Emergence of Lexicons in Family-Based Homesign Systems in Nicaragua

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1 Introduction

Where does language come from? What role do learner and environment play in its development? These are age-old questions that, despite the time and attention paid them, continue to prove difficult to investigate, as nearly all situations of language development have both typical learners and rich environments. Instead, researchers must look to the rare experiments of nature where learner and environment vary independently. In the present work, we investigate such a case: homesigners.

1.1 Homesigns

Homesigners are deaf[1] individuals who are not exposed to and thus do not acquire any signed, spoken, or written language. In the absence of such linguistic input, they develop proto-linguistic gestural systems to communicate with their hearing family and friends. These systems have been shown to have many linguistic properties, such as grammatical subject (Coppola & Newport, 2005), proto-pronouns (Coppola & Senghas, 2010), simple morphological structure (Goldin-Meadow & Mylander, 1990a; Goldin-Meadow, Mylander, & Franklin, 2007), and phonological complexity closer to that of signers than to that of hearing gesturers (Brentari, Coppola, Mazzoni, & Goldin-Meadow, 2012). In addition, hearing family members appear not to fully share (Goldin-Meadow & Mylander, 1990b; 1984) or understand these structures (Carrigan & Coppola, 2012), suggesting that the source of these systems is the homesigners themselves, and not the family members. Thus, there is substantial evidence that homesigners create aspects of syntax, morphology, and phonology *de novo*. However, there is an aspect of language structure that has been not been as thoroughly investigated in these homesign systems: the lexicon.

1.2 Homesign lexicons

Despite being arguably the most fundamental linguistic *and* communicative level of organization of languages, there have been only two studies investigating lexicons of homesign systems: Goldin-Meadow, Butcher, Mylander, and Dodge (1994) and Osugi, Supalla, and Webb (1999). Goldin-Meadow et al. (1994) were primarily concerned with whether a child homesigner named David displayed a noun-verb distinction in his system, but they also investigated the degree of consistency over time of form-meaning mappings of gestures produced in a naturalistic context by David and his hearing mother. They found that, from ages 3 to 5 years (their window of study), 90% of David's 706

[1] We use deaf with a lower-case "d" to refer to homesigners, because, according to the traditional view of membership, they have not entered any capital "d" Deaf community. However, all deaf people, by virtue of living as deaf people in a hearing world, share certain experiences that are common to Deaf cultures around the world.

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gesture tokens (containing 109 lexical types) conformed to prototype[2], and 67% of these types never varied from prototype (the 706 tokens did not include types that only appeared once). In contrast, David's mother showed much less consistency in her form-meaning mappings over time: only 59% of her 290 gestures conformed to prototype (significantly less than David), and only 35% of the 74 gesture types she produced more than once never varied from prototype (again significantly less than David). Goldin-Meadow et al. concluded from these data that David, and not his mother, innovated a lexicon of form-meaning mappings.

While Goldin-Meadow et al. (1994) investigated users' consistency *within themselves over time*, Osugi et al. (1999) examined the extent of lexical consistency *among users at a single time point*. They investigated consistency among 21 deaf and hearing individuals in the Koniya region of Amami Island south of Japan. Due to geographical isolation from the rest of the island and Japan, residents in the Koniya region intermarried at a high rate, leading to a higher incidence of genetic deafness in the area than elsewhere in the population. As a result, many Deaf individuals on the island have contact with other Deaf individuals, and many hearing villagers are familiar with the gestures used by Deaf villagers. This variability in Deaf individuals' contact with other Deaf and hearing individuals allowed Osugi et al. to test whether patterns of lexical consistency among users mirrored their patterns of social interaction. Indeed, using a gestural elicitation method (in contrast to Goldin-Meadow's naturalistic observational method), Osugi et al. found that participants' gestures for 25 basic objects and concepts (20 of which were derived from Swadesh, 1971) overlapped to the extent these participants interacted with one another. Specifically, a family of Deaf (and hearing) individuals and their friends shared forms for 16 items, this group and isolated Deaf individuals shared forms for 10 items, and these two groups and hearing individuals with little to no contact with Deaf people shared forms for only 3 items.

