of what children acquiring Kata Kolok actually are exposed to. Conversations with multiple interlocutors with varying sociolinguistic profiles are common in Bengkala but typical conversational settings remain, at this point, unexplored and much is still to be learned with respect to frequency, number and profiles of (potential) interlocutors. Children likely receive input only from a subset of the community and not all potential interlocutors spend equal amounts of time with or around the child. In addition, it is likely that input stems from many hearing second language users with varying degrees of proficiency which has been shown to impact language learning in other contexts (Lu et al. 2016 for signing children; Place & Hoff 2016; Unsworth et al. 2019; Hoff et al. 2020 for bilingual children). Therefore, we do not know what exactly the linguistic input for children entails. The longitudinal data used in this dissertation (Chapter Six) comprise informal, naturalistic language use between children and adult signers, providing an excellent starting point for both qualitative and quantitative studies examining the characteristics of the linguistic input for children acquiring Kata Kolok. Such a study would be particularly important since existing studies on sign language acquisition have not yet investigated language acquisition in cultures where multiparty interactions are the default. Predominately multiparty settings,

however, may shape not only the input (Lieven & Stoll 2013) but also the acquisition of (pre-)linguistic behaviour, such as coordinating visual attention, turn-taking and pattern extraction from variable input.

Second, how do signers modify signs for children? Like child-directed speech, child-directed signing is often anecdotally reported in studies on macro-community sign languages. While little is known about the impact of factors such as culture and child-rearing practices on child-directed signing, these factors have been shown to greatly influence the quantity and role of child-directed speech in the acquisition of diverse spoken languages (Cristia et al. 2019; Casillas et al. 2020b; 2020a; Bunce et al. 2020). Few studies are entirely dedicated to this register and, mostly focused on American Sign Language (Holzrichter & Meier 2000; Pizer, Meier, et al. 2011; Pizer, Shaw & Meier 2007; but see Sümer, Schoon & Özyürek 2019). Nonaka's (2004) work on Ban Khor Sign Language, used in Thailand, is the only study of child-directed signing in a micro-community sign language. Although there has been anecdotal mention of child-directed signing as a special register of Kata Kolok (Marsaja 2008; de Vos 2012b; 2012c), there exists no dedicated study of child-directed signing in this language. Thus, a future study can bridge these two areas of research by investigating (i) the characteristics of child-directed signing in Kata Kolok, and (ii) the frequency and continuity of child-directed signing over time. The Kata Kolok Child Signing Corpus is an excellent resource to explore these questions as it contains longitudinal data of caregiver-child interactions. The data including the transcription files are continuously being archived at The Language

Archive as a restricted collection for which access can be requested for research purposes.[41]

8.5.2 SOCIOLINGUISTIC VARIATION

More research focused on exploring the social networks of Kata Kolok signers in order to better understand (sociolinguistic) variation is needed. This dissertation and follow-up work has provided initial insights, finding effects of deafness (Chapter Three) and gender (Mudd et al. 2021) on lexical choices. Nevertheless, our analysis takes a different approach than standard sociolinguistic studies given the difficulty of determining a standard form in Kata Kolok. As discussed in Chapter Five, standard forms, or citation forms, build the foundation for sociolinguistic research since all variation is analysed as a deviation from the citation form. However, the concept of standard forms is tightly linked to institutional and political contexts and often represents an (arbitrary) decision during language standardisation (most often dictionary creation). Since micro-community signers exist in very different contexts with little pressure for standardisation (from government or education for example), the macro-community concept of citation forms may not be appropriate, or at least may require re-imagining.

Moreover, sociolinguistic research suggests that social variables tend to co-vary and are often more complex than the super-categories we studied in Chapter Three (see e.g., Bayley et al. 2000). In our case, typical social variables such

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[41] The collection Kata Kolok Child Signing Corpus can be found on The Language Archive under https://hdl.handle.net/1839/24a10552-8aa5-4d03-9e32-6e572b9b484f.

as region have to be translated to match the scale of the community. Nevertheless, the current methods need to be expanded in order to better capture the intricacies of Bengkala's social networks. One approach could be to use anthropological and ethnographic methods such as focal following, i.e., following a small number of participants on a regular basis, or self-recordings of participants using portable devices (methods that have been applied in sign contexts, e.g., Hou 2016). Both methods would provide us with detailed insights about the frequency, identity and quantity of interaction of individual community members with others that can build the basis of sketching out interaction patterns. Note, however, that this can be done only with selected individuals due to limitations in the researcher's time and resources or the participants profile, e.g., age or openness to the method. Generalisations should therefore be drawn carefully given the heterogeneous experiences of community members (see Section 8.2.1.2).

8.5.3 PERCEPTION & JUDGMENTS

Using production data, the studies in this dissertation have demonstrated that variation surfaces at all levels. However, at the same time our results show that generalisations made from production data about the phonemic status of certain features are critically limited. Collecting perception data, as shown in Chapter Five, provides an excellent opportunity to complement and refine the patterns obtained from production data. Here, I discuss two different tasks that I consider feasible given my familiarity with the community members: (i) a large-scale acceptability judgment modelled on the small-scale study presented in Chapter Five (and Chapter Seven) and (ii) a sign repetition task.

First, Chapter Five showed that acceptability judgments of Kata Kolok signs and carefully manipulated nonsense signs are a successful tool to both finetune and explore phonological distinctions (Chapter Five) and to judge the suitability of stimuli for children (Chapter Seven). Due to the global COVID-19 pandemic, I was not able to conduct a planned extension of this task testing multiple contrasts. Thus, future research could scale up this small-scale study to systematically test specific contrasts on multiple examples across more participants. For example, we could test the contrastiveness of *spreading* in the handshapes *B* and *5* by showing signers various Kata Kolok target signs with these handshapes alongside nonsense derived signs in which the *spreading* feature is manipulated (e.g., *C_spread, B_bent, B* with thumb extension, etc.).

Second, a sign repetition or recognition task could be used to tackle how phonological contrasts are perceived and re-produced. Participants would be asked to either identify or repeat the stimulus and the productions of participants are analysed in terms of whether or not their production matched the stimulus (for an example see Mann et al. 2010). Nevertheless, it is important to keep in mind that repetition tasks may not work the same in Bengkala as in macro-communities. Our study in Chapter Three included an unsuccessful pilot of a sentence repetition task with hearing and deaf signers. Instead of reproducing the stimulus, signers responded to or commented to the stimulus either as if they were in a conversation or directly addressed me. In contrast, the acceptability judgment task contained no explicit instructions for repetition yet in practice elicited re-production of signs by adult and child participants (Chapter Five; Chapter Seven). This task included an

animated character, and was conducted in an informal setting under the framing that we are trying to teach the animated character how to sign to use it with the children and would like their help to check if the monkey knows the sign well already or still needs to practice. Modelling a similar set-up may be helpful for future experiments.

Both tasks could be done to refine the phoneme inventory, to further examine minimal pairs, or even in a completely different domain that is not directly related to phonology, e.g., how actively known variants are (related to Chapter Four) or whether variants are indeed perceptive synonyms (as suggested in Chapter Three). Moreover, similar tasks have been used with children (Mann et al. 2010) and adults (Stamp 2016) which promises fruitful outcomes through linking language use and language acquisition like in this dissertation.

8.6 GENERAL CONCLUSION

In this dissertation, I have provided the first in-depth study of Kata Kolok phonology, taking a variationist approach to data from adult signers and adding the first insights into how Kata Kolok is acquired. To do so, I have pioneered in adapting existing and developing new methods, capitalising on mixed-methods approaches, and original ways of data analysis, maximising insights into limited data. To conclude this dissertation, I evaluate the answers to the questions raised at the beginning of this dissertation based on findings of the five studies in this dissertation and end with what I consider necessary changes for the field to flourish.

What characterises variation in Kata Kolok phonology?

Similar to macro-community sign languages, Kata Kolok shows variation in both the lexicon and the form of signs. While the social determinants, and their intersections, that underlie variation require further analysis, at least hearing status as possible predictor of lexical variation. Crucially, Chapter Three and Chapter Four show that it is essential to move forward with methods that fit the language ecology and thus provide adequate ecological validity. The lexical distance measure circumvents the need for a standard variant, which may not be a suitable concept for sign languages like Kata Kolok (discussed in Chapter Three and Chapter Five); the variation index represents a more comprehensive and highly adaptable variation measure that allows us to identify dominant variants. In short, when variation in Kata Kolok is not treated as a marker of immaturity, lexical and phonological variation appears to relate to social variables, similar to other well-studied sign languages.

