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Mothers Do Not Drive Structure in Adult Homesign Systems: Evidence from Comprehension

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Abstract

Some profoundly deaf individuals without conventional linguistic input develop gestures, called “homesign,” to communicate. We examined homesign systems (HSs) used by four deaf Nicaraguan adults (ages 15-27), and evaluated whether homesigners’ mothers are potential sources for these systems. Study One measured mothers’ comprehension of descriptions of events (e.g., “A man taps a woman”) produced in homesign and spoken Spanish. Mothers comprehended spoken Spanish descriptions (produced by a hearing child) better than homesign descriptions, suggesting a greater degree of sharedness for spoken Spanish. Study Two compared the homesign comprehension of each homesigner’s mother to that of a native user of American Sign Language (ASL). ASL Signers performed better than mothers, confirming that homesign productions contain comprehensible information, to which mothers are not fully sensitive. Taken together, these results suggest that mothers are not the source of their deaf child’s HS, and add to evidence that HSs are more like language than like gesture.

Keywords: Language acquisition; homesign; deafness; language creation; gesture; sign language; Nicaragua

Introduction

The language sciences have long grappled with the question of what drives language acquisition. At the heart of this debate is the question: What are the contributions of language input versus the contributions of the learner? It can be difficult to disentangle these two factors in typical language acquisition situations, as such situations do not offer the opportunity to experimentally manipulate the presence of linguistic input.

Studying spontaneously occurring cases of degraded linguistic input can help discern human predispositions for language learning. Previous research has shown that children can surpass their linguistic input (e.g., Singleton & Newport, 2004, Senghas & Coppola, 2001). In addition, some deaf children born into hearing families have no access to signed or spoken linguistic input. While their parents primarily speak, and do not use gesture with them, these children nevertheless use a system of manual gestures, called “homesign,” to communicate. Homesign has many, but not all, of the features of fully developed languages (e.g., a stable lexicon, basic syntax and morphology, Goldin-Meadow,

2003). The gestures and gesture combinations produced by the mothers of child homesigners lack the morphological and syntactic structure observed in the children’s productions (e.g., Goldin-Meadow & Mylander 1984, 1990; Goldin-Meadow et al. 1994, Goldin-Meadow 2003). While mothers’ gestures may serve as an initial foundation for their deaf child’s homesign system, children surpass whatever “input” they might receive from their mother. These mothers tended not to engage in gestural communication with the child homesigners, and such child homesigns are used for a relatively short time, until the children reach school age. It is possible that, given increased gestural communication and a lengthier period of use, mothers might play a greater role in the development of homesign systems.

This research examines homesign systems developed *with communication partners who engage homesigners using gesture*, unlike the young deaf children studied by Goldin-Meadow and her colleagues. In Nicaragua, we can locate rare cases in which deaf individuals develop and use homesign systems as their primary means of communication for their entire lives. These individuals are not part of the Deaf community that uses the recently emerged Nicaraguan Sign Language (NSL) (Senghas, 1995; Senghas & Coppola, 2001). The homesigners do not learn conventional sign language, and they have not acquired the Spanish spoken around them.

These mature homesign systems display many linguistic features, for instance, the grammatical relation of Subject (Coppola & Newport, 2005), proto-pronouns (Coppola & Senghas, 2010), use of space, and devices for establishing reference (Coppola & So, 2005). Given the accumulated interactions over time between a homesigner and his or her family members, and the more abstract, language-like devices that homesigners produce, it is possible that these family members may have contributed more to the development of the homesign system than the mothers of the homesigners Goldin-Meadow & colleagues observed. One step in determining the source of the linguistic features we observe in mature homesign is evaluating family members’ potential contributions.

Study One

We begin by evaluating homesigners’ mothers as potential sources, because they each have significant gestural

communication experience with their deaf child, and because this type of transmission (mother to child) parallels that of typical language acquisition situations. One approach would be to compare Mothers' and homesigners' gesture productions. However, comparing their productions now does not allow us to assess Mothers' role in the *development* of their child's homesign system, especially in cases where Mothers' and homesigners' productions are similar. Looking instead at how well Mothers comprehend homesign productions can address this. We reason that, if mothers served as models for homesigners' abstract linguistic devices, they should comprehend their child's homesign productions.

