

## **Phonological category resolution in a new Sign Language: A comparative study of handshapes\***

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Stokoe's (1960) demonstration that the words of sign languages are constructed from a discrete and finite list of meaningless units — that they have phonology — dispelled the myth that sign languages were comprised of iconic gestures, holistic in form. But do the meaningless units that Stokoe identified exist at the inception of a new sign language? Or does it take time for a phonological system to self-organize? More specifically, how does a language develop phonological categories? The answer to this question cannot be discovered empirically in spoken languages, as they are all very old. But sign languages arise anew wherever a community of deaf people forms, and, as new languages, they have much to teach us about the emergence of linguistic form.

The present study grew out of observations on the part of the research team investigating Al-Sayyid Bedouin Sign Language (ABSL), a new sign language that arose spontaneously in an isolated desert community about 75 years ago. The investigators saw unexpected variation in sign production across the village — both in the choice of lexical items and in the form of the same lexical item (Aronoff et al 2008). Following up on this observation, we conducted a detailed analysis of the form of ABSL sign productions in isolation and compared them to those of two other sign languages with different social histories, American Sign Language (ASL) and Israeli Sign Language (ISL; Israel 2009).

In the present paper, we focus only on the handshape category, and demonstrate how our investigation confirmed the initial impression of considerable variation within this category. We adopt a comparative method that enables us to quantify the amount of variation in the three sign languages. The results reveal a cline, with ABSL exhibiting the most variation in the formation of handshapes, ISL next, and ASL showing the least variation across signers. Taken together with other evidence, we hypothesize that ABSL signers are often aiming for a holistic iconic image, and that discrete phonological categories are not yet robust in the language.

We begin with a description of ABSL in section 1, and illustrate with some of the variation in sign production that was discovered in the broader ABSL research project (Aronoff et al. 2008; Sandler et al. in press). We then turn to the

study of handshape (following Israel 2009), coding and analyzing handshapes in 15 signs for ten signers in each of the three languages. Section 2 describes the handshape features of interest, and the methodology of the study is the topic of section 3. Results and discussion follow in section 4. In section 5, we consider some explanations for differences across languages, including language age, community size and other social characteristics. While our results suggest that ABSL may not yet have formed discrete phonological categories, there is some evidence pointing in the direction of formal organization, which we mention briefly in section 6. Section 7 is a summary and conclusion.

### 1. Al-sayyid Bedouin Sign Language

The young village sign language that is our focus here took root in the Al-Sayyid Bedouin village in the Negev Desert of present day Israel, when four deaf children were born in a single household about 75 years ago. Today, there are about 150 deaf people in the village.<sup>1</sup>

ABSL functions as a fully fledged language, used for a range of social interactions, for instructions and plans, personal histories, folk remedies, national insurance, childcare, or how to cajole a husband. Among the grammatical features that have been found in the language are a robust word order within the clause and the noun phrase (see Sandler et al. 2005) and a kind of size and shape classifier affixation (Meir et al. 2010; Sandler et al. 2011).

At the lexical level, the research team investigating ABSL observed a surprising degree of variation in lexical items themselves. Even signs for everyday items sometimes have several variants. In addition, across tokens produced by different signers there is variation in sublexical components, and that is the object of study here. This sublexical variation seemed greater than what we would expect in more established sign languages, such as ISL and ASL. Moreover, tokens seemed to vary in features that are potentially contrastive in established sign languages. One example is variation in place of articulation found in different tokens for ABSL DOG shown in Figure 1.

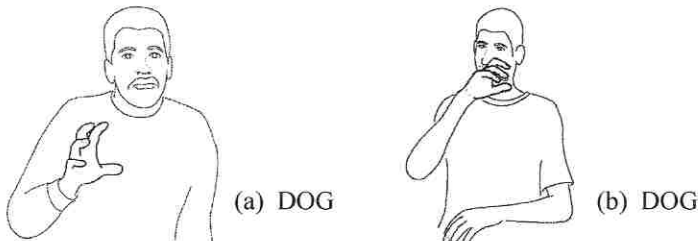


Figure 1. Variation in location across ABSL tokens for DOG. Variant (a) is articulated in neutral space, variant (b) in front of the mouth.<sup>2</sup>

One might be tempted to compare this to different pronunciations of words such as English *route*, [rut] and [raut]. In the English example, while the vowels are potentially contrastive (cf., boot [but] and bout [baut]), we tend to associate the two forms of *route* with different varieties or dialects. However, in the case of ABSL, the different signers whom we have recorded are members of the same extended family within a small, closely-knit community, and we suspect that the variation is not 'sociolinguistic' in the normal sense of subgroups within a language community. Rather, it seems to us that this variation is an indication that the ABSL lexicon has not yet developed discrete, meaningless formational categories. A perhaps more basic reason for suspecting that, currently, formal categories do not exist in ABSL is the fact that no minimal pairs have surfaced in all the ABSL data collected to date. Apparently, it takes time for users of a new language to converge on a fixed set of meaningless primitives for forming lexical items.<sup>3</sup>

In order to test the hypothesis that distinct formational categories are not yet defined in ABSL, we recorded and analyzed both the amount and type of variation in languages with different social characteristics. The current study, taken from a larger project (Israel 2009), focuses on one sublexical component – hand configuration. In the next section, we discuss briefly the internal structure of this component as a way of introducing the phonetic features that we will use for the coding of signs. This will be followed by a discussion of the measures of variation and the way to compare them across languages.