In sum, Goldin-Meadow et al. examined lexical consistency within a child homesigner and his mother, and found greater consistency within the child homesigner; Osugi et al. examined lexical consistency among deaf and hearing individuals, and found that users were consistent with each other to the extent that they interact with each other. Goldin-Meadow et al. and Osugi et al. thus examined two different dimensions of lexical consistency: consistency within individuals over time, and consistency within individuals at a single time point. A more comprehensive investigation of the emergence of lexicons in homesign systems would investigate *both* dimensions of lexical consistency in the same population. We did so in the present study, but we also investigate another crucial element of lexicons: efficiency.

1.3 Lexicon efficienty: Ease and clarity

In addition to having consistent form-meaning mappings, natural language lexicons tend to have an efficient balance between *clarity* of intended meaning and *ease* associated with learning, storing, and retrieving form-meaning mappings (Zipf, 1949; Ferrer i

[2] For frozen forms, the prototype was the most frequent form. For componential gestures that expressed motion events (known as classifier predicates in sign languages), the prototype was determined separately for handshape, location, and movement, again on the basis of frequency of each of these for a given meaning.

Cancho & Sole, 2003; Piantadosi, Tily, & Gibson, 2012)[3]. To illustrate how these two constraints compete, consider a lexicon with a 1-to-1 mapping between forms and meanings – every meaning has its own form (Figure 1a). Such a lexicon is perfectly clear – when a speaker utters a form, the listener knows exactly what the speaker meant – but it would also be impossible to learn, store, and retrieve such an astronomical (perhaps infinite) number of form-meaning mappings.

Contrast the lexicon exemplified in Figure 1a with anoter in which one form is used for absolutely every meaning (Figure 1b). This lexicon is trivial to learn and store, yet leaves the listener completely uncertain as to what the speaker meant. Natural languages of course find an efficient solution to these constraints by using one-to-few mappings between forms and meanings (among other things, like context, which allows the lexicon to sacrifice some clarity for the sake of ease; Piantadosi et al., 2012). However, little is known about how this efficiency emerges (but see Ferrer i Cancho & Sole, 2003 for a simulation of the emergence of efficient lexicons). For example, what determines a lexicon's balance between clarity and ease? We take up these questions in the present study.

a. 

Figure 1a. An example of a lexicon high in clarity and low in ease; a different form (A, B, or C) is paired with each meaning (X, Y, or Z, respectively). The intended meaning is thus unambiguous, but users of the lexicon must learn, store, and retrieve many form-meaning mappings.

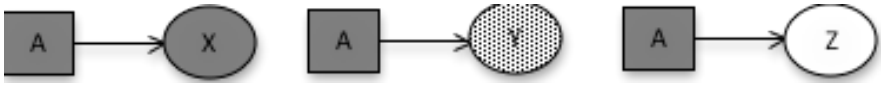
b. 

Figure 1b. An example of a lexicon low in clarity and high in ease: there is a single form (A) for every meaning (X, Y, and Z). The intended meaning is ambiguous, but users only need learn, store, and retrieve one form.

Figure 1. Contrasting lexicons favoring clarity versus ease, respectively

1.4 Present study

Building on Goldin-Meadow et al. (1994) and Osugi et al. (1999), we investigate how lexical consistency in homesign arises both *i)* within individuals, across time, and *ii)* within a time point, across individuals (see Figure 2 for illustrations of these two different dimensions). In addition, we report on the first stage in our investigation of how lexicons of naturally emerging language systems achieve efficiency, focusing here on clarity and ease of production. While Goldin-Meadow et al. (1994) observed their participants in naturalistic situations, we follow Osugi et al. (1999) and use an elicitation method.

[3] Some think of efficiency as minimizing and balancing listener effort and speaker effort (Zipf, 1949; Ferrer i Cancho & Sole, 2003). However, along the lines of Piantadosi et al. (2012), we prefer to recast these as just clarity and ease, respectively. We do this because it is not clear that these pressures fall uniquely upon the listener or the speaker.

Assessing consistency among users necessitates an elicitation method, as observation methods do not guarantee that participants will talk about the same things. Our predictions are as follows:

1. If homesigners and their partners have or are constructing a lexicon like those of natural languages, then consistency among individuals should increase over time, or be at ceiling (insofar as we can test for ceiling[4]).
2. If homesigners are the primary drivers of innovation of the lexicon of the homesign system, then they should be more consistent within themselves over time than are their partners (as in Goldin-Meadow et al., 1994). Similarly, if any individual has a lexicon like those of natural languages, they should be close to ceiling in measures of consistency.
3. Given that homesigners' only communication system is the homesign system, and that their hearing communication partners also have a spoken language, homesigners are behooved to make themselves understood with the homesign system. Accordingly, we expect that homesigners' lexicons will reflect more clarity/less ease than those of their hearing communication partners. That is, we expect homesigners to have lexicons more like Figure 1a, and their partners to have lexicons more like Figure 1b.