Study One: Predictions

If mothers invent and pass down homesign systems to their deaf children in the same way that they serve as models for the spoken Spanish acquired by their hearing children, we would expect mothers to comprehend descriptions of events produced by their deaf child at least as well as they comprehend spoken Spanish descriptions of the same events produced by one of their hearing children.

Participants

Producers: Four deaf adult Nicaraguan homesigners (1 female), ages 16-26 *at the time of production*, produced the descriptions used as stimuli for this task. All four homesigners were deaf, with *very* minimal knowledge of spoken or written Spanish. Some could produce and/or comprehend a limited number of common spoken Spanish words, such as "mamá," "papá," and "agua" (water). All find writing their names effortful. They had had little to no formal education, had not acquired Nicaraguan Sign Language (NSL), and *do not interact with each other*.

Four hearing siblings of homesigners (1 female), ages 17-43. The siblings were native monolingual Spanish speakers, had an average of 8.5 years of education (range 0-14), and had not acquired NSL.

Receivers: Four hearing mothers (henceforth "Mothers") of homesigners, ages 45-60. The mothers were native monolingual Spanish speakers, had an average of 2.25 years of education, and had not acquired NSL.

Materials

The stimuli were **descriptions** of 83 simple videotaped events involving live actors and real, everyday objects. The events had one or two participants; the two-participant events included all combinations of animate and inanimate. The two animate participants in the events were the same man and woman throughout, and the inanimate participants were objects such as "cup," "banana," and "flower." Example events include "A man kisses a woman" and "A sheet of paper falls".

The comprehension array used in this task included four pictures. One picture always depicted the target event. For one-participant events, the non-target foil pictures could

depict: a) the same participant/object involved in a different action *or* state ("Other Action"); b) a different participant/object involved in the same action/state ("Other Entity"); or c) a different participant/object involved in a different action/state ("Unrelated"). For two-participant events, the non-target foil pictures could depict: a) the same participants involved in reversed thematic roles ("Reverse"); b) one participant involved in the same action with a different entity ("Other Entity"); c) the same two participants involved in a different action ("Other Action"); or d) one participant involved in an unrelated action (either with or without a second entity; "Unrelated"). Because these materials were originally designed as an elicited production task (Coppola & Newport, 2005, which also lists the stimulus items), the comprehension arrays are not standardized across all items, and contain different combinations of foil types.

Homesign descriptions were produced by the homesigners described above. We videotaped these descriptions, then clipped and compiled them into QuickTime video files.

Spoken Spanish descriptions of these same events were produced by a hearing sibling of each homesigner, in the presence of their Mothers.

Procedure

Each Mother watched the videotaped homesign descriptions (83 total) produced by her own deaf child. The task is divided into two subtests, each beginning with 3 practice items, to ensure that mothers understood how to do the task¹. Mothers watched each description as many times as they wanted, then selected, from an array of four pictures, the picture that best matched that description. One picture was a still from the target (correct) event, and the others were distracters.

Mothers also completed the task using spoken Spanish descriptions of events produced by one of their hearing children in real time. The order of the homesign and spoken Spanish tasks was counterbalanced.

Results & Discussion

The Mothers comprehended homesign descriptions at rates significantly better than chance (25%; exact binomial test, $p < 0.001$).

However, despite performing above chance, Mothers comprehended spoken Spanish descriptions better than they comprehended homesign descriptions of the same events (For 3 mothers, $p < 0.05$, McNemar's Test for Correlated Proportions; fourth mother, $p = 0.057$). This result acts as a built-in control, showing that Mothers are not having trouble with the task itself, but rather with the content of the homesign descriptions.

¹ We are confident that mothers understand how to do the task, as all of them have completed it in the past, though typically with live descriptions from their deaf child.