How does Kata Kolok phonology fit into a broader typological landscape?

Kata Kolok phonology shows many similarities and differences with the phonologies of other sign languages when analysed under the same methodological conditions. There are critical similarities in the phoneme inventory, the applicability of common phonotactic regularities and in social variables shaping variation and in the acquisition of Kata Kolok phonology. Taken together, these observations suggest shared pressures and/or cultural evolution trajectories. At the same time, Kata Kolok shows language-specific patterns, such as preferences for certain feature values and the role of nonmanuals in the lexicon. These differences underscore the need to re-evaluate existing theories

about sign language phonology, particularly highlighting the contributions of diverse languages in testing and corroborating our ideas about language.

How is the phonological system acquired by children?

Children acquiring Kata Kolok from birth show similar modification patterns as deaf children acquiring sign language from birth in the Global North. In addition to shared motor and cognitive development, similarities in the acquisition of sign phonology may be exacerbated by the great overlap between the phonologies of different sign languages, as well as the impact of iconicity on the vocabulary. Language-specific aspects of phonology and the language acquisition setting also influence how children learn phonology. They may therefore provide an excellent case study for closely examining crosslinguistic differences. However, methodological adaptation and innovation is needed to reach appropriate crosslinguistic comparisons. I have shown that it is important to take into account the characteristics of the community and adapt methods to the community and the language ecology rather than trying to squeeze the language ecology into the existing infrastructure that was designed for WEIRD languages. In sum, methodological innovation is needed to understand how sign phonologies are acquired in different acquisition settings for example through further developing mixed-methods approaches that allow to corroborate findings across small samples.

This dissertation has demonstrated that examining a diversity of languages helps testing and improving linguistic theory. To accommodate and integrate differing language ecologies, existing methodologies need to be adapted carefully and new methodologies need to be developed: only in doing so can ecologically valid comparisons be made. With this dissertation, I have made the first step in creating the necessary infrastructure for robust and representative crosslinguistic studies of sign language phonology. I hope that future work will follow this example of methodological innovation rather than limiting themselves to studying few aspects of understudied languages with methodologies that have proven successful with macro-community sign languages from the Global North. As recently called for by Ghai (2021) in the context of the dichotomy of WEIRD versus non-WEIRD communities, the time is ripe for acknowledging and addressing diversity and gradience on all levels of research. It is each researcher's obligation to reflect on and deconstruct their own ideologies about sign languages, and in particular micro-community sign languages, to break the harmful cycle of comparing 'languageness' that has been established and ingrained in the field. More than that, developing methods that are optimally suited for micro-community sign languages and then adapting them to macro-community sign languages would represent a huge step towards making reasonable crosslinguistic comparisons. The development of methods that are optimally suited would greatly benefit from working with deaf community members, train linguists from the same communities, and encourage true intellectual and academic partnership. The future of sign language linguistics lies in researchers actively reflecting on and deconstructing their own ideologies and working towards innovation that optimally fits the language ecology.

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DATA MANAGEMENT PLAN (DMP)

1 GENERAL INFORMATION

1.1 TITLE

Emergence of phonology across six generations

1.2 SUMMARY OF RESEARCH PROPOSAL

It has been one of the great linguistic discoveries of the past century that sign languages parallel spoken languages on all relevant levels of linguistic analysis, including sublexical structure at the phonological level. However, while spoken languages predate several millennia, sign languages generally go back only a few centuries and, in a handful of cases, a few generations. By comparing snapshots of the later type of emergent signing variety across generations, linguists study the emergence of human languages and the evolutionary mechanisms that shape them. Al-Sayyid Bedouin Sign Language (ABSL; Israel) is an emergent signing variety which has been used as a fully functional language by three generations of signers. Nevertheless, ABSL exhibits only incipient levels of phonology, i.e., the formation of meaning from combinations of abstract formal parameters such as handshape, place of articulation and movement. This is surprising especially since phonology had been attested in older sign languages such as American Sign Language. What are the social and linguistic pressures for a sign language to develop arbitrary form-meaning mappings? To address this question we will document the phonology of Kata Kolok, an emergent signing variety of Bali for which data exists from the third through sixth generation of signers. These findings will allow us to construct computer models that determine the influence of social and linguistic factors in the emergence of phonology.

1.3 UNIVERSITY, FACULTY AND INSTITUTE, INCLUDING REFERENCE TO ITS RDM POLICY

Radboud University, Faculty of Arts, Centre for Language Studies (CLS)

Link to RDM policy: https://www.radboudnet.nl/letteren/onderzoek/regelingen-werkprocessen/research-data-management/

1.4 INVOLVED RESEARCHER(S) AND/OR RELEVANT PARTIES, AND THEIR ROLE IN DATA MANAGEMENT

Responsible for writing and adjusting the DMP:
Hannah Lutzenberger, Paula Fikkert, Connie de Vos, Onno Crasborn

Responsible for data collection and analysing: Hannah Lutzenberger

Responsible for data storage during research: Hannah Lutzenberger

Responsible for long term data archiving and sharing after the project, including transfer of data management roles
Hannah Lutzenberger (The Language Archive)
Onno Crasborn (Global Signbank)

Hannah Lutzenberger will retain access to the data in the Kata Kolok Corpus and the Kata Kolok Child Signing Corpus in The Language Archive after her PhD. Connie de Vos also has full access to both corpora.In addition to Onno Crasborn (administrator), Hannah Lutzenberger and Connie de Vos also have managing and editing rights for the Kata Kolok dataset

1.5 WHO IS THE RIGHTS HOLDER OF THE DATA THAT YOU WILL COLLECT AND/OR PROCESS DURING THE PROJECT?

Radboud University is the rights holder of my research data.

1.6 ARE ANY AGREEMENTS ON DATA MANAGEMENT (SUCH AS CONSORTIUM AGREEMENTS, DATA USE AGREEMENTS AND NON-DISCLOSURE AGREEMENTS) REQUIRED FOR YOUR PROJECT?

No, during my research no such agreements are necessary.

1.7 PROJECT NUMBER, AND IF APPLICABLE, FUNDER AND FUNDER ID

23000431 (FWO-NWO grant (NWO 326-70-002) "The emergence of phonology within six generations" awarded to Bart de Boer, Paula Fikkert, and Connie de Vos)

1.8 START AND END DATE OF THE PROJECT

01.09.2017 – 31.09.2021

1.9 DID YOU CONSULT A LOCAL EXPERT (E.G., YOUR INSTITUTE'S DATA STEWARD OR THE UNIVERSITY LIBRARY'S RDM SUPPORT TEAM) WHEN WRITING THIS DMP? IF YES, PROVIDE A NAME, POSITION AND EMAIL ADDRESS.

Yes, Henk van den Heuvel, Research Data Manager, henk.vandenheuvel@ru.nl

2 DATA COLLECTION

2.1 ARE YOU GOING TO COLLECT YOUR OWN DATA DURING THIS RESEARCH PROJECT?

Yes, I will collect my own data. During this research project I will collect the following data:

- spontaneous data from child and adult signers
- elicited data from child and adult signers

2.2 WILL YOU USE EXISTING DATA DURING THIS RESEARCH PROJECT?

Yes, I will make use of existing data. During my research I will make use of the following existing data:

- use of data in the Kata Kolok Corpus
- use of data in the Kata Kolok Child Signing Corpus

2.3 GIVE AN ESTIMATE OF THE TOTAL EXPECTED DATA SIZE OF YOUR RESEARCH.

The size of my research data is > 200 GB.

3 PERSONAL DATA

3.1 WILL YOU PROCESS PERSONAL DATA? IF YES, HOW WILL YOU ENSURE COMPLIANCE WITH LEGISLATION ON PRIVACY?

Yes, I process personal data during my research.I will collect or process the following personal data:

- video data
- social variables such as age, gender, birth date, family circumstances, hearing status

These data do not contain special categories of personal data.