X	**Homesigner**	**Partner**
Time 1	A	C
Time 2	A	A

Table 1. This table illustrates predictions 1 and 2 with idealized data for a single meaning X. Observe that the two users grow more consistent with each other over time (Prediction 1), and that the homesigner is more consistent than his/her partner (Prediction 2).

2 Methods

2.1 Participants

Participants were four deaf Nicaraguan homesigners [3 male; aged 11 to 33 years (M=24) at various times of testing] and nine of their hearing family members and friends (4 male; aged 10 to 59 (M=30) at various times of testing; we henceforth refer to these family and friends as *communication partners*). The homesigners have minimal or no interaction with other deaf individuals, including each other, and have minimal or no knowledge of Nicaraguan Sign Language or Spanish, spoken or written. Instead, these homesigners have been using their invented homesign system all their lives. Despite this

[4] As will become clear, we use two measures of consistency here. Only one has a theoretical ceiling, and it doesn't capture the whole picture with respect to consistency. Regardless, we are confident in the conclusions we reach with respect to participants' (lack of) being at ceiling levels of consistency.

lack of linguistic knowledge, they socialize with others, hold jobs, have families, and otherwise have typical lives. Table 2 shows the relationships of individuals within each family group.

Family Group 1	Family Group 2	Family Group 3	Family Group 4
Homesigner	Homesigner	Homesigner	Homesigner
Mother	Mother	Mother	Younger brother
Older brother	Younger brother		Younger sister
Friend	Younger sister		

Table 2. The top row indicates the designation we have given to each family group. Rows 3-5 indicate the relation of the communication partners to the homesigner in their group.

2.2 Stimuli

Stimuli were images of 21 basic objects and concepts (see Appendix for complete list of items). Examples include 'fish', 'boy', and 'hot'. All items were familiar to participants. Nineteen of these objects and concepts were taken from Osugi et al. (1999), which itself was derived from Swadesh (1971).

2.3 Procedure

In 2002, 2004, 2006, and 2011, M.C. showed participants images of the objects and concepts outlined above. Participants were tested individually. Using gesture and non-manual markers, M.C. elicited participants' gestural responses to these images. Participants responded to the camera, *not* to each other, and were not allowed to see each other's productions. All responses were videotaped for later analysis.

2.4 Coding

Participants' responses were coded by J.F. in consultation with R.R. A majority of responses (62%) contained more than one gesture: we coded every gesture individually for its *Conceptual Component* (CC), or aspect of the items' meaning that the gesture iconically represented. For example, a response to 'cow' might contain two gestures, one iconically representing horns (its CC is thus HORNS) and another iconically representing milking (its CC is thus MILKING).[5] See Table 3 for example responses to 'cow' for two different participants across the four time points (and for an illustration of how we calculated the measures of consistency).

2.5 Measuring Consistency

To measure consistency in CC's among multi-gesture responses, we borrowed two measures of consistency from Meir, Aronoff, Sandler, and Padden (2010): Mode and

[5] We have also coded every gesture for its formal components, but this coding does not bear on the current analysis, and so we do not discuss it further.

Number of Variants (NoV). Mode is simply the proportion of responses containing the most frequently used CC. NoV, as used by Meir et al., is simply the number of unique types of Conceptual Components used by a participant over time, or by a homesigning group at a given time point. Meir et al. took a higher value as evidence of less consistency, but this number by itself can be misleading. Consider two participants, one who always expresses 'cow' using a gesture depicting HORNS, and another who always expresses 'cow' by gesturing MILKING + HOOVES. NoV would make the latter participant look more consistent than the former (1 NoV vs 2 NoV), even though each participant *always* used their respective form. Dividing Number of Variants by the number of *tokens* across responses corrects for this (in corpus linguistics, such a measure is of course called Type/Token ratio – we use this term here). Now, if these two participants both participated 4 times, they would have equal Type/Token ratios (1/4 = 2/8). See Figure 1 for sample calculations of these measures of consistency.