Comparing Receivers' comprehension to different reference levels of performance (e.g., 25%, 33%, 50%) can give us clues as to how much of the descriptions (homesign or spoken Spanish) they understand. For example, in an event like "A man kisses a woman," the picture choices show: a) A man pushing a chair; b) A man sitting; c) A man kissing a woman (the correct choice); and d) A woman kissing a man. One homesigner's description of this event was glossed as MAN WOMAN KISS. If the Receiver understands the gestures for the participants, or even just the action gesture the homesigner produced for this event description, picture choices (a) and (b) could be eliminated. It is also possible for Receivers to narrow their choices based solely on a general, non-linguistic strategy. They might have noticed, for instance, that two of the picture choices contained the same two actors, engaged in the same action (although in different thematic roles), and reasoned that the correct choice must be one of those two pictures.

The performance of three of the four Mothers does *not* differ significantly from 50%. Regardless of the strategy they might be using to complete the task, Mothers' performance indicates that they do not understand enough of the homesign description to reliably select the right picture; however, we may not be able to make claims from these data about exactly what Mothers do understand. In future work, will more carefully control participants' cognitive ability (including use of general strategies to complete tasks such as these), and be designed to isolate which aspects of the homesign descriptions mothers do understand (see the Results & Discussion section of Study Two for a brief attempt at the latter with these data).

Mothers' poorer comprehension of homesign versus spoken Spanish descriptions suggests that Mothers play a different role in the communicative development of their hearing and deaf children: they share, and are likely a main source of spoken Spanish input for their hearing children, but do not share or transmit homesign to their deaf children. This finding accords with previous studies of the structure in child homesign, which is also not attributable to the deaf children's mothers (Goldin-Meadow & Mylander, 1984).

Study Two

Each mother has had between 20 and 30 years of experience communicating with her deaf child; why should their comprehension levels be so low? One could argue that the homesign descriptions themselves are the cause; perhaps Mothers fully understood the descriptions, but the descriptions themselves did not contain sufficient information for mothers to succeed at the task. It also might be the case that factors such as age of exposure to a visual communication system, and quantity and/or length of time of experience with that system, play a role in comprehension.

Study Two: Predictions

If ASL Signers comprehend homesign productions at levels equal to or worse than homesigners' Mothers, it might be

the case that those productions do not contain sufficient information to allow *any* Receiver to succeed at the task. If, however, ASL Signers comprehend homesign descriptions better than Mothers, the descriptions do contain enough information to succeed at the task.

Participants & Methods

Four fluent Deaf users of ASL (3 females), ages 21-66, who did not know the homesigners or their homesign systems, participated in this study. The ASL Signers had all been exposed to ASL before the age of five, used ASL every day, and had an average of 15.25 years of education. We paired each ASL Signer with one homesigner's Mother; that ASL Signer watched the same homesigner's productions as did the Mother, and chose, from the same picture array, the photo that matched each event description.

Unlike the Mothers, at the start of the task the ASL Signers saw the 6 practice items, which all involved the man and/or the woman, to ensure that they had learned the homesigner's lexical items for "Man" and "Woman." As previously mentioned, the man and the woman in the events were always played by the same male and female actor; thus, neither the producers nor receivers in the task ever had to distinguish one man or woman from another. ASL Signers were, as Mothers were, allowed to watch each description as many times as they wanted (they watched most descriptions no more than once). ASL Signers and Mothers thus had roughly equal exposure to these stimuli (although each Mother still had vastly more experience with her deaf child's homesign system than the ASL Signer with whom she was matched).

Results & Discussion

Like homesigners' Mothers, ASL Signers comprehended homesign descriptions at rates significantly better than chance (25%; exact binomial test, $p < 0.0001$). Furthermore, ASL Signers comprehended the homesign descriptions they viewed better than that homesigner's Mother (For 3 pairs, $p < 0.01$, McNemar's Test for Correlated Proportions; fourth pair, $p = 0.851$). Thus, the homesign descriptions *did* contain sufficient information to allow a receiver to successfully complete the task. Mothers did not succeed for some other reason; we explore this further in subsequent analyses.