It is necessary to collect or process these personal data to achieve the goals of my project because:

- video data is required for work with sign languages
- work with developmental data requires precise calculations of age
- work with intergenerational data requires age estimates
- in a small community it is necessary to collect personal data to understand, acknowledge and integrate it in the analyses (aiming to understand variation in the social network)

I will ensure that I will not collect more personal data than necessary for achieving the goals of my research project as follows:

- acquisition of Kata Kolok
- variation in phonology
- social networks
- social variables influencing phonology and the lexicon

Note, however, that work with a small community like in this case necessarily is based on non-anonymity since I have developed personal bonds with individuals, research is based

3.2 IN ORDER TO PROTECT THE PRIVACY OF YOUR PARTICIPANTS, WILL YOU ANONYMISE OR PSEUDONYMISE THE DATA?

I will protect the privacy of my participants by anonymising or pseudonymising (some of) the personal data.
Informed consent is conducted with participants individually; consent forms are translated to Bahasa Indonesia and are explained verbally (Balinese or Kata Kolok). This procedure includes explaining the goal of the research, data collection, data storage and data sharing (for all of which participants can opt in or out). See example consent forms in English here attached.

I will do this in the following manner:
- I use codes and exclude names in transcription files and naming of files
- for videos, full anonymity is not an option (primary sign language data)
- data is available through The Language Archive only with restricted access, i.e., videos, metadata and transcriptions are locked and access can be requested through the archive by specifying the aims and conditions of use of data. Access can be granted by Connie de Vos or Hannah Lutzenberger under reviewing each request. Access to data of participants who opted not to share their data will not be granted.

Specify when and how you will anonymise/pseudonymise data, where you will store the key file and when you will dispose of it
- all data is anonymised upon collection in form of using acronyms for naming files
- video data is not anonymised (since necessary for the research)
- codes are used to name the the video and transcription files- codes may or may not be used in publications
- personal data is stored in a locked enriched metadata with the video data available under specific conditions

3.3 DO YOU NEED APPROVAL FROM AN ETHICS COMMITTEE FOR YOUR PROJECT?

Yes, for my research I will receive/have received approval from an ethics committee.
I received approval from the Ethics Assessment Committee of the Faculty of the Arts and the Faculty of Philosophy, Theology and Religious Studies (EAC) on 7 March 2017.
Consent forms are provided in Bahasa Indonesian and signed by signature or thumbprint. In case of illiteracy or low literacy skills, the entire consent form is discussed in Bahasa Indonesia, Balinese or Kata Kolok, depending on the participant's preferred language.

3.4 DOES YOUR RESEARCH REQUIRE AN INFORMED CONSENT PROCEDURE?

Yes, I work with human participant data and need an informed consent procedure.
I will follow the informed consent procedure established by the Ethics Assessment Committee Humanities at Radboud University, as specified here.

4 STORING AND SHARING DURING RESEARCH

4.1 WILL YOU MAKE USE OF SAFE STORAGE DURING YOUR RESEARCH, INCLUDING BACK-UP FACILITIES?

Yes, I will make use of safe storage but I deviate from the institute's policy.
The Sign Language Linguistics group headed by Onno Crasborn has special storage space on Ponyland which is used for sharing data in the group during research and for store for research integrity for at least 10 years. Data collected in this project is stored on external harddrives during data collection in the field, then migrated to this store space on Ponyland (vol/signlang3/ru/KataKolok). Processed data is archived in The Language Archive under the Kata Kolok Corpus for data from adult signers and in the Kata Kolok Child Signing Corpus for data from child signers.

4.2 WITH WHOM WILL YOU SHARE YOUR DATA DURING RESEARCH?

During my research I need to share my data with researchers and/or students affiliated at Radboud University and another institute.
I will follow the policy of my institute and use the work group folders of the University network, Ponyland and/or encrypted harddrives to easily and safely share my data with researchers and/or students affiliated at Radboud University. I will use Surfdrive and/or encrypted harddrives as a safe and secure way to share my data with researchers and/or students outside the Radboud University.

I need to share the data with researchers and/or students from Radboud University as well as researchers and/or students from another institute outside of Radboud University because of collaborations (e.g., with Katie Mudd at Vrije Universiteit Brussels; Connie de Vos at Tilburg University).

4.3 HOW WILL YOU DEAL WITH SECURITY ISSUES THAT ARISE DURING YOUR RESEARCH?

According to our policy, the data are stored in Ponyland, locally on an encrypted computer and encrypted external harddrives (because of need of video data) while research is ongoing. This storage location meets legal and ethical requirements. Safe and secure storage is guaranteed by the IT security and safety protocols. In addition, Surfdrive will be used to exchange standard data between researchers during the project. Ponyland, locally on an encrypted computer and external encrypted harddrives will be used to exchange personal data. When I am gathering personal data off-campus, I will use a secure VPN connection to transfer the data to Ponyland and The Language Archive as soon as possible. Before my data will be transferred I will save my data on an encrypted laptop/external harddrive/USB stick. Because my data is stored on Ponyland and The Language archive, the data is automatically backed up on a daily basis.

4.4 I ORGANIZE MY PROJECT'S FOLDER ACCORDING TO THE FOLLOWING FORMAT:

I have my own structuring format. For children data, the data is organised by child and age in individual sessions (following the structure of the Kata Kolok Child Signing Corpus). For adult data, the data is organised by topic and by signer in individual sessions (following the structure of the Kata Kolok Corpus).
Data in Global Signbank are organised by lexical item.

5 LONG TERM ARCHIVING AND REUSE

5.1 IN THE CONTEXT OF SCIENTIFIC INTEGRITY, WHERE WILL YOU ARCHIVE YOUR DATA (INCLUDING RAW DATA, METADATA AND DOCUMENTATION) FOR AT LEAST 10 YEARS?

I will deviate from the institute's protocol. My research data will be stored on The Language Archive, containing processed high quality video recordings and a documentation file. The locked metadata file is archived on The Language Archive. In accordance with Onno Crasborn and Henk van den Heuvel, raw video files will be stored on encrypted external harddrives for 10 years. Raw data are not needed for the research and serve the mere purpose of regenerating a converted mp4 file if the needed.

5.2 IN THE CONTEXT OF DATA REUSE, WILL YOU MAKE YOUR RESEARCH DATA PUBLICLY AVAILABLE?

Yes, but I will deviate from my institute's policy. The data is archived at The Language Archive, to extend the Kata Kolok Corpus and the Kata Kolok Child Signing Corpus, following their metadata requirements and basic documentation. The data is available with restricted access due to the fact that all data are video data of people including children. Access can be requested through The Language Archive and access is granted to students and researchers on a case to case basis (in case participants give consent for sharing their data).

Data in Signbank is open access; videos of individual signs are published there (participants gave consent to make videos publicly available).

5.3 HOW WILL YOU ENSURE THAT YOUR RESEARCH DATA WILL BE STORED IN A FAIR MANNER?

My data will comply with the FAIR principles in the following way:

Where data can be made public, my data will be Findable via The Language Archive using persistent identifiers assigned by the archive.
My data will be Accessible as well, since The Language Archive uses an open internet protocol, including clear authorisation procedures.

My data will be Interoperable by the use of standards for metadata, The Language Archive metadata scheme, documentation (preferred formats) and, if existing – standard (domain-specific) vocabularies.

My data will be Reusable via The Language Archive, including rich metadata and documentation for reuse, and a clear license.

6 COSTS

6.1 APART FROM THE COSTS COVERED BY YOUR INSTITUTE, DO YOU FORESEE COSTS OF DATA MANAGEMENT?

All the costs are covered by my institute.
My institute provides me with computers, software, and storage space during research and for long term storage.

ENGLISH SUMMARY

What makes languages all so different yet so similar? And how do children manage to learn a language so effortlessly?

All languages we have studied to date have small building blocks that are used to create words or signs. In spoken languages, those are distinctive sounds and in sign languages, those are aspects of the shape, the movement, or the location of the hands. Every language uses slightly different building blocks and has their own rules of how building blocks can be combined. Regardless of how different languages are, children grow into proficient speakers of any language, even without explicit instruction.

But how does this work? Linguists are still trying to find an answer to this question because what we know about languages and how children learn languages is largely based on research from Western countries. Contexts of use in the West can be very different from those of other types of language communities. This is especially true for sign languages; in the West, the vast majority of deaf children are born to hearing parents who do not know a sign language. This dissertation focuses on a village in Bali, Indonesia, where a relatively large number of deaf people have been born over the past ~150 years and a sign language called Kata Kolok has emerged. Today, many deaf and hearing villagers know to sign and use Kata Kolok in daily life. Unlike deaf children in Western countries, deaf children in this village are exposed immediately and continuously to both indirect language use (i.e., passively overseeing the sign language), and direct language use (i.e., signing that is addressed to the child).

The main questions of this dissertation are **what is Kata Kolok's phonology like and how do children learn it?** I investigated this question using field-based primary data, combining both corpus and experimental approaches.