## **2. Sublexical structure in sign language: hand configuration**

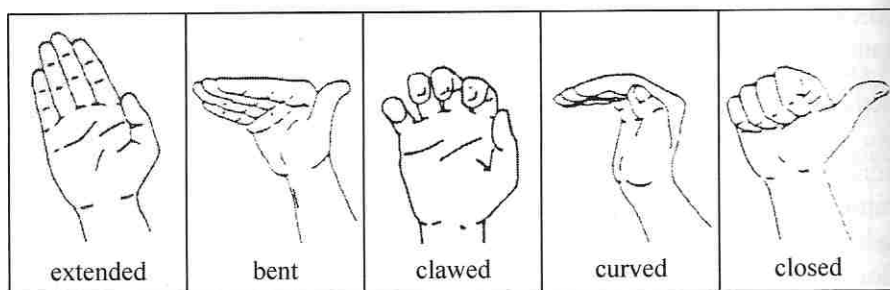
A considerable portion of the sign language phonology literature has been dedicated to the lexical representation of hand configuration. In this study, we adopt finger selection features from an early detailed model of hand configuration (Sandler 1987; 1989). That model proposed a hierarchical representation of feature classes, in which the handshape is determined by selected finger features together with subordinate categories of finger position and orientation features. The model was later further developed (Sandler 1993, 1995, 1996); and other models with changes and innovations were proposed (e.g., van der Hulst 1993; van der Kooij 2002). In this study, we adopt the features and categories informed by these models that are shown in Table 1. The phonological status of different subsets of these features, category membership, and hierarchical relations among the categories are

supported in Sandler (1989, 1995, 1996), Corina & Sandler (1993), Brentari (1998), and van der Kooij (2002), among others (see also Sandler & Lillo-Martin 2006).

*Table 1.* Hand Configuration subcategories and features.

Handshape	
Selected Fingers	[index], [middle], [ring], [pinky], [thumb], [any combination of fingers]
Flexion	[extended], [bent], [curved], [clawed]
Aperture	[open], [closed]
Spreading	[spread], [non-spread]
Unselected Fingers	[open], [closed]
Thumb	[extended], [opposed], [adducted], [crossed]
Orientation of palm, Orientation of metacarpals	[up], [down], [in], [out], [contralateral]

Phonological representations by definition avoid phonetic features that are predictable, but as this study addresses convergence on the production of basic phonological elements, we are not concerned here with models of the internal organization of these features. Here we intentionally retain a certain amount of phonetic detail, since we are investigating a new language in which the phonetics/phonology distinction is not yet known, or, as we suspect, has not yet crystallized.



*Figure 2.* Four flexion positions in handshapes with all the fingers selected. The [extended] position has no flexion of the fingers; in a [bent] position, only the base joints are partially to fully flexed; in a [clawed] position only the non-base joints are partially to fully flexed; and in the [curved] position, base and non-base joints are partially flexed. Selected fingers that are fully folded into the palm, irrespective of thumb position, are coded as [closed].

The **finger selection** category is comprised of a set of five features – one for each finger: [index], [middle], [ring], [pinky] and [thumb].<sup>4</sup> As for **finger position**, we distinguish between the four different degrees of flexion (van der Kooij 2002) illustrated in Figure 2 using handshapes with all four fingers selected.<sup>5</sup>

Specification in underlying representation has been argued to be redundant for most other hand configuration features, namely the configuration of unselected fingers (Corina 1993), the posture of the thumb (shown in Figure 3) and the spread/non-spread configuration of the selected fingers (van der Kooij 2002). In the ‘extended’ configuration illustrated in Figure 2 the fingers are also ‘non-spread’; in the handshape with the adducted thumb (Figure 3e) the selected fingers are in a ‘spread’ configuration. Nevertheless, as already noted, our primary aim here is to record formational differences as a first step towards an analysis of phonological organization in ABSL, which may or may not currently have phonological categories, and we adopt these distinctions for this purpose alone. We make no a priori assumptions about the phonological status of these sublexical components.

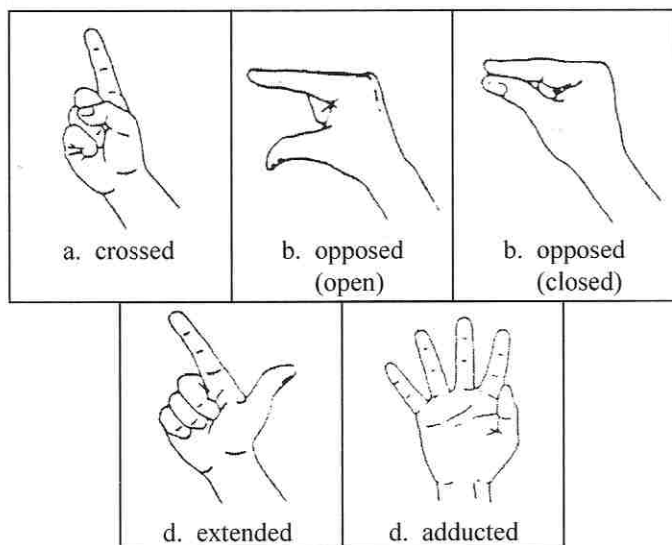
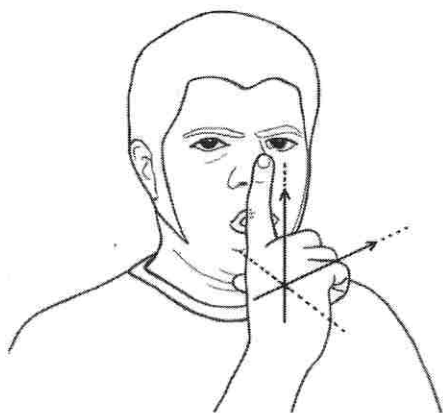


Figure 3. Thumb position features.<sup>6</sup>

The last component of hand configuration in our coding system is orientation. We specify orientation with the following features: [up], [down], [in] (faces signer's body), [out] (faces away from signer), and [contralateral]. These features are used to specify two degrees of freedom: the side faced by the palm of the hand and the direction in which the hand's metacarpal bones

(i.e., the bones connecting the wrist and MCP joints) point, as illustrated in Figure 4.