'cow'	Homesigner	Mother
2002	**MILKING** + *HORNS*	**MILKING** + HOOVES
2004	HOOVES	MILKING + HORNS
2006	No data	HORNS
2011	*HORNS* + ANIMAL	MILKING

Table 3. Example responses to 'cow' for two participants at the four time points. The homesigner's Modal CC *(HORNS*) proportion is 2/3 (66%), and their Type/Token ratio is .80 (4/5). In 2002, the Modal CC (**MILKING**) proportion among the homesigner's and mother's gestures is 2/2 (100%), and their Type/Token ratio is .75 (3/4).

2.6 Measuring ease/clarity

Recall that lexicons that contain more clarity/less ease differentiate forms for different meanings more than lexicons that contain less clarity/more ease (the intended meaning is clearer when its corresponding form is not similar to other meanings' forms). By measuring the degree to which they used different CC's for different objects and concepts, we assessed the ease/clarity of participant's lexicons at a particular time point. In other words, we measured the average 'distance' between each pair of responses given by a participant in a particular year [there are $\binom{21}{2}$, or 210 possible pairs of responses[6]]. By treating each CC observed in the entire dataset as a dimension in a conceptual space, each response constituted a point in this space, taking a 1 on a dimension if it contained that CC, and a 0 if it did not. Ease/clarity was thus the average Euclidean distance between each possible pair of responses for a given participant and year. Table 4 illustrates such responses and calculations in a simplified conceptual space.

3 Results

We present results supporting our third prediction (regarding clarity/ease) first, as this was the novel aspect of our study and turned out to be the only measure on which homesigners differed significantly from their communication partners. Recall that a lexicon with greater average distance among pairs of responses means forms are more

[6] $\binom{21}{2} = \frac{21!}{2!(21-2)!} = 210.$

differentiated for different meanings, which in turn reflects greater clarity and less ease (in learning, storage, and retrieval). Because no clear patterns emerged for change of lexicon distance over time, we averaged individuals' measures of lexicon distance across their years of participation. Doing so, we found that all nine communication partners had lower distances within their lexicons than their corresponding homesigner (Exact Binomial Test, $p < .001$), reflecting more clarity and less ease, in homesigners' lexicons.

	Conceptual Component Dimensions (subset)						
Item	CUT	EAT	SMALL-OBJECT	UPROOT	MIX	HORNS	MILKING
'orange'	1	1	1	0	0	0	0
'potato'	1	1	0	1	1	0	0
'cow'	0	0	0	0	0	1	1

Table 4. A simplified conceptual space for a single participant and year. A response receives a 1 on a dimension if it contained that Conceptual Component, and a 0 if it did not. The distance between two responses is the sum of the differences between their values on each Conceptual Component dimension. For example, 'orange' and 'potato' don't differ on four of the seven dimensions here (CUT, EAT, HORNS, AND MILKING), but they do differ on SMALL-OBJECT, UPROOT, and MIX, each of which contributes 1 to the distance measure, for a total distance of $\sqrt{3}$. The same formula is applied to each of the other pairs across the dataset. In the simplified example given here, ease would be the average of the distance between 'orange' and 'potato', 'orange' and 'cow', and 'potato' and 'cow', or $(\sqrt{3} + \sqrt{5} + \sqrt{6})/3 = 2.14$.

We now turn to our two predictions regarding consistency within individuals and within groups. Table 5 summarizes consistency within individuals, across time. Table 6 summarizes consistency within a group, at a time point. It is clear from the Mode data that users and groups are not at ceiling levels of consistency, as would be expected in a completely conventionalized natural language lexicon.

Group		Group 1				Group 2				Group 3		Group 4		
Participant		**Hser**	CP1	CP2	CP3	**Hser**	CP1	CP2	CP3	**Hser**	CP1	**Hser**	CP1	CP2
Modal CC	Mean	**0.78**	0.85	0.81	0.89	**0.93**	0.81	0.91	0.73	**0.92**	0.86	**0.95**	0.95	0.86
	SD	**0.18**	0.17	0.22	0.21	**0.15**	0.21	0.15	0.23	**0.14**	0.22	**0.15**	0.15	0.23
Type/ Token	Mean	**0.59**	0.55	0.52	0.75	**0.57**	0.64	0.57	0.66	**0.59**	0.64	**0.75**	0.69	0.75
	SD	**0.13**	0.18	0.19	0.19	**0.16**	0.21	0.18	0.23	**0.10**	0.19	**0.16**	0.18	0.22

Table 5. Within-participant, across time consistency. **Bolded** participants are homesigners; others are communication partners. Homesigners are not reliably more consistent than their partners.