In the first part of the dissertation (Chapters Three through Five), I investigated the set of building blocks, called phonological features, in Kata Kolok. I did this by examining how different signers produce different signs for the same meaning, and how different signers produce variations of the same sign using different phonological features.

First, I collected as many signs as I could, both for as many things as possible and from as many signers as possible because I was particularly interested in finding out whether common social variables such as age, gender or deafness are related to variation among signers. For collecting the signs, I looked at many hours of videotaped spontaneous conversation and asked people directly for their signs for specific pictures and objects. Based on all different sign variants that I found for different concepts, I compiled a database of signs. In this database, I described each sign in detail for its phonological features and then used this description to compare the phonological features of Kata Kolok to the ones of Sign Language of the Netherlands, which was already described in a similar database. I found both similarities and differences in the phonological features used and how they are combined in the two sign languages. I also used this database to specifically look at how social variables affect variation. Focusing on the signs that I collected by picture naming from a large proportion of the adult Kata Kolok signers who are deaf, I checked how many and which variants different signers used. I found that signers produce many different sign variants for many concepts but that specific variants occur most often. Also, I found that producing the same or different variants is not dependent on whether you are old or young or a man or a woman, but may be determined by whether you are deaf or hearing. We need more research to find out how such social variables interact with each other.

In the second part of this dissertation, I investigated how children learn the phonological features of Kata Kolok. I did this by studying both children's language production (the signs they produce) and their perception (the signs they understand).

To see the signs that children produce, I looked at video recordings of four deaf children who grew up learning and using Kata Kolok from birth. Recordings were made of the daily routines over the course of several years and contain observations of the children when they were between 1 and 3 years old. I studied the specific signs that children produced and compared those to the adult versions of those signs to see how they differed. I found that although the signs produced by children resemble the ones of adults in their overall form, children modified signs, changing for example the handshape, the orientation of the palm and the location. The way they do this was quite similar to deaf children learning other sign languages used in Western countries. Furthermore, I found that children commonly tend to modify more than one aspect, for example, they changed the shape and the movement of the hand within the same sign. My hypothesis is that children might make modifications in part to increase sensory feedback, such as replacing hand movements with body movements, or making more contact between hand and body.

To see how children perceive signs, I took an experiment commonly used to study speech-acquiring children in laboratory settings, and tried to adapt it for deaf and hearing children who acquire Kata Kolok. The experiment tests whether children can distinguish the same small differences in phonological features that adults can. Adjusting this experiment to suit children acquiring Kata Kolok required me to adapt the method in two ways: 1) to the cultural and physical environment of the field and 2) to working with children who acquire a sign language from birth. This experiment revealed many insights about how signing children interact with this task and what changes need to be made in all stages of preparing, carrying out and analysing such experiments when working with children whose primary language is produced gesturally and perceived visually. It also highlighted the challenges of working with a population that is not often studied and is very small.

Overall, the research chapters of this dissertation highlight great similarity and differences of Kata Kolok to other, socio-demographically distinct sign languages: phonological features are similar and often combined similarly, and social determinants of variation are complex and different in each language. The route of acquisition generally resembles other sign languages but great differences are found in the social and cultural environment in which the language is used and learned.

DUTCH SUMMARY – SAMENVATTING

Hoe komt het dat talen zo verschillend zijn maar ook zo op elkaar lijken? En hoe kunnen kinderen een taal zo makkelijk leren?

Alle talen die tot nu toe onderzocht zijn hebben kleine bouwblokken waaruit woorden of gebaren zijn opgebouwd. In gesproken talen zijn dat de onderscheidende klanken en in gebarentalen zijn het eigenschappen van de vorm, beweging of plaats van de handen. Elke taal kent weer net andere bouwblokken, en heeft eigen regels voor hoe ze gecombineerd kunnen worden. Ongeacht hoe verschillend talen zijn groeien kinderen op tot vloeiende sprekers van een taal, ook zonder expliciete instructie.

Maar hoe werkt dat precies? Taalkundigen proberen deze vraag nog steeds te beantwoorden, omdat onze kennis nog grotendeels gebaseerd is op onderzoek uit westerse landen. Gebruikssituaties in het Westen kunnen heel anders zijn dan die van andere soorten taalgemeenschappen. Dat geldt in het bijzonder voor gebarentalen: in het Westen heeft de meerderheid van dove kinderen horende ouders die geen gebarentaal beheersen. Dit proefschrift richt zich op een dorp in Bali in Indonesië, waar een relatief groot aantal doven mensen geboren is in de afgelopen 150 jaar en waar een gebarentaal genaamd Kata Kolok is ontstaan. Veel dove en horende dorpelingen kunnen tegenwoordig gebaren en gebruiken Kata Kolok in het dagelijks leven. Anders dan dove kinderen in westerse landen worden dove kinderen in dit dorp van jongs af aan en doorlopend blootgesteld aan zowel indirect taalaanbod(d.w.z. passief de gebarentaal waarnemen) en direct taalaanbod (d.w.z. gebaren die tot het kind zelf gericht zijn).

De belangrijkste vragen in dit proefschrift zijn **hoe de fonologie van Kata Kolok er uit ziet en hoe kinderen die leren**. Ik onderzocht deze vragen op basis van primaire data uit veldwerkonderzoek, in combinatie met corpus- en experimenteel onderzoek.

In het eerste deel van het proefschrift (Hoofdstuk 3-5) heb ik de verzameling van bouwblokken in Kata Kolok onderzocht, fonologische kenmerken genaamd. Dit heb ik gedaan door te onderzoeken hoe verschillende gebaarders andere gebaren voor dezelfde betekenis gebruikten, en hoe verschillende gebaarders varianten van hetzelfde gebaar gebruikten met andere fonologische kenmerken.

Allereerst heb ik zoveel gebaren verzameld als ik kon, zowel voor zoveel mogelijke dingen als van zoveel mogelijk mensen, omdat ik vooral geïnteresseerd was in de vraag of gebruikelijke sociale variabelen zoals leeftijd, gender of doofheid met die variatie tussen gebaarders samenhingen. Om gebaren te verzamelen heb ik gekeken naar uren gesprekken die op video waren opgenomen, en vroeg ik mensen gericht naar hun gebaren voor specifieke afbeeldingen en objecten. Op basis van alle gebaarvarianten die ik voor diverse concepten kon vinden, heb ik een database van gebaren samengesteld. In deze database heb ik voor elk gebaar in detail de fonologische kenmerken beschreven en deze vervolgens gebruikt om de fonologische kenmerken van Kata Kolok te vergelijken met die van Nederlandse Gebarentaal, die al in een vergelijkbare database waren gedocumenteerd. Ik vond zowel overeenkomsten als verschillen tussen de fonologische kenmerken die gebruikt werden en hoe die gecombineerd werden in de twee gebarentalen. Deze database heb ik ook gebruikt om specifiek te kijken naar hoe sociale variabelen variatie beïnvloedden. Inzoomend op de gebaren die ik met de plaatjes-taak heb verzameld van een groot deel van de volwassen dove Kata Kolok gebaarders, heb ik gekeken hoeveel en welke varianten verschillende gebaarders gebruikten. Ik vond dat gebaarders veel verschillende varianten voor veel concepten gebruikten, maar dat een aantal varianten het meest voorkwamen. Daarnaast vond ik dat of je dezelfde of verschillende varianten gebruikt niet afhangt van of je jong of oud of man of vrouw bent, maar wel bepaald kan zijn door of je doof of horend bent. Meer onderzoek is nodig om vast te stellen hoe die variabelen met elkaar samenhangen.

In het tweede deel van dit proefschrift heb ik onderzocht hoe kinderen de fonologische kenmerken van Kata Kolok leren. Hiervoor heb ik de taalproductie van kinderen onderzocht (de gebaren die ze maakten) en hun taalperceptie (de gebaren die ze waarnamen).

Om gebaren die kinderen maken te onderzoeken heb ik video-opnames van vier dove kinderen bekeken die vanaf hun geboorte opgroeiden met Kata Kolok. Gedurende een aantal jaar werden opnames gemaakt van de dagelijkse routine, die observaties bevatten van de kinderen tussen de één en drie jaar oud. Ik onderzocht welke gebaren kinderen precies gebruikten en vergeleek deze met de volwassen versies van diezelfde gebaren om de verschillen te zien. Ik vond dat hoewel de gebaren van kinderen in grote lijnen wel leken op die van de volwassenen, kinderen ook gebaren aanpasten, bijvoorbeeld door de handvorm, de palmoriëntatie of de locatie te veranderen. Hoe ze dit deden leek erg op hoe dove kinderen dit deden die in westerse landen een gebarentaal leren. Bovendien vond ik dat kinderen vaak meer dan één aspect aanpasten. Ze veranderden bijvoorbeeld de vorm en de beweging van de hand in hetzelfde gebaar. Mijn hypothese is dat kinderen aanpassingen wellicht mede maken om sensorische feedback te versterken, zoals het gebruiken van bovenlichaambewegingen in plaats van handbewegingen of zorgen voor meer contact tussen hand en lichaam.