*Figure 4.* Degrees of freedom in the representation of orientation. The figure shows the position of the hand in the ISL sign SUNDAY. The hand is oriented so that the metacarpal bones point upward (specified as [up]), and the palm faces the contralateral side (specified as [contralateral]), as indicated with solid arrows.

### **3. Methodology**

Ten signers from each language (ABSL, ISL and ASL), each signing 15 signs, provided the data for the study.

#### **Participants**

##### **ABSL**

The signers included in the study are members of an extended family, six of them members of the same immediate family. The reliance on sign language as the means of communication within the family ensured that the signers chosen are highly proficient in ABSL. There was a wide distribution of ages among the subjects: two second generation signers were between 40 and 50 years old at the time of videotaping; one signer was about 28 years old – a young second generation signer. Of the third generation participants, four were between 20 and 30 years old, and three were between 7 and 12 years old.

While many hearing people know ABSL well and use it daily within deaf families, all ABSL participants in the study were deaf. The oldest two, Th. and A-B., were born in the second generation of deaf people in the Al-Sayyid village. The rest of the participants represent the third generation of deaf people, all of whom are attending school in a nearby village, where ISL signs are used by the teachers. At school, children from Al-Sayyid interact with deaf children from other villages in the area.<sup>7</sup> However, the majority of second generation deaf people and the hearing signers in the Al-Sayyid village have had little direct exposure to ISL, and we infer from this that the communication among family members takes place in ABSL. In the study, each signer signed to another ABSL signer while being videotaped.

In order to compare variations across the three sign languages, group sizes were balanced, so that each of the ISL and ASL groups also numbered 10 signers each.

### **ISL**

All ISL participants were deaf signers who learned the language at an early age (by the age of six) and have been using it continuously since. The ISL group was formed in such a way that it would be as analogous as possible to the ABSL group, both linguistically and socially. Thus, all ISL participants were from the same small geographic area, the city of Haifa. This was intended to result in data that are maximally lexically unified.<sup>8</sup> In addition, of the 10 participants, four were members of a single immediate family (cf. the six same-family members in ABSL), two of them one generation older (the two parents), aged 45 and 50. The ages of the other participants were 40, 38, 37, 32, 21, 21, and 14. All ISL participants have had formal education.

### **ASL**

The group of ASL signers was less homogenous than the other two language groups. All 10 participants were "recruited" while spending leisure time on the University of California, San Diego campus.<sup>9</sup> All, except for a single participant (who acquired ASL from a deaf parent), were deaf, and the only requirement for participation was a perceived high level of ASL proficiency. No information regarding participants' (original) area of residence, educational background, etc. was collected. The ages of the two youngest



participants are between 20 and 30 years (the exact ages were not recorded). The other participants were 32, 33, 35, 41, 42, 43 and 54 years old. Three participants acquired ASL from deaf parents, and the rest began acquiring the language by the age of six.

### 3.1 Stimuli and procedure

Citation forms were elicited from participants using pictures of objects presented on a computer screen using Microsoft Powerpoint software. The pictures presented single objects with which participants were familiar, such as common animals, furniture, types of vehicles, fruits, etc.

Each participant was seated opposite another signer of the same language, and next to the computer used for the presentation of pictures. Participants were instructed to look at the computer screen and then to sign to their interlocutors their sign(s) for the presented object. The presentation of pictures on the screen was controlled by a researcher, so that one picture was presented at a time, and the next picture was presented after the sign was produced clearly by the participant. Since the younger ABSL participants knew some ISL, they were explicitly asked to use only their native (i.e., ABSL) signs. If a participant produced an ISL sign, he or she was asked to sign again, using the local sign.

The total number of elicitation pictures presented to each signer was 35. Of these, 20 were eliminated, for reasons such as the following: signers presented a description using a sequence of signs rather than a lexical item; in a few cases, a lexicalized and potentially reduced compound was produced by some signers; signers did not use the same lexical item for the concept (e.g., a bit in the mouth vs. legs straddling an object for HORSE; or, in the case of ASL, fingerspelling was used instead of a sign, a common strategy in that language).<sup>10</sup> The total number of signs included in the analysis is 15, as noted above.

The list of lexical items in the study is given in Table 2. The first 11 items are shared by all three language sets, and the remaining 4 items overlap only partly, because of the constraints just mentioned on which signs were accepted for analysis in each language. In any case, a lexical match of the three language sets is not critical, since the same concept may reflect different attributes of an object in different sign languages in any case. What matters is sublexical variation for the same form within a language.



The lists of signs in Table 2 were not compiled with the intention of representing the entire range of handshapes found in each of the languages. Rather, these signs were chosen primarily as a random sample of items that symbolize highly familiar real-world objects, with the assumption that such signs are very frequent in the language and therefore are highly conventional in form. In other words, we expect the amounts of cross-signer variation recorded in the production of these signs to represent the *minimal* amounts of variation found in these languages.

Table 2. The lexical items represented in the collected data.