To assess our first prediction – that individuals within homesigning groups would become more consistent with each other over time – we conducted eight repeated measures ANOVA's (two measures of consistency x four homesigning groups). No

significant linear or quadratic trends were obtained for either Type-Token ratio (p's >.05) or for Mode (p's >.05), thus providing no support for this prediction.

	Group	Group 1				Group 2			Group 3			Group 4	
	Year	2002	2004	2006	2011	2002	2004	2011	2002	2004	2011	2004	2011
Modal CC	Mean	0.71	0.70	0.74	0.64	0.81	0.81	0.89	0.93	0.80	0.88	0.89	0.86
	SD	0.19	0.22	0.23	0.17	0.20	0.20	0.15	0.18	0.22	0.16	0.17	0.15
Type/ Token	Mean	0.56	0.54	0.68	0.55	0.53	0.57	0.50	0.74	0.80	0.65	0.53	0.50
	SD	0.15	0.20	0.20	0.12	0.11	0.16	0.14	0.16	0.18	0.16	0.12	0.10

Table 6. Within-group consistency at each time point. Data were not available for each time point for all families. Consistency is generally low, and no significant trends were obtained.

To assess our second prediction – that homesigners would be more consistent than their partners – we conducted two kinds of analyses. In the first, we conducted paired samples t-tests between each homesigner and each of their partners. For Type-Token, 8 of 9 paired samples t-tests were not significant (p's > .05). The only significant result revealed a partner (a friend of HS1) who had a lower Type-Token ratio than Homesigner 1, (p < .005), indicating the friend's greater consistency, which is the opposite direction than expected. Similarly, on Mode, 6 of 9 paired samples t-tests were not significant (p > .05). Two of the three significant t-tests revealed that HS2 had higher Mode's than his brother and sister (reflecting greater consistency in HS2, p < .05 and p < .005, respectively), while the third revealed that HS1 had a lower Mode than his friend (reflecting lower consistency in HS1, p < .05). In our second analysis, we tested whether more partners were less consistent than their corresponding homesigners than would be expected by chance. Only 4 of 9 partners had higher Type-Token ratios than their corresponding homesigner (Exact Binomial Test, p >.75), and only 6 of 9 partners had lower Modes than their corresponding homesigner (p > .25). Thus, almost entirely across the board, results failed to support the prediction that homesigners would be more self-consistent than their partners.

4 Discussion

In this study, we investigated the emergence of lexicons among four deaf Nicaraguan homesigners and their hearing family members and friends. We first focused on consistency of form-meaning mappings, both within users across time, and across users at a time point. First, for all groups and time points, consistency among individuals was never close to ceiling (1.0) on the Mode measure of consistency (there is no ceiling on Type-Token). Further, for all groups, we found no reliable trends over time towards increasing consistency of form-meaning mappings among users, by either measure of consistency (Type/Token ratio and Mode). Similarly, neither homesigners nor their partners were at ceiling on Mode. In addition, we found that homesigners and their partners did not differ reliably in consistency, by either of these measures. In contrast, we found that homesigners' lexicons very reliably contain more clarity/less ease than their partners'. Below we discuss these findings and their limitations, as well as our current directions.

As stated above, ceiling levels of consistency were not found within individuals or groups, nor did groups increase in their consistency over time. We thus have not found positive evidence that these Nicaraguan homesigning systems have or are in the process of constructing lexicons like those of natural languages. If this null result is not a false negative (and we are circumspect in interpreting a null result), this lack of a feature of natural languages in homesign systems would contrast with the many natural language properties found by previous studies (Goldin-Meadow, 2003; Coppola & Newport, 2005; Coppola & Senghas, 2010). Why might homesign systems have this gap in their linguistic richness? Besides the possibility that our measures and/or materials are insensitive (an issue we return to later in this section), we have a more theoretical two-part answer. The first part of the answer is simple: while features of language found in homesign (e.g. grammatical subject; Coppola & Newport, 2005) might be resilient to variations in linguistic input, form-meaning mappings obviously must be learned from the language input, or created *de novo*. Why might homesigners and their partners *not* conventionalize such mappings, then? Our best answer lies in the highly asymmetric communicative pressures facing homesigners and their partners alluded to in the introduction. While the homesigner is under great pressure to invent a system (they have no other way to communicate their needs), hearing communication partners are not—they can use their spoken language to communicate with almost everyone. This contrasts with the situation and findings on Amami island, where many Deaf people interact with each other, leading to high and symmetric communicative pressure to communicate via signing, which in turn leads to consistency in form-meaning mappings (Osugi et al., 1999).