Om te zie hoe kinderen gebaren waarnemen heb ik een experiment dat vaak in laboratoriumsettings wordt gebruikt om spraak-lerende kinderen te onderzoeken aangepast voor dove en horende kinderen die Kata Kolok leren. Het experiment test of kinderen dezelfde kleine verschillen in fonologische kenmerken kunnen waarnemen als volwassenen. Om dit experiment geschikt te maken voor kinderen die Kata Kolok verwerven was het nodig om de methode op twee punten aan te passen: 1) aan de culturele en fysieke omgeving van de situatie ter plekke; en 2) om te werken met kinderen die vanaf hun geboorte een gebarentaal leren. Dit experiment leidde tot veel inzichten in hoe dove kinderen omgaan met deze taak en in welke veranderingen nodig waren in alle fases van zo'n onderzoek (voorbereiden, uitvoeren, analyseren) om het te kunnen toepassen op kinderen die een manueel-visuele taal leren. Ook kwamen uitdagingen aan het licht in het werken met een taalgemeenschap die klein is en maar weinig is onderzocht.

De onderzoekshoofdstukken in dit proefschrift brengen grote verschillen en grote overeenkomsten aan het licht tussen Kata Kolok en andere, socio-demografisch verschillende gebarentalen: fonologische kenmerken lijken op elkaar en worden vaak op vergelijkbare manier gecombineerd, en de sociale herkomst van variatie is complex en mogelijk in elke taal weer anders. Het pad naar taalverwerving lijkt in grote lijnen op andere gebarentalen ook al zijn er grote verschillen in de sociale en culturele omgeving waarin de taal wordt gebruikt en geleerd.

GERMAN SUMMARY – ZUSAMMENFASSUNG

Was macht Sprachen so unterschiedlich und doch so ähnlich? Und wie schaffen es Kinder Sprachen so mühelos zu lernen?

Alle Sprachen die bis jetzt erforscht wurden haben kleine Bausteine die wir verwenden um Worte und Gebärden zu formen. In gesprochenen Sprachen sind das unterschiedliche Laute und in Gebärdensprachen unterschiedliche Aspekte der Handform, wie sie sich bewegt oder wo sie platziert wird. Jede Sprache verwendet unterschiedliche Bausteine und hat eigene Regeln, wie die Bausteine miteinander kombiniert werden können. Egal wie verschieden Sprachen sind, Kinder wachsen ohne explizite Anleitung zu kompetenten Sprechern jeder erdenklichen Sprache heran.

Doch wie funktioniert das? Sprachwissenschaftler versuchen noch immer eine Antwort auf diese Frage zu finden, denn was wir über Sprache wissen und darüber, wie Kinder Sprache lernen ist stark von Studien in westlichen Ländern geprägt. Wie Sprache im Westen genutzt wird kann aber sehr davon abweichen, wie andere Sprachgemeinschaften Sprache nutzen. Das wird anhand von Gebärdensprachen besonders deutlich: Im Westen hat die große Mehrheit tauber Kinder hörende Eltern, die nicht gebärden können. Diese Doktorarbeit konzentriert sich auf ein Dorf in Bali, Indonesien, in dem über die letzten ~150 Jahre hinweg verhältnismäßig viele taube Menschen geboren wurden und deswegen die Gebärdensprache Kata Kolok entstanden ist. Heute können sowohl viele der tauben als auch der hörenden Dorfbewohner gebärden und verwenden Kata Kolok tagtäglich. Anders als taube Kinder in westlichen Ländern sind taube Kinder in diesem Dorf sofort und kontinuierlich dem direkten (d.h. Gebärden mit denen das Kind direkt angesprochen wird) und indirekten (d.h. Gebärden die nicht an das Kind gerichet sind, die es aber mitbekommt) Sprachgebrauch von Gebärdensprache ausgesetzt.

Die zentralen Fragen dieser Doktorarbeit sind: **Wie sieht Kata Koloks Phonologie aus und wie erlernen Kinder diese?** Ich habe diese Frage anhand von Daten erforscht, die auf Feldforschung basieren und kombiniere Korpusforschung mit experimentellen Forschungsansätzen.

Im ersten Teil der Doktorarbeit (Kapitel Drei bis Fünf) erforsche ich welche Bausteine, auch phonologische Merkmale genannt, in Kata Kolok verwendet werden. Dafür habe ich untersucht, ob unterschiedliche Gebärdensprachnutzer verschiedene Gebärden für dieselbe Bedeutung produzieren und wie unterschiedliche Gebärdensprachnutzer dieselbe Gebärde hinsichtlich ihrer phonologischen Merkmale variieren.

Zunächst habe ich so viele Gebärden gesammelt wie möglich, sowohl für so viele verschiedene Dinge wie möglich, als auch von so vielen verschiedenen Gebärdensprachnutzern wie möglich. Das war wichtig, da ich herausfinden wollte ob die üblichen sozialen Variablen wie z.B. Alter, Geschlecht oder Taubheit, mit Variation zwischen unterschiedlichen Sprachnutzern im Zusammenhang stehen. Um all diese Gebärden zu sammeln, habe ich viele Stunden an Videodaten von spontanem Sprachgebrauch observiert und zusätzlich die Dorfbewohner befragt wie ihre Gebärden für bestimmte Bilder oder Fotos und Objekte aussehen. Basierend auf den unterschiedlichen Varianten von Gebärden, die ich dokumentiert habe, habe ich eine Datenbank erstellt. Darin habe ich jede Gebärde hinsichtlich ihrer phonologischen Merkmale beschrieben und dann diese Beschreibung weiterverwendet, um die phonologischen Merkmale von Kata Kolok mit denen von der Niederländischen Gebärdensprache zu vergleichen. Dieser Vergleich hat sowohl Ähnlichkeiten als auch Unterschiede zutage gefördert im Hinblick darauf welche phonologischen Merkmale verwendet werden und wie sie in den beiden Sprachen kombiniert werden können. Desweiteren habe ich die Datenbank dafür verwendet zu untersuchen wie soziale Variablen sich auf Variation auswirken. Hierfür habe ich mich auf Gebärden konzentriert, die ich mithilfe von Bildern von einem Großteil der tauben Erwachsenen im Dorf erhoben habe. Ich habe untersucht wie viele und welche Varianten verschiedene Gebärdensprachnutzer verwenden. In dieser Studie habe ich herausgefunden, dass Gebärdensprachnutzer ziemlich viele verschiedene Gebärden für unterschiedliche Konzepte produzieren, aber auch dass bestimmte Varianten sehr häufig verwendet werden. Außerdem ergab die Studie, dass es nicht vom Alter oder Geschlecht abhängt, welche Variante man verwendet, sondern vermutlich damit zusammenhängt ob man taub oder hörend ist. Um das zu bestätigen müssen wir aber die Zusammenhänge verschiedener sozialer Variablen noch besser erforschen.

Im zweiten Teil der Doktorarbeit (Kapitel Sechs und Sieben) habe ich erforscht, wie Kinder phonologische Merkmale von Kata Kolok erlernen. Dazu habe ich mir sowohl die Sprachproduktion (d.h. die Gebärden die Kinder produzieren) als auch Sprachwahrnehmung (d.h. die Gebärden die Kinder verstehen) angeschaut.