Item Type and Error Analyses In order to better understand which aspects of homesign production drive comprehension (or non-comprehension) by receivers, we examined how features of the items themselves might influence comprehension of homesign descriptions. The events had one or two animate or inanimate participants; all events with two animate participants, that is, "Reversible" events (e.g. "A man kisses a woman"), included a distracter picture that depicted reversed roles for the participants (e.g. "A man kisses a woman").

To show correct comprehension of "Reversible" event descriptions Receivers need to understand how the arguments represented by the lexical items relate to the

verb. That is, they need to understand the structure of these descriptions. Comprehension of “Non-Reversible” event descriptions, in contrast, only necessitates that the Receiver recognize and remember the lexical items produced by the homesigner.

On the Non-Reversible events (collapsing across number of participants, $n=52$ items), all four ASL Signers performed significantly better than chance (25%; exact binomial test, $p<0.0001$). Mother also performed significantly above chance on this subset of items ($p<0.01$).

Comparing Mothers to ASL Signers, we see the same pattern as for the overall analyses: the same three out of four ASL Signers do significantly better than the Mothers with whom they are paired at comprehending the non-reversible events (For three pairs, $p<0.001$, McNemar’s Test for Correlated Proportions; fourth pair, $p=0.359$). This indicates that even when comprehension relies only on recognizing and remembering the lexical items, Mothers did not succeed. This is particularly surprising given that: a) Mothers were allowed to view the descriptions as many times as they wanted; and b) Mothers have had much more practice with homesigners’ lexical items (indeed, with each homesign system in general) than did the ASL Signers (20-30 years interacting with the homesigner and using the homesign system, as opposed to one hour viewing homesign descriptions for the ASL Signers). The Mothers’ apparent lack of comprehension of lexical items does not necessarily indicate that they did not recognize them—they might have difficulty processing the lexical items in real time, even with repeated viewings.

Table 1 presents an analysis of the incorrect foil types chosen for Non-Reversible items (again, collapsing across 1- and 2-Participant items).

Table 1: Errors on Non-Reversible Items
(Proportion of each foil type chosen)

Participant	Unrelated	Other Entity	Other Action	Total Number of Errors
ASL 1	0.22	0.22	0.56	9
Mother 2	0.31	0.45	0.24	29
ASL 2	0.38	0.38	0.25	8
Mother 2	0.23	0.77	0.00	13
ASL 3	0.33	0.00	0.67	6
Mother 3	0.43	0.30	0.26	23
ASL 4	0.13	0.38	0.50	8
Mother 3	0.32	0.48	0.20	25

Each Mother chose the “Other Entity” foil more often than the ASL signer with whom she was paired. This indicates that Mothers are poorer than ASL Signers at understanding or remembering the homesign gestures produced for the participants in these items.

Comparing Mother-ASL Signer pairs on the Reversible 2-participant events ($n=16$), only 1 ASL signer performed significantly better than the Mother with whom he was paired ($p<0.05$, McNemar’s Test for Correlated

Proportions). However, this lack of a difference between Mothers and ASL Signers may be due to the small number of items on which the comparison is based.

If, as discussed in Study One, Receivers understand something about the lexical items the homesigner produces in a description (either for the participants *or* the action in an event), they should be able to narrow their picture choices to two for the Reversible items. Previous work with three of the four homesigners who produced these event descriptions has demonstrated that they reliably place the noun phrase expressing the subject in clause-initial position (Coppola & Newport, 2005). If Receivers are further sensitive to the systematic way homesigners represent argument structure, we would expect to see comprehension of these reversible event descriptions at rates significantly above 50%.