Item number	ABSL; ISL; ASL		
1	LEMON		
2	SCORPION		
3	TOMATO		
4	CARROT		
5	COW		
6	DONKEY		
7	FORK		
8	LEAF		
9	DOG		
10	GOAT		
11	TRAIN		
	ABSL	ISL	ASL
12	WOMAN	TELEVISION	WOMAN
13	BROOM	BROOM	EGG
14	STUFFED GRAPE LEAVES	FLOWER	FLOWER
15	GARLIC	CUCUMBER	CAT

Items 1 – 11 were elicited from signers of all three languages, and (12 – 15) are items not shared across the three languages.

### 3.2 Measuring variation


The essence of variation is the existence of different variants of the *same* item, which, in our case (i.e., at the sublexical level), is a single lexical item. Therefore, for each language, variation is measured first for each of the 15 lexical items separately, and only then are these measures combined to get an indication of the amount of variation at a more global level. This methodology is detailed here.

For the analysis, we use two measures which we believe capture the essence of variation in a way that is both transparent and simple: *number of variants* and *mode*. These measures correspond to two important aspects of variation: the range of the distribution and the extent to which the data are concentrated or spread within this range.

We begin with number of variants. Recall that in the current analysis, for each token, the hand configuration component is specified in terms of discrete phonetic features which cannot be considered in terms of higher or lower values. This method of coding is comparable to specifying the features [high] [mid] and [low] for vowels, rather than measuring their formant frequencies, since features are discrete whereas frequency is measured along a continuous scale. Therefore, for our purposes we may define the range of variation in hand configuration as the number of different features found across tokens.

To make this measure clear, let us consider a hypothetical situation in which we have two different sets of ten tokens each for the sign FORK. For each set of tokens, Figure 5 shows a distribution of features within the subcategory Selected Fingers (SF). We can see that in the first set of tokens (represented by Distribution A) there are two different finger selections:

[I+M] () and [I+M+R] ().

In the other set of tokens (represented by Distribution B) there are three different finger selections, [IMR], [IM] and [I] (). In other words, there are two different variants of SF in the first set of tokens and three variants of SF in the second set. That is, the range of variation in SF is wider in the second distribution. The number of different values for selected fingers found within a set of tokens is therefore an indicator of the range of a distribution.

## Distribution A:

	Signer A	Signer B	Signer C	Signer D	Signer E	Signer F	Signer G	Signer H	Signer I	Signer J
Category Selected Fingers	I+M	I+M	I+M+R	I+M	I+M	I+M+R	I+M	I+M	I+M	I+M

## Distribution B:

	Signer A	Signer B	Signer C	Signer D	Signer E	Signer F	Signer G	Signer H	Signer I	Signer J
Category Selected Fingers	I+M	I+M	I+M	I+M	I+M+R	I+M	I+M	I	I+M	I+M

Figure 5. Different amounts of variation indicated by the number of variants produced for the same lexical item: wider range of SF variation in Distribution B.

The other measure we use – the *mode* – provides information about the spread (or dispersion) of a distribution. This measure counts the total number of tokens that exhibit the most frequent feature or, as in the case of SF, feature set (see Footnote 4). Consider the distributions in Figure 6. Since in each distribution there are two different feature sets realizing the SF category, both distributions have the same range of variation (*number of variants* = 2). However, in Distribution A, eight out of ten tokens have the same feature set [I+M], whereas in Distribution C the two feature sets are distributed more equally across tokens: six tokens have the feature set [I+M] and four tokens have the feature set [I+M+R]. We may say that in Distribution C tokens are more “spread out” – i.e., they vary more – compared to tokens in Distribution A. The frequency of the modal feature – i.e., the number of tokens in which the most frequent feature is found – therefore captures an important aspect of variation that escapes the *number of variants* measure. For further discussion of the advantages and disadvantages of this method, see Israel (2009).

## Distribution A:

	Signer A	Signer B	Signer C	Signer D	Signer E	Signer F	Signer G	Signer H	Signer I	Signer J
Category Selected Fingers	I+M	I+M	I+M+R	I+M	I+M	I+M+R	I+M	I+M	I+M	I+M

## Distribution C:

	Signer A	Signer B	Signer C	Signer D	Signer E	Signer F	Signer G	Signer H	Signer I	Signer J
Category Selected Fingers	I+M	I+M	I+M	I+M+R	I+M+R	I+M	I+M	I+M+R	I+M	I+M+R

Figure 6. Different amounts of variation indicated by the frequency of the modal feature in a set of tokens for the same lexical item: more dispersion in Distribution C.

The ultimate aim of this study is to use the measures of variation calculated for individual lexical items to arrive at a more global measure of sublexical variation within a language, to which we turn now.

### 3.3 Beyond the single lexical item: a global measure of variation

The first step then is to average all the measures obtained for the same phonological category across lexical items within the same language. This is exemplified with hypothetical data in Table 3.

*Table 3.* Average mode and average number of variants as global measures of variation in phonological category X.

Category	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Average
Mode (%)	95	80	100	87	80	93	84	100	89.88 %
Number of variants	1	2	2	1	1	2	1	3	1.63

Recall that the first stage in the analysis was to calculate the mode for each lexical item separately. In the above table, 95% represents the mode of the set of tokens produced for Item 1. 80% was the mode of all the tokens elicited for Item 2, etc. Once the averages of all the modes and numbers of variants have been calculated (rightmost column), we will already have reached a more global representation of variation, since for each phonological category we are left with two measures per language: (1) *average mode* and (2) *average number of variants*. Now it is possible to compare the values of each of the two measures of variation across languages. For example, if the average mode calculated for Thumb Position is 90% for language A and 95% for language B, we may say that with respect to this measure of variation, language A shows more variation in thumb position than language B. The two languages will also have to be compared with respect to the average number of variants for this feature.