Um zu untersuchen welche Gebärden von Kindern benutzt werden, habe ich Videoaufnahmen von vier tauben Kindern verwendet, die alle von Geburt an Kata Kolok lernen. Wir haben die Kinder im Alter zwischen 1 und 3 Jahren über mehrere Jahre hinweg im Alltag gefilmt. Ich habe die Gebärden der Kinder mit denen von Erwachsenen verglichen und untersucht wie sich die beiden unterscheiden. Das Ergebnis war, dass Kinder die Form von Gebärden verändern, z.B. die Form der Hand, wohin die Handfläche zeigt oder wo die Gebärde produziert wird, wobei Gebärden von Kindern denen von Erwachsenen bereits sehr ähnlich sehen. Die Art wie die tauben Kinder in meiner Studie ihre Gebärden anpassen ähnelt dem was für taube Kinder in anderen (westlichen) Ländern dokumentiert wurde. Außerdem habe ich entdeckt, dass Kinder oft nicht nur einen einzelnen Aspekt einer Gebärde verändern, sondern meistens mehrere; zum Beispiel verändern Kinder innerhalb einer Gebärde nicht nur die Form der Hand, sondern auch wie sich die Hand bewegt. Meine Hypothese ist, dass Kinder Anpassungen vornehmen um mehr sensorisches Feedback zu bekommen und deswegen z.B. Handbewegungen mit Bewegungen des ganzen Oberkörpers ersetzen oder den Kontakt zwischen Hand und Körper in einer Gebärde vergrössern.

Um zu untersuchen, wie Kinder Gebärden verstehen habe ich versucht ein Experiment, das normalerweise mit Kindern die eine gesprochene Sprache erlernen und im Labor durchgeführt wird, an taube und hörende Kinder die Kata Kolok erlernen anzupassen. Das Experiment ist darauf ausgelegt zu testen ob Kinder zwischen den gleichen kleinen Unterschieden in phonologischen Merkmalen unterscheiden können wie Erwachsene. Die zwei wichtigsten Anpassungen des Experiments waren:

1) Anpassungen an die kulturelle und physische Umgebung im Dorf und 2) Anpassungen an die Arbeit mit Kindern, die eine Gebärdensprache lernen. Das Experiment liefert viele Einsichten wie gebärdende Kinder mit der Aufgabe umgehen und vor allem welche Anpassungen in allen Stadien der Experimentvorbereitung und -durchführung sowie bei der Datenanalyse vorgenommen werden müssen. Dieses Experiment hat auch nochmals gezeigt welche Schwierigkeiten auftauchen, wenn man mit einer Gemeinschaft arbeitet, die noch nicht oft untersucht wurde und zudem sehr klein ist.

Alles in allem haben die forschungbasierten Kapitel dieser Doktorarbeit gezeigt, dass die Charakteristiken von Kata Kolok denen anderer Gebärdensprachen mit unterschiedlichen soziodemografischen Profilen auf der einen Seite stark ähneln und sich auf der anderen Seite stark davon unterscheiden. Phonologische Merkmale sind oft ähnlich und werden auf ähnliche Weise miteinander kombiniert, während hingegen die sozialen Variablen, die Variation beeinflussen oft komplex sind und sich in jeder Sprache und Sprachgemeinschaft unterscheiden. Der Spracherwerb von Kata Koloks Phonologie ist dem von Kindern in anderen Gebärdensprachen im Großen und Ganzen ähnlich, aber die Unterschiede in der sozialen und kulturellen Umgebung in welcher eine Sprache verwendet und erlernt wird, sind groß.

INDONESIAN SUMMARY – RINGKASAN

Apakah yang membedakan semua bahasa namun masih terkesan sama? Bagaimanakah anak-anak dapat belajar Bahasa dengan mudah?

Semua bahasa yang telah dipelajari memiliki bagian terkecil yang digunakan untuk membentuk kata atau simbol. Dalam Bahasa lisan, ini dinamakan bunyi khusus dan dalam bahasa isyarat, aspek tersebut terdiri atas bentuk, gerakan, atau pergerakan tangan. Setiap bahasa menggunakan proses pembentukan kata yang berbeda dan aturan pembentukan katanya masing-masing. Terlepas dari bagaimana pembentukan tiap bahasa, anak-anak tumbuh menjadi pembicara handal di berbagai bahasa, bahkan tanpa instruksi secara langsung.

Bagaimanakah ini bisa terjadi? Ahli Bahasa masih mencari jawaban untuk menjawab pertanyaan tersebut karena yang diketahui tentang bahasa dan proses anak belajar bahasa sebagian besar berdasarkan penelitian di negara barat. Konteks penggunaannya pun berbeda dari tipe komunitas bahasa lainnya. Hal ini dibenarkan pada bahasa-bahasa simbol/isyarat: di negara barat, mayoritas anak-anak tuli bisu terlahir dari orang tua yang tidak bisa bahasa simbol. Disertasi ini fokus pada sebuah desa di Bali, Indonesia, yang mana telah terlahir banyak orang tuli bisu lebih dari 150 tahun silam dan bahasa simbolnya yang disebut Kata Kolok, yang telah berkembang. Kini, banyak orang tuli bisu di desa ini telah mengetahui cara memberi simbol dan menggunakan Kata Kolok dalam kehidupannya sehari-hari. Lain halnya dengan anak-anak tuli bisu di negara-negara barat, anak tuli bisu di desa ini dibiasakan secara langsung dan terus-menerus untuk menggunakan bahasa tidak langsung (misal: secara pasif dari segi pengontrolan bahasa) dan penggunaan bahasa secara langsung (simbol yang ditujukan kepada anak).

Pertanyaan utama dari disertasi ini adalah **bagaimanakah fonologi Kata Kolok dan bagaimana anak -anak mempelajarinya**? Saya menginvestigasi pertanyaan ini menggunakan data primer berbasis lapangan, mengkombinasikan korpus dan pendekatan experimental.

Pada bagian awal disertasi (Bab 3 - 5), saya menginvestigasi set pembentuk kata, yang disebut fitur fonologi dalam Kata Kolok. Saya melaksanakannya dengan menguji pengguna simbol yang berbeda menghasilkan simbol berbeda dengan arti yang masih sama, dan bagaimana pengguna simbol menghasilkan produk yang bervariasi dari simbol yang sama dengan menggunakan fitur fonologikal yang berbeda.

Pertama-tama, saya mengumpulkan data simbol sebanyak mungkin, kedua aspek yaitu pengguna simbol dan bahasa simbolnya karena saya secara khusus tertarik untuk meneliti apakah sosial variabel seperti usia, gender, dan ketulian memengaruhi variabel diantara para pengguna simbol. Dalam mengumpulkan simbol, saya mendengarkan rekaman percakapan spontan berulang – ulang kali dan bertanya secara langsung pada pengguna simbol juga gambar dan objek khusus. Berdasarkan simbol-simbol berbeda yang saya temukan dalam konsep yang berbeda, saya mengumpulkan indeks dari simbol-simbol. Dalam indeks yang terkumpul, saya mendeskripsikan setiap simbol secara detail untuk setiap fitur fonologinya dan menggunakan deskripsi ini untuk membedakan fitur fonologi Kata Kolok dengan satu dari bahasa simbol di Netherlands, yang mana juga sudah dideskripsikan di dalam indeks. Saya menemukan kesamaan dan perbedaan pada penggunaan fitur fonologi dan penggabungannya pada dua bahasa isyarat. Saya juga menggunakan indeks kata ini untuk mengetahui pengaruh variabel sosial pada variasi bahasa isyarat. Terfokus pada simbol yang saya kumpulkan melalui penamaan gambar dari banyaknya proporsi orang dewasa pengguna Kata Kolok yang tuli bisu, saya mengecek banyaknya variasi dan variasi yang berbeda dari pengguna simbol lainnya. Saya menemukan bahwa pengguna simbol menghasilkan beberapa variasi simbol yang berbeda untuk beberapa konsep namun variasi spesifik ditemukan beberapa kali dalam penelitian. Terlebih lagi, saya mendapatkan bahwa produksi variasi yang sama atau berbeda tidaklah bergantung pada tua, muda, laki-laki, wanita, namun ditentukan oleh tuli bisunya seseorang. Kami membutuhkan penelitian lebih lanjut untuk membuktikan variabel sosial berinteraksi satu sama lainnya.

Pada bagian kedua (Bab 6-7) dari disertasi ini, saya menginvestigasi proses anak mempelajari fitur fonologi dari Kata Kolok. Saya menelaah ini dengan mempelajari produksi bahasa oleh anak (simbol yang mereka hasilkan) dan persepsi mereka (simbol/isyarat yang mereka pahami).