Table 2: Proportion Correct on Reversible Items

Participant	Number Correct	Number of Reversible Items	Difference from 50%, Exact Test, p-value (2-tailed)
ASL1	8	16	0.598
Mother 1	9	16	0.402
ASL 2	11	15	0.059†
Mother 2	11	15	0.059†
ASL 3	15	16	<0.001*
Mother 3	8	16	0.598
ASL 4	11	15	0.059†
Mother 4	5	15	0.941

*: significant †: marginally significant

Three out of the four ASL signers performed significantly or marginally better than 50% correct on the reversible items, compared with only one of the Mothers (Table 2).

An analysis of the incorrect foil types chosen for Reversible items can be found in Table 3.

Table 3: Errors on Reversible Items
(Proportion of each foil type chosen)

Participant	Unrelated	Other Entity	Other Action	Reverse	Total Errors
ASL 1	0.13	0	0	0.88	8
Mother 1	0.14	0.14	0	0.71	7
ASL 2	0	0	0	1.00	4
Mother 2	0	0	0	1.00	4
ASL 3	0	0	0	1.00	1
Mother 3	0	0.13	0	0.88	8
ASL 4	0	0	0	1.00	4
Mother 4	0.30	0.10	0	0.60	10

Both Mothers and ASL Signers chose the “Reverse” foil most often when they erred, although Mothers showed slightly more variability than ASL Signers. The fact that Mothers mostly selected the “Reverse” foil means that they were likely narrowing the picture choices for this type of item to just the “Correct” and “Reverse” pictures. As

outlined in the Results & Discussion section of Study One, for most of the Reversible items, it is possible to narrow choices using three strategies: 1) By understanding the gesture produced for the two participants in the event; 2) By understanding the gesture produced for the action in the event; or 3) By using a general test-taking strategy that assesses the similarity of the different foil pictures. The data from the Error Analysis of Non-Reversible items indicate that Mothers do *not* always recognize or remember the gestures produced for the participants in an event, which allows us to eliminate the first candidate strategy. It is likely, therefore, that Mothers are able to narrow their options for the correct picture either via an understanding of the action or event gesture produced by the homesign (which tends to be highly iconic), or via a direct comparison of the picture foils to one another.

The results of the comparison to fifty percent and the Error Analysis for Reversible items indicate that, although ASL Signers' comprehension of homesign descriptions is not error-free, they comprehended enough of both the lexical items and the structure to outperform the homesigners' Mothers. Indeed, the ASL Signers' errors are understandable, since their experience with the homesign systems is so limited.

The success of ASL signers indicates that the homesign descriptions do contain systematic, comprehensible information. Homesigners' Mothers, despite their much greater experience with the individual homesign systems, are apparently not sensitive to the information that ASL Signers are presumably using to succeed in the task.

General Discussion

Taken together, the results of Studies 1 and 2 suggest that Mothers do not directly transmit homesign systems to their deaf children. Mothers' comprehension of their adult child's homesign system is relatively poor; this lack of understanding apparently persists despite the fact that Mothers report regularly using gesture to communicate since their now-adult offspring were children. These findings do not preclude the possibility that Mothers' gestures served as a foundation for their child's homesign system. However, these data do indicate that Mothers are *not masters* of their adult child's homesign system, which tells us that, at present, homesign is qualitatively different for Mothers than it is for homesigners. This, in turn, suggests that it is homesigners rather than Mothers who drive the development of their homesign systems.

Our failure to find a statistically significant difference between Mothers' and ASL Signers' comprehension of reversible events is likely due to the small number of items of that type. We are currently designing new stimuli that will include greater numbers of these informative events.

Our dataset is obviously limited by the small number of homesigning participants, and the logistical difficulty of working with them. Though we have a small number of Mother-ASL Signer pairs, each participant contributes a relatively large number of data points. A hierarchical linear

model will allow us to better account for sources of variability at the levels of Item (Reversible vs. Non-reversible events); Receiver Type (ASL Signer, Homesigner Sibling, etc.) and Homesigner Family Unit.

Mothers' poor comprehension of their child's homesign systems compared with that of ASL Signers raises several questions: Which factors distinguish Mothers from ASL Signers? Which of these factors drives comprehension (or non-comprehension) of homesign descriptions?