The average measures calculated for subcategories may be considered together in order to characterize the degree of variation within the major category of hand configuration. We achieve this by calculating the average of the averages of each of the seven HC subcategories.

#### 4. Results and discussion

As can be seen in Figure 7, in all subcategories of this component, mode values were lowest in the ABSL data. That is, as indicated by this measure in the data collected for this study, for each subcomponent of Hand Configuration, the amount of variation is greatest in ABSL. For the categories Thumb, Unselected Fingers, and Orientation, we find a cline of mode values from ABSL through ISL to ASL. No difference between ISL and ASL was found for Flexion<sup>11</sup> and Aperture. Finally, Selected Fingers and Spreading varied in the ASL data more than in the data collected from ISL. Overall, when the mode values are averaged over all seven subcategories, the global amounts of variation form a pattern in which ABSL and ASL have the highest and lowest amounts of sublexical variation, respectively, with ISL somewhere in between.

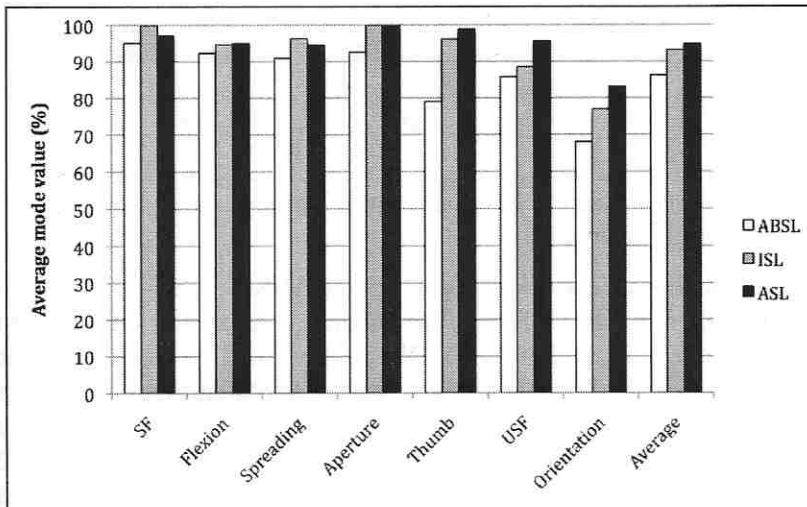


Figure 7. Average mode values within Hand Configuration subcategories.

This picture of the differences across the three languages is made clearer by the second measure of variation – the number of variants. Figure 8 shows that in five of the seven hand configuration subcategories the average number of variants is highest in ABSL. The only subcategory for which the number of ABSL variants measured was the lowest is Spreading. As the figure shows, the ABSL > ISL > ASL cline indicated by the mode measure for Thumb, USF and Orientation is also indicated by the average number of variants. Overall, this cline emerges as a global pattern indicated by both the Mode and the Number of Variants.

In order to check whether the differences found are statistically significant, A Kruskal-Wallis test was performed on the data. A highly significant difference was found between the degree of variation in thumb position in ABSL and those measured for ISL and ASL. This was found for both the mode measure ( $p < 0.001$ ) and the number of variants ( $p < 0.01$ ).

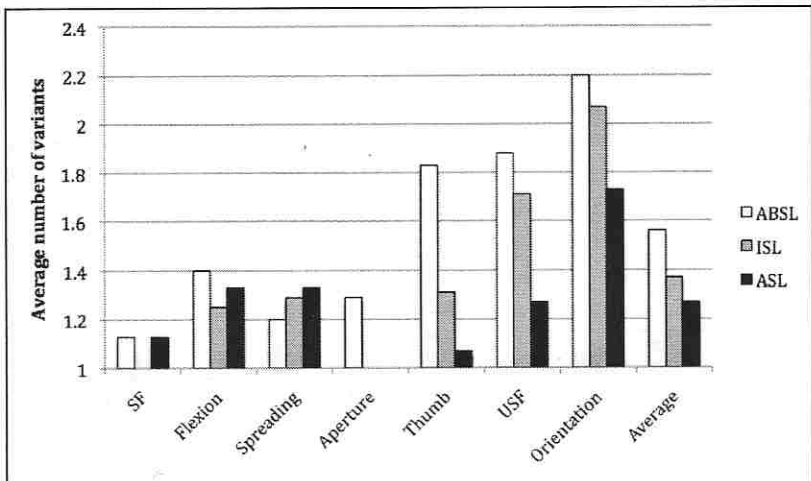


Figure 8. Average number of variants within each subcategory of Hand Configuration.

It appears that the subcategories for which the  $ABSL > ISL > ASL$  cline was found, namely Thumb, USF, and Orientation, also exhibit more variation than other categories within ABSL. We propose that the relative amounts of variation measured for these three sublexical categories are especially suggestive of the qualitative differences across the three languages *because* the phonological status of these components, if any, is marginal. Specifically, the position of the unselected fingers is highly predictable in established sign languages, and handshapes are not distinguished by this feature. Similarly, the position of the thumb is often predictable (van der Kooij 2002), and there are very few cases in which contrast is based on thumb position. Finally, as argued by Crasborn (2001), it is most likely that orientation is lexically specified in relative terms (see Crasborn & van der Kooij 1997; Crasborn 2001), and that variation in absolute orientation (coded in this study) is non-distinctive and often predictable from the lexically specified parameters, such as the part of the hand which contacts the place of articulation.