We have less certainty of what might account for our lack of a difference between homesigners and their communication partners in measures of consistency. We expected that, if homesigners are driving creation of the lexicon of the homesign system, homesigners' form-meaning mappings should be more consistent than that of their partners. We did not find this result. This contrasts with suggestive positive evidence that homesigners drive other innovations of homesign structure (e.g. argument structure, Carrigan & Coppola, 2012). But why do our results contrast with those of Goldin-Meadow et al. (1994), who found that the child homesigner David was more internally consistent than his mother? One explanation is that, in accordance with the above, the homesign system(s) simply do not have and are not creating lexicons, and thus there is no "leading the innovation" for homesigners (or partners) to do. A second possibility concerns cultural differences. In general, Nicaragua is a "gesture-friendly" culture, and specifically, hearing parents of deaf children in Nicaragua gesture more with their deaf children than do hearing parents in America (Coppola, Mylander & Goldin-Meadow, 2006). David's mother thus may have made less of an effort to form a self-consistent lexicon (or a lexicon consistent with David, for that matter). A third possibility is that, assuming the Nicaraguan homesigning systems *do* have a lexicon (and that we failed to detect ceiling or increasing consistency effects), the homesigners *did* drive their formation, but that communication partners have *caught up* to them. The Nicaraguan communication partners have had many years (decades, even) to do so, in contrast to David's mother, who had only observed David's signing for two years during and prior to testing.

We believe asymmetry in communicative pressures also explains our main finding, that homesigners' lexicons contain less ease but greater clarity than do their partners' lexicons. Recall that lexicons face competing pressures for clarity and ease (in learning,

storage, and retrieval). Thus, while communication partners can almost always communicate with (and convey their needs with) their spoken language, they are not under such pressure to be clear with the homesign system. This contrasts with the situation facing homesigners, who can only communicate with their homesign system, and thus understandably will try to be clearer using their gestures, despite the increased costs in ease. As suggestive as this finding regarding lexicon ease/clarity is, these data only speak to how clear the systems are in principle. That is, we do not know whether these increases in clarity-in-principle translate to actual increases in real-life comprehension. To assess this, we recently collected data on homesigners' and communication partners' comprehension of each other's lexical productions. These data will enable us to *i)* determine whether clarity-in-principle is related to actual comprehension, and *ii)* determine whether homesigners' systems are, overall, more efficient (by combining comprehension scores with our measure of clarity/ease).

As rich as our dataset and analyses are compared to other investigations of homesign lexicons, the current study's methodology was nevertheless limited. First, it is possible that the gestures we collected do not reflect participants' standard gestures for the objects/concepts we showed them (i.e., participants might be making up signs on the spot). The current data do not allow us to test this, but running our task on people not familiar with the homesigners or their families would: if homesigners and their families were more consistent with each other than with strangers, then that would be evidence for true conventions among the families themselves. Second, we assessed consistency across entire family groups, rather than within pairs of individuals. Perhaps there is no convergence among the entire group, but rather between homesigners and particular individuals; we are currently investigating this possibility. Third, while we used two measures of consistency that each captured different aspects of the consistency present in multi-gesture responses, it was not clear how they could be combined for a single, comprehensive measure of consistency. We are currently developing such a comprehensive measure. Fourth, as is readily apparent from the stimuli in the appendix, the images are not well-controlled. Some are simply not clear representations of the target object/concept (e.g. 'cold'). Others contain additional objects besides the target object/concept (e.g. the image for 'boy' has a very salient but irrelevant cummerbund). In addition, there is nothing in the stimulus set or in the procedure to constrain participants' responses to the desired level of category hierarchy. For example, when responding to the image for 'dog', there is nothing to prevent participants from providing their form for superordinate ('animal') or subordinate (e.g. 'beagle') level categories, rather than the intended basic level category ('dog'). Similarly, there is nothing in the stimuli or procedure to prevent participants from simply *describing* the image, rather than giving their (compound) *word/sign* for the image, nor can we apply the typical tests to participants' productions to differentiate descriptive phrases from compounds (Meir et al., 2010). We recently piloted new stimuli that addressed all these issues. In these stimuli, all images are photographs of *objects* (no concepts or properties). In addition, each object type is represented in the stimulus item by three *tokens* of that object. This helps constrain participants' responses to the desired level of category structure (Tenenbaum & Xu, 2007), and makes participants less apt to describe individual objects.