Untuk memahami simbol yang anak pahami, saya menggunakan rekaman video dari empat anak yang tumbuh dengan belajar dan menggunakan Kata Kolok dari lahir. Rekaman diambil dari rutinitas setiap hari dari beberapa tahun silam termasuk observasi saat mereka berusia 1 dan 3 tahun. Saya mempelajari simbol khusus yang anak hasilkan dan membedakannya dengan versi dewasa untuk melihat perbedaannya. Meskipun simbol yang dihasilkan anak menyerupai simbol yang digunakan orang dewasa, anak-anak memodifikasi simbol, mengganti (misalnya: bentuk gerakan tangan), orientasi telapak tangan dan penempatannya. Caranya melakukan sedikit sama dengan bahasa isyarat dan simbol yang digunakan oleh orang-orang di negara barat. Bahkan, anak-anak secara umum cenderung memodifikasi lebih dari satu aspek, misal, mereka mengubah bentuk dan gerakan dari tangan dalam simbol yang sama. Hipotesis saya yaitu anak diperkirakan memodifikasi sebagai bentuk peningkatan umpan balik sensorik, seperti mengganti gerakan tangan dengan gerakan tubuh, atau membuat kontak antara tangan dan tubuh.

Untuk mengetahui cara anak memahami simbol/isyarat, saya melakukan percobaan yang biasa digunakan untuk studi perolehan bahasa pada anak dalam seting laboratorium, dan mencoba untuk mengadaptasikannya pada anak tuli bisu dalam pemerolehan Kata Kolok. Experimen ini membuktikan bahwa anak bisa menentukan perbedaan fitur fonologi yang kecil dan sama pada orang dewasa. Hal ini menyebabkan penyesuaian pada penelitian untuk menggunakan 2 metode yaitu: (1) budaya dan kondisi fisik di lapangan dan (2) meneliti anak dalam pemerolehan bahasa isyarat dari lahir. Experimen ini menghasilkan beberapa pandangan tentang anak dan interaksi simbol dan perubahan yang diperlukan dalam semua aspek persiapan, implementasi, analisis seperti experimen dengan anak-anak yang masih pada tahap awal produksi bahasa secara gestur dan pemahaman visual. Hal ini juga menekankan bahwa tantangan yang dihadapi yaitu bekerja pada populasi yang tidak umum dan sangat sempit.

Secara umum, bagian-bagian pada disertasi ini menekankan besarnya perbedaan dan kesamaan Kata Kolok pada bahasa isyarat lainnya, sosial demografis bahasa isyarat yang ditentukan; fitur fonologi yang sama dan biasanya digabungkan secara bersamaan, dan faktor sosial penentu dari variasi yang kompleks dan berbeda di tiap bahasa. Arah pemerolehan isyarat secara umum menyerupai bahasa isyarat lainnya, namun terdapat perbedaan besar yaitu pada lingkungan sosial dan budaya dimana bahasa digunakan dan dipelajari.

ACKNOWLEDGEMENTS

Whoever believes that a PhD is a one-(wo)man-show is wrong; it's a team effort – and mine was for sure. Turns out, writing an acknowledgement section is almost as hard as writing a whole dissertation – for me, both are best done in teams. Thanks, R, for chipping in! So many wonderful people accompanied, inspired and supported me over the last four years! I was lucky to be planted into a group of warm, kind and lovely colleagues who helped me think, grow and develop in so many different ways, I am surrounded by the most amazing friends who make me feel loved and treasured, no matter what, and I have the best and most beautiful family in the world who just always manages to create a safety net for me, support me in whatever I do and are there for me at all times, in all highs and lows. I know I can always trust on you – thank you for sharing this part of the journey, all you wonderful beings around me!

I am forever grateful for my supervisors, **Paula, Onno** and **Connie,** – for me, you were the best team of supervisors I could have wished for on this journey!
Paula – thank you for being such a reliable source of patience and confidence – never missing the chance to remind me that there should also be life and I am very grateful for this. I felt so taken care of and whenever I needed support, you always had good and practical advice ready. With your help, making decisions became lighter, even though it is one of my least favourite things to do. Thank you for always reminding me about what is important in life, for knowing how everything works and for encouraging me that I can actually do child acquisition even though it felt impossible for most of the time.

Onno – thank you for always having an open door and a good and slightly weird sense of humour. You are such a kind soul and I am so grateful for all the little things you said and did that made me more confident in myself. I am so lucky for having my office so close to your open door that I could always just pop in for advice, a cheer up or simply to get a quick Onno-recharge. Thank you for always having time for a coffee break and for assuring me at the very beginning of this journey that reading my stuff is actually your job not a favour you do for me. It really took a huge weight from my shoulders for the rest of this PhD. Thank you for all the time together.

Connie – thank you for taking a shot on a random student who emailed you. We have gone from intern supervisor to PhD supervisor and became good friends. I am forever grateful to you for bringing me to this whole Bengkala situation. Nothing would have gone the way it did without you seeing a little fieldworker in me and helping me grow this passion – I really have loved everything about it and could not have imagined it any other way. I am glad to have had you as a supervisor on this project, helping me get the best out of me and trusting that I will figure things out. Thank you for believing in me from the very start, for being my second hardest critique (after myself), for always pushing me to the best could be and making sure we never stop working on making this raw diamond shine.

My biggest thanks go to all the hearing and deaf **people of Bengkala**: Terima kasih! I am immensely grateful that you all just let me into your hearts and integrated me in your community. Thank you for all the patience with my languages and my other-ness, teaching me, slowly but steadily and always asking me to come back. Matur suksma!

My deepest thanks go to my research assistants **Papa Kanta** for adopting me like one of your own children and to **Dadi** and **Sumarni** for their friendship, interest and passion to work with me. Thank you **Anggri** and **Somelly** for your kindness and excitement to get involved in this project as well and helping me out with language, taking me part in as a lost cousin!

Special thanks to my favourite little people in Bengkala – **CSA** and **CSC**, I am so glad I could make you smile and convince you that I am to be trusted. **CSS, CSW** and **CST**, thank you for being so easy to befriend. **CSD** and **CSHM**, thank you for slowly opening up. I am really grateful for getting the opportunity to share part of your childhood with you and watch you grow! Thank you!

Thank you very much to my manuscript committee: **Steve Levinson**, **Roeland van Hout**, **Rachel Mayberry**, **Nick Palfreyman**, and **Julie Hochgesang.** I am delighted to have such an excellent group of people evaluating this dissertation – and grateful for your thoughtful feedback and all the inspiration I got from each of you individually. Thank you **Theo Engelen**, **Asli Özyürek**, and **Victoria Nyst** for making my Doctoral Examination Board complete. I am very excited to have you there on this occasion.

Thank you to my paranymphs **Katie**, **Aurora** and **Tashi** for simply everything.

Katie – Thanks for being a sane, fun weirdo who just walked into my life and decided that we're gonna be really good friends. Lucky for me I had you as a collaborator – but even luckier, I walk away from this PhD with you as a friend! High five.

Aurora – although you were Rehana's friend first and I was not sure if you liked me, I really enjoyed this growing friendship with you (and Anke and Paco/Tacito/Rosso). Thanks for roping me in for lunches and coffee breaks, making sure I don't miss out on the department gossip, explaining pop culture to me, and letting me practice teaching yoga on you! I am very glad you stick around in my life.

Tashi (& Tevi) – I am so glad you ended up where I ended up and we got to share office and be around each other. While I still remember our pancake day dinner in Preston, I am just so delighted that we got to see each other much more often than that. I am glad I can always come to you and Tevi for everything, especially hugs and cuddles.

Thank you **Gede Prima**, **Dezzy, Meri** and **Ketut** for being so kind and friendly with me and accepting me into your family. **Gede Prima**, for helping me sort out things, print and draw money, picking me up from the airport and getting us snacks and drinks. **Dezzy** for always having an open door and bed for me to sleep at your family home in Denpasar and letting me play with your daughters!

Thank you also to **Wisnu** for your humour, to the **Kepala Desa** for integrating me, to **Danny** for your patience in answering so many of my culture and religion questions and explaining things over and over again.

In addition, I would like to thank **Wahyu** for being so lovely and excited to work with me, **Dian** for your friendship and the academic exchange, **Professor Sutjaja** for kindness and the openness for discussion, and **Hery** for the lovely exchanges.

Middy – thank you for just being there and roping me deeper and deeper into child acquisition reseach. Just like Paula, I am so glad you kept on reminding me that I

actually can do child acquisition research and for helping me find out that I actually really really like working on child data and with children – what a delight that came out of this PhD. I remember so vividly you and Sean questioning me about stuff in a PhD application mock up way back at the MPI – ever so kindly, ever so on spot. I am glad to have you by my side through this – and beyond this!

Roland – thank you for helping me shape my interests during the Masters and teaching me your way of doing things. I really appreciate your input and opinion and having been trained by you made me a more tolerant scholar who believes that frameworks are just one thing but not everything to base a fruitful exchange on. You can learn from anybody!