We suggest that the development of systematic lexical representation targets first those features which contribute most to the distinction between different lexical items, with other features being consistently incorporated

into lexical representations at a later stage. In the case of sign language, the features which contribute most to the overall configuration of the hand are SF, Flexion and Aperture. Thus, we propose that because ABSL is in the early stages of developing a phonological system – our main conclusion here – it exhibits a greater degree of cross-signer consistency with respect to these features. The production of Thumb, USF, and Orientation features, which are least consistent across ABSL signers, gradually becomes more uniform as the language develops, as exhibited by the measures calculated for ISL and ASL (discussed below). It seems that cross-signer convergence on the production of phonologically marginal features is a more stable correlate of a language’s developmental stage.

To help conceptualize the differences across the three languages, Figure 9 and Figure 10 present the range of average mode values and of average number of variants for each language shown discretely and feature by feature in Figure 7 and Figure 8 above.

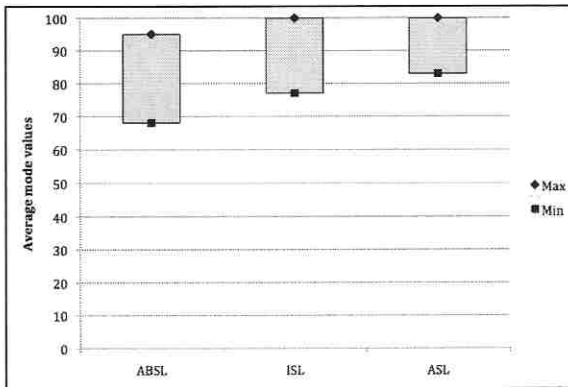


Figure 9. Ranges of average mode values.

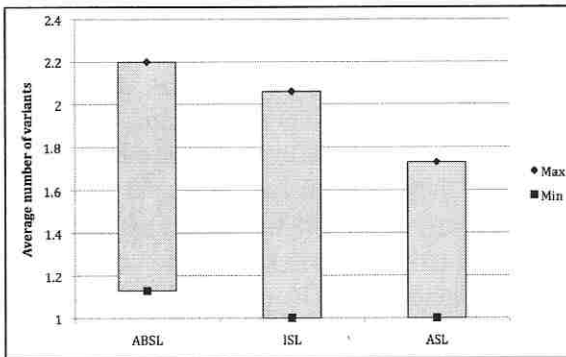
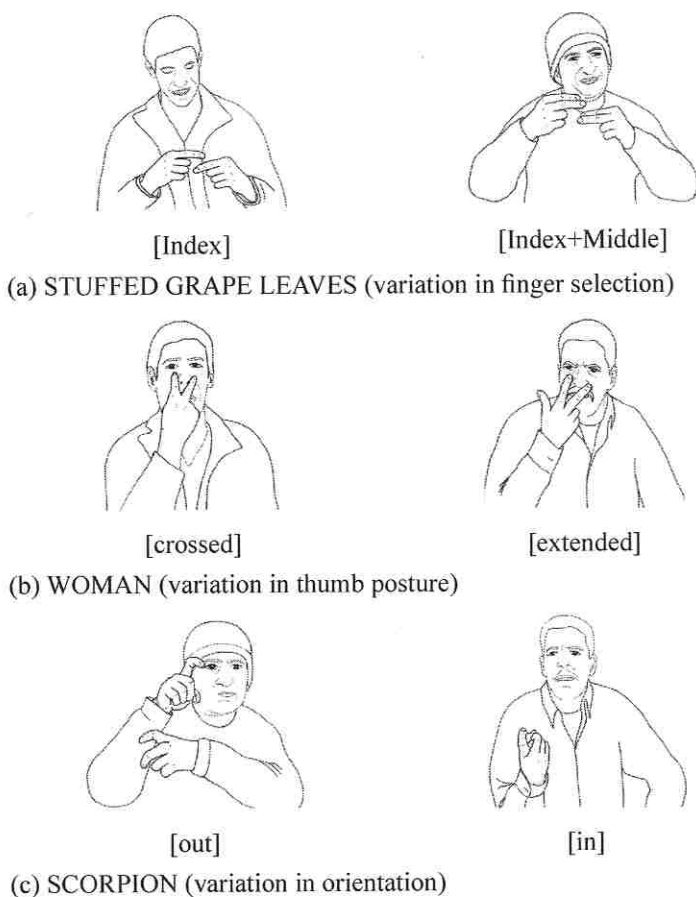


Figure 10. Ranges of average number of variants.



The range measure shows clearly the differences among the three languages with respect to both the size of the range and its location along the Y-axis. As for the mode (Figure 12), in ASL, its values are distributed within the smallest range, about 17 percent. Like ASL, ISL's maximum value is 100 % (representing a subcategory with zero variation), but its range of average modes is wider than that of ASL – about 23%. Finally, ABSL's average modes spread over 27 %. Moreover, unlike ASL and ISL, none of the average modes calculated for ABSL reaches 100%. In other words, there is not a single subcategory of Hand Configuration in which there is no variation across ABSL signers in the study. Figure 10 shows similar differences in the range of average numbers of variants. Examples of variation in ABSL are shown in Figure 11.



*Figure 11.* Examples of hand configuration variation in ABSL.