One difference between Mothers and ASL Signers is their length of experience with the homesign system itself; Mothers have significantly greater experience with the homesign system than do ASL Signers. However, given this, we would expect mothers to comprehend homesign production *better* than ASL Signers, which they do not.

Mothers and ASL Signers also differ in their age of exposure to a visual communication system. This factor could explain Mothers' poorer comprehension of homesign. Brentari, Coppola, Mazzoni & Goldin-Meadow (2012) show that the handshapes produced by homesigners pattern more like those of established sign languages than like the gestures produced by hearing individuals in terms of phonological features (specifically, finger complexity in Object and Handling handshapes used in classifier predicates). These comprehension data could provide further evidence that homesign is closer to a linguistic system than to gesture; that is, homesign must be acquired beginning at an early age in order to reach proficiency (Johnson & Newport, 1989; Newport, 1990).

The mother of Homesigner 2, who shows the best comprehension compared to the ASL Signer with whom she is paired, began using homesign with her son at an earlier age than the other mothers in our study (she was 16 years old when he was born). Although well beyond the critical period for language acquisition established by Newport and colleagues, her relative youth might have conferred a crucial advantage in acquiring her deaf child's homesign system.

It might also be the case that ASL Signers' early and significant experience with an established visual-manual language helped them perform better than Mothers in comprehending homesign productions. Perhaps the ASL Signers are drawing on their (implicit) knowledge of how visual languages are structured to understand homesign.

Comparing our two current groups with two additional groups could further distinguish the effects of the age of exposure to a visual communication system, and the type of system (homesign vs. an established language), on homesign comprehension (summarized in Table 4).

First, we can measure the comprehension of homesign by siblings of those homesigners. The siblings of homesigners who are close to them in age likely started using homesign at a young age to communicate with their deaf sibling. Comparing homesigners' siblings to their mothers will tell us whether early exposure to homesign can also drive better comprehension. In addition, comparing the comprehension of homesigners' siblings to that of native ASL Signers will reveal whether the nature of the visual communication

matters (e.g., homesign vs. an established visual language like ASL).

Second, we can look at comprehension of homesign by signers who acquired ASL later in life (e.g. in adolescence or beyond). In our current groups of native ASL Signers, age of exposure is confounded with knowledge of a complex, established language. Measuring the comprehension of late-learning ASL signers can tell us whether (and if so, how much) experience with an established visual language supports homesign comprehension.

Table 4: Comparison groups and their characteristics

Group	Type of visual system	Age of Exposure	Length of exposure
Mothers of Homesigners	HS	late	significant
Native ASL Signers	ASL	early	significant
Siblings of Homesigners	HS	early	significant
Non-native ASL signers	ASL	late	Range from minimal to significant

These comparisons will help elucidate the nature of homesign systems. If more experience with an complex, established visual communication system (ASL) supports better comprehension of homesign, we can, in conjunction with data regarding the systematicity of homesign production, provide further support that homesign systems are themselves linguistic. Moreover, if better comprehension of homesign is predicted by factors that are associated with acquiring linguistic systems (namely, age of exposure), such results would accord with Brentari et al.'s findings, providing evidence that homesign systems are more like language than like gesture.

More work must be done to create a full and accurate characterization of the structure and development of homesign systems. If such research supports our claim that homesigners and not their mothers drive the development of homesign systems, this will have interesting implications regarding the capacity of the human brain for language. To the degree homesigners *are* innovating their systems and to the degree that their systems resemble existing visual languages, we can say there is something in the learner that is capable of producing language. As others have suggested (e.g., Senghas & Coppola 2001), it may be that the capacities that evolved to support language acquisition are also capable of creating language, to some degree. Future work involving converging methods—spontaneous and elicited production and comprehension—and different populations—such as homesigners and different cohorts of users of Nicaraguan Sign Language—will help further clarify the specific contributions of the brain, and the environmental conditions necessary for different features of language to emerge.

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