Anne – what a wonderful strike of life that you moved in (and thank you Linda for your helping hand!). I am so glad we got to be flatmates during this time – I learned so much about so many things and I even got to be your pilot, despite the fact that you tested Dutch contrasts on me as non-Dutch native.

Calle – how lucky I was to have you as a flatmate in the Castle. Thank you for all your support throughout all our joint Nijmegen time, for all the conversations about nothing and everything, for being chatty with me, hugging me (sometimes) and for loving the boys. Thank you for helping me solve coding issues, solving problems I sometimes didn't even knew I had and for listening to and reading my stuff. I am really grateful for having such a bright Swedish friend now!

Thank you to the best office mates with the best corner office (with a view): **Aurélia** and **Tashi** – thank you for making our office a nice place to be. Thanks to **Tashi** for stuffing the office with every little thing we could potentially need, and also things we certainly will not ever need and for always giving my orchid water, making sure my best killing-it-efforts had no effect on this immortal plant. Thanks to **Aurélia** for the perseverance of getting us all standing desks – absolute game changer – and always updating me on what the newsletter said. I am very glad for your constant excitement, your Zumba company and for coming to my house – agreeing to making me your friend rather than an acquaintance.

Thank you all the **SLL team** – I am really glad that this group was my academic home over the last four years. Dear **Tom, Merel, Ellen, Wendela, Maya, Calle, Lori** (and **Neil**) thank you for forming such a lovely community and for keeping up our regular joint lunches!

Thank you to the **FLA group** at Radboud and the **FLADD group** at the MPI for taking me into the most supporting and nurturing environment I could have hoped for and for making sure we share highs and lows with each other. Thank you for merging the groups, **Paula** and **Caro**!

Jeroen Geerts, **Jeroen Derks** and **Peter Withers** – my MPI TG dream team, even though I was not really MPI. Thank you **Jeroen** for putting up with my delayed return of hard drives, the insane amount of data and for taking care of all TLA related problems I encountered. Thank you, **Jeroen** and **Peter**, for agreeing to embark with all of us on the monkey project, for the patience of talking through how things should be and for teaching me how to pick it up myself from where you didn't get round to.

Lots of thanks go to all those lovely PhD fellow friends from near and far who made doing this PhD much more fun – thank you all for just being there, socialising, and for all the fun things we did together.

Nina, you long lasting diamond. I am so glad we met and grew our friendship since this first day in the MPI guesthouse, door to door. **Greta** and **Fritz**, I am so sad we never got round to singing lessons, but I am so happy you joined our quizzes, always had us over when we didn't have a home and decided that being friends was a good decision. **Kangsuk**, thanks for your friendship, the time spent together, and the exchange and help throughout. It's good to have friends you can always count on. **Limor**, you bubbly person of encouragement. Thank you for all your little words of support and meet ups. **Laura**, you Ruhepol – whenever I met you I thought, everything is going to be okay – and I am grateful for that!!! **Francie**, thank you for your open arms, the wonderfully relaxed and cosy evenings at yours or mine and for all the times you jumped in to take care of Tom and Oskar! The (former) MPI-based folks**,** **Sara, Eirini, Linda, Naomi, Julia**, and many others – you are great and this was fun because you were there! I am extremely grateful that my PhD spanned CLS and the MPI, going beyond the IMPRS. The CLS crew **Lotte, Shen, Katherine, Emily, Ely, Saskia** and many more – thank you for having shared lunches, coffee breaks and all the jokes and laughter around them. **Marta, Mariana**, **Anique** and everyone else in the Leiden group – thank you for reaching out and keeping the constant exchange of academic talk, peer support and friendship across the Netherlands flowing. **Felicia** – thank you for coming to visit Nijmegen and just spending time, talking about stuff and never getting tired of making Trini food and talking linguistics. **Ben** and **Rowan**, you are great and I am glad you popped into my PhD journey at some point – and more importantly, stayed in and even more excited to spend more time with you, **Ben**, and **Maria** now. **Rowan**, thank you for becoming and being our best Goettingen friend – I loved your dance lessons, am forever grateful for babysitting our boys and so so so happy you decided that you can have vacation-feels in our house! **Gio** – I am so glad we met all these years ago in Paris and became friends. You are my favourite supporter and I love that no matter the achievement, you will celebrate it. Thank you for all the excitement and cheering you bring into my life and brought into this PhD. **Elisabet** – I know that I always have your full support, whether or not we see or hear each other and I am so grateful for that. I am the most grateful for becoming your friend during the rMA at UvA. I am glad to have such a beautiful critical thinker and overachiever as a friend and enjoy every single moment when you just let yourself go….

Thank you to all those wonderful, inspiring academics around me who made me feel like a colleague from the very start.

Markus, Victoria, Hope, Nick, Lauren, Diane Brentari, Diane Lillo-Martin – thank you for meeting with me one, helping me to develop my ideas and shaping the PhD project.

Asli, Gerardo, Beyza, Dilay, Renske, Huku. Thank you for taking me into your MPI sign/gesture family! I am glad for all the exchange and support I had from you. **Mark, Sean, Harald, Middy.** Thank you for shaping my MPI family for me – I am so glad we met there and I got the chance to keep being inspired by you. **Mark** – Thank you for always watching out for me, for supporting me and for always having an open door and ear when needed – regardless of whether I am your PhD student or not. **Rabia** – thank you for being an academic friend who can immediately be excited about everything and for your open arms to jump in where needed, may this be a coffee, a Zumba class, a bed to sleep in Istanbul or having your family show me around! **Adam** – thanks for already giving me a job when I was not even done this PhD! I am really excited to learning from you and continue developing my ideas with your input.

Kevin- we all know you are a gem, but thank you for all your help with figuring out with how I can do the IMPRS courses around fieldwork and making sure everybody is happy and supported in the best way possible. Thank you for always trying to respond to every wish, need and feedback – we really appreciate your efforts immensely!

Friends and **family** who have nothing to do with linguistics, you are a blessing. You make everything so easy and light and make me appreciate you so much. Thank you for all your visits, calls, post cards, time, thoughts, love – I know living away sucks and makes everything harder, but I am so glad we make it work anyway! Everybody, and especially **Kerrin**, **Rebecca** and **Cosima**, I am glad to have you by my side. **Family** in Germany and Trinidad, you are simply the best – better than all the rest.

I am the luckiest person in the world to have two such wonderful families who totally have my back. I am extremely grateful to have you. Thank you **Mama** for helping me make this dissertation pretty, **Papa** for managing all crises, and **Jakob** for offering me to come and live in your attic, just in case I don't make a fortune by doing linguistics...

Tom and **Oskar** – you are life savers. One of the best decisions to bring you into our life... Thank you PhD for making me geographically bound for long enough to justify getting cats!

Rehana, you know that I would not have been able to do everything without your support – and definitely would not have wanted to. Thank you for being in my life and for making it beautiful. I am so glad that I get to share everything with you – now and forever.

And then also thank you to everyone I forgot in here... of course I did not have the foresight to keep a list of all the people who crossed paths with me during this PhD and all the little suns and rays brightening up my life throughout.

Thank you to you all!

CURRICULUM VITAE

Hannah Lutzenberger was born in 1991 in Starnberg, Germany. In 2011, she obtained her Bachelor's degree in Sign Languages from Hamburg University, Germany, and in 2017, her Master's (research) degree in Linguistics with a specialisation in Sign Language Linguistics from Universiteit van Amsterdam, The Netherlands. During her Bachelor's degree she spent six months studying at Universite Paris VIII, France. After obtaining her Bachelor's degree, Hannah was a research intern at the International Institute for Sign Languages and Deaf Studies (iSLanDS) at University of Central Lancashire with Prof. Ulrike Zeshan and at the Max Planck Institute for Psycholinguistics in Nijmegen with Dr. Connie de Vos where she accompanied Dr. de Vos to Bengkala for the first time. During her studies, she worked as a research assistant in the Language and Cognition Group headed by Prof. Dr. Steve Levinson at the Max Planck Institute for Psycholinguistics, working with Steve Levinson, Connie de Vos and Harald Hammarström.

In 2017, Hannah began her PhD within the Sign Language Linguistics Group and the First Language Acquisition Group at the Centre for Language Studies at Radboud University.

Currently, Hannah is a postdoctoral research fellow in the ERC SignMorph project awarded to Prof. Dr. Adam Schembri at Birmingham University.

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