The robustness of the cross-linguistic differences reported on here is further supported by results from two additional analyses of variation along features of location and movement – the two other major parameters of sublexical form. Using the same methodology, Israel (2009) found the same cross-linguistic pattern of variation, namely ABSL > ISL > ASL, for both Location and Movement. It is therefore not only the Hand Configuration component which varies to different extents, but the entire form of lexical items.<sup>12</sup>

Certainly, there must be some phonetic variation in any language (see Crasborn 2001), and indeed, the most established of the three languages studied here, ASL, does exhibit some variation. However, assuming that all languages eventually develop lexicons with highly conventionalized forms, the consistent cline of variation found in Israel (2009) and partially reported here suggest that ABSL, ISL and ASL are currently situated at different points along this conventionalization continuum. In the next section we briefly discuss the possible contributions of four different factors to the development of regularity in new languages.

### **5. Three different sociolinguistic backgrounds**

We would like to put forth the hypothesis that, in the early development of a sign language, an aggregate of sociolinguistic factors affects the convergence by signers on a relatively fixed set of forms used as lexical items. Underlying this hypothesis is the assumption that convergence – i.e., transition from more to less variation – is universal and characterizes the emergence of any new language. In each case of language emergence, however, the social and linguistic settings, which have an impact on the way language develops, are unique. Our hypothesis incorporates the following factors: a) relation to other languages, b) the language's age, c) the size of the community, and d) the existence of prescriptive norms. In this section we discuss the possible influence of these factors and relate it to the case at hand.

A new language may come to life in one of two settings: within a community whose members have no language at all, and within a community whose members use different languages but none of which is shared by all. The languages that emerge in settings of the latter type are known as pidgins and, when passed on to children, as creoles. Even though these languages are fundamentally distinct from any of the languages used natively by the original members of the community, there is no doubt that some grammatical elements are borrowed from native languages into the pidgin and preserved in

the creole (e.g., McWhorter 1997). This means that, compared to a language developed by people who know no language at all, pidgins and creoles get a head start.

The study of ISL and ASL has shown that both of these languages developed in ways that resemble pidginization and creolization, with contributions from German Sign Language, and other sign languages of Europe, North Africa, and elsewhere in the case of ISL (Meir & Sandler 2008), and influence from French Sign Language and local American varieties in the case of ASL (Woodward 1978; Fischer 1996). Therefore, in both cases, at the outset, experienced signers who had been using signs skillfully and consistently made a contribution. In contrast, ABSL has emerged in a relatively isolated community and for many years was developed by deaf people who had no knowledge of any other language. It is reasonable to believe that for such signers it takes longer to converge on a single form for each concept.

If conventionalization is indeed gradual, then we expect forms to be produced more consistently across signers as the language gets older. A language's age may be measured not only in years but also in the number of generations of users that have acquired it. Young children have the capacity to acquire and build upon the language as it is passed on to them from a previous generation, or cohort, as in the case of Nicaraguan Sign Language (Senghas, Coppola, Newport & Supalla 1997; Senghas 2003; Senghas, Senghas & Pyers 2005). It is likely that children play an important role in the process of convergence by taking the language a step closer to fully conventionalized production of lexical items. In our case, ASL is the oldest language, which, according to our hypothesis, explains the fact that it exhibits the least amount of sublexical variation. However, since ABSL and ISL are of the same age but vary to different extents, it is clear that this factor by itself cannot predict differences in the amount of variation.

The size of the community in which a language develops may be another factor affecting the amount of variation. Trudgill (1995) suggests that within a small and isolated community there is likely to be a large amount of shared information, making variation more easily tolerated. This may well be the case within the community of Al-Sayyid. When much of the background information is shared by interlocutors, it may be sufficient for a signer to produce a token that approximates the overall image which is conventionally associated with the target concept in order for communication to succeed.

Metalinguistic awareness may have a strong impact on language production. One aspect of such awareness is the idea that some forms are "better" or "more appropriate" than others, and that certain forms are "correct" and others are "incorrect". Usually, these concepts are shaped by authoritative

sources, such as schools, books, interpreters, and other influential individuals, and are often associated with formality. On this basis, it is reasonable to distinguish between languages used in formal settings, such as ISL and ASL, and languages whose users are not subject to prescriptive pressure because it is never used formally, such as ABSL. Thus, in both the ISL and ASL communities there are Deaf organizations which organize formal meetings and sign language courses; social interaction and public events in Deaf clubs; dictionaries; Deaf theater and dance groups; and sophisticated interpreting, including academic material for university students. Finally, following linguistic studies on both languages, the status of both languages – mainly within, but also outside the Deaf communities – has risen considerably, which may somewhat ironically add to the pressure for standardization. In both ASL and ISL communities, dictionaries, sign language instruction, and interpreter training programs exist, which may have the effect of establishing norms to some extent. Such norms may in turn considerably reduce the variety of alternate forms, thus contributing to more consistent signing. In the ASL community, the normative sources just mentioned have longer histories and are therefore more established compared to ISL, which could partly explain the differences in the amount of variation found between the two. In Al-Sayyid, where deaf people are integrated into the larger hearing community, none of these socio-cultural developments has taken place, and, to the best of our knowledge, the language is only used in informal, everyday settings.<sup>13</sup>

We propose that all of the sociolinguistic factors just discussed played a role in the cross linguistic differences found in this study. Table 4 shows that each language has a different aggregate of these factors (population numbers are approximate). According to the discussion in this section, the sum of factors is most conducive to convergence in ASL and least conducive to convergence in ABSL.

The hypothesis developed above is motivated by the amounts of variation measured in this study. In order to test this hypothesis further, it is necessary to measure variation in additional sign languages with different aggregates of sociolinguistic factors. We leave this investigation for future research.

Table 4. A summary of cross-linguistic differences along sociolinguistic parameters.