5 Conclusion

In sum, we found that homesigners and their families did not possess maximally consistent form-meaning mappings—within individuals or across groups—nor did we

detect increasing consistency in form-meaning mappings among groups. We tentatively interpret this null result as evidence that lexicon creation requires a community, or at least multiple individuals, who face high and equal pressure to use an emerging communication system. Similarly, we found no evidence that homesigners were more consistent than their partners in their form-meaning mappings. There are many possible reasons for this null result, so we are more circumspect in interpreting it. Last, we found that homesigners' lexicons contained greater clarity/less ease (at least in principle; we are currently investigating whether this translates to greater comprehension in practice). We interpret this finding as evidence that communicative pressure plays another role in shaping the lexicon—greater communicative pressure tilts the clarity/ease balance toward greater clarity at the cost of ease.

These findings are thus a step toward filling the gap in what we know about the emergence of language in general, and about the emergence of lexicons in particular. We built on prior investigations of homesign lexicons (Osugi et al., 1999; Goldin-Meadow et al., 1994), in terms of richness of research questions—in particular, the previously uninvestigated issue of lexicon efficiency—data, and analyses. Future work will refine and expand upon these findings using improved materials and analytic techniques.

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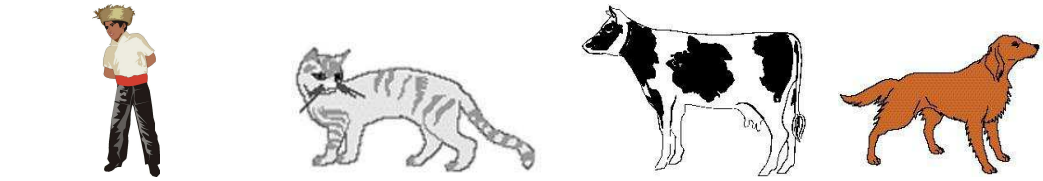
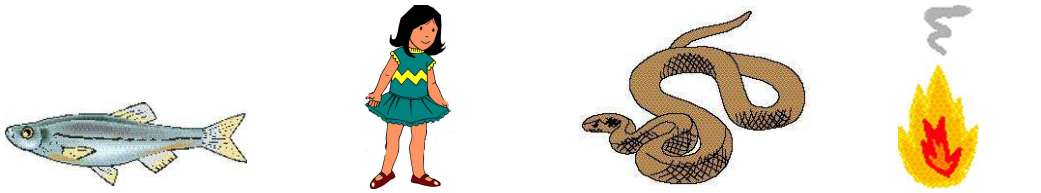
Appendix

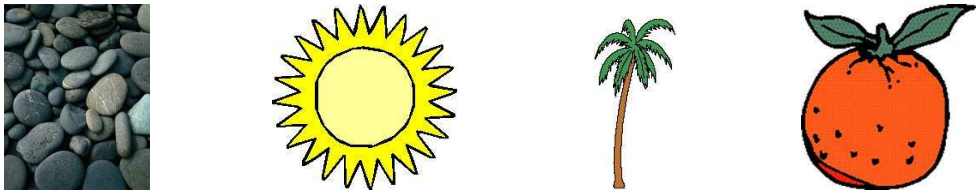


‘boy’ ‘cat’ ‘cow’ ‘dog’



‘fish’ ‘girl’ ‘snake’ ‘fire’

‘flower’ ‘moon’ ‘rain’ ‘stars’



‘stones’ ‘sun’ ‘tree’ ‘orange’

‘potato’ ‘cold’ ‘cold’ ‘hot’ ‘hot’

Figure. Stimulus items in order or presentation. Items were presented individually.