	ABSL	ISL	ASL
Contribution from other languages	–	+	+
Age in years	~75	~75	~200
Size of deaf signing population	~150	~10,000	~500,000–1,000,000
Prescriptivism	–	+	+

## 6. Seeds of phonological form in ABSL

ABSL is a language by any functional measure. Conversations about any topic relevant to the community take place in real time with no apparent effort or hesitation. Humor is conveyed, stories are told. There is a shared vocabulary. Even the variation that we find in the lexicon is apparently well tolerated if ease of communication is any indication, possibly suggesting that the language simply has synonyms

Minimal pairs are a standard indication of duality of patterning: two distinct levels of structure, one meaningless (a phonological level) and one meaningful (Hockett 1960). As we have said, no minimal pairs have surfaced yet in investigations of ABSL. However, contrast is not the only measure of duality. The isolation of discrete, meaningless units systematically in processes such as assimilation, epenthesis, or deletion, also provide evidence for a formal system of this kind. The ABSL team has identified the seeds of phonology by observing the occurrence of such processes under particular circumstances (Sandler et al 2011).

One example is assimilation of handshape within one family in a compound that is lexicalized. The compound, CHICKEN<sup>^</sup>OVAL-OBJECT = EGG, is signed with regressive assimilation of handshape from OVAL-OBJECT to CHICKEN across members of this family. The assimilation is countericonic and systematic within the family, indicating that the handshape is functioning as a meaningless and abstract formational element (see Sandler et al. 2011 for illustrations).

Another indication of the emergence of phonological form is the addition of movement to movementless signs on the part of some third generation signers (see Sandler to appear). This is particularly interesting because, while the movement category often contains very little phonological information, in established sign languages, signs must have movement to be well-formed (Wilbur 1987; Sandler & Lillo-Martin 2006). In ABSL, movementless signs do exist. But among some third generation signers with deaf parents, the addition of movement has been observed. For example, to the sign for GOAT, which depicts the horn of a goat on the side of the forehead, these young signers add a tapping movement. As with assimilation, the process of movement epenthesis results in a countericonic image, and seems to be fulfilling a phonological function, such as providing a minimal amount of salience to a syllable-type unit. These and other closely observed phenomena show us how ABSL is moving toward phonological organization.

## 7. Summary and Conclusion

This study has shown that sign languages differ in terms of the amount of variation in the form of sign production across a community. The amount of variation in the category of handshape in a new language with little outside influence is shown to be greater for nearly all subcategories of that class than in languages with different social histories. In particular, we find a cline of regularity in form across ABSL, ISL, and ASL, such that ABSL shows the most variation, ISL next, and ASL shows the least amount of sublexical variation. The results reported here are from the first cross-sign-language study of phonetic variation and, as such, we hope it will pave the way for other, larger-scale studies in the future.

Undoubtedly, the small scale of this study requires that we adopt a careful interpretation of the cross-linguistic differences in the amount of hand-configuration variation. Nevertheless, there is additional evidence in support of our interpretation, detailed in Israel's (2009) broader study, such as the amount of variation across languages in the other major formational categories, as well as the differences in the amount of variation when whole tokens are considered.

Specifically, regarding quantitative analysis of the other categories, Israel found that Location and Movement also exhibit a greater amount of variation in ABSL compared to ISL and ASL. In addition, when the forms of tokens were considered as bundles of features from all three major sublexical categories – Handshape, Location and Movement -- highly significant cross-linguistic differences which correspond to the ABSL > ISL > ASL cline emerged. In that analysis, tokens that were different in one or more sublexical features were considered different variants of the same lexical item, and the average number of variants per item was calculated for each language. ABSL was found to have about 6.47 variants per lexical item on average, compared to 4.67 variants in ISL and 2.07 variants in ASL, a striking difference that is statistically significant.

These and other related results mentioned above support the suggestion that, while ABSL functions fully as a language with certain grammatical regularities, it appears not to have developed robust phonological categories. We find in addition that differences in social factors such as language age, size of community, and normative pressures that hold between ABSL, ISL, and ASL, correlate with differences in the amount of variation across these languages.

## Notes

1. For a detailed account of the social setting in which ABSL arose, see Kisch (2000).
2. Figure 1 is taken from Aronoff et al. (2008).
3. Models of linguistic communication proposed in a number of computational studies produce gradual convergence across different "language users" (see, for example, Barr 2004; Hutchins & Hazlehurst, 1995)
4. The coding system differs from the model in that when more than one finger is selected in a handshape, this selection is treated as a single feature set. For example, [I+M] and [I+M+R] are two different feature sets.
5. It should be noted that these different degrees of flexion are not necessarily distinctive in any of the three languages studied here. See Crasborn (2001) for a discussion on non-contrastive variation between [bent] and [extended] finger flexions in Sign Language of the Netherlands.
6. The handshapes in Figure 3b and 3c illustrate an 'opposed' thumb position with an 'open' and 'closed' Aperture specification, respectively.
7. It should be noted that neither the grade school teachers nor the other children use Israeli Sign Language. Instead, the teachers use signs from ISL that they learned in a brief course, and the children integrate these into whatever signing they bring with them to the school. This means that the only influence from ISL is lexical, and not grammatical, and that the children do not have a real ISL model at school.
8. Naturally, there are a few regional lexical differences in ISL. We attempted to avoid lexical variation by choosing signers from the same area.
9. We are grateful to Carol Padden and Deniz Ilkbasaran for collecting the ASL data used in this study.
10. Fingerspelling is the use of handshapes which represent letters of the alphabet to spell a word borrowed from a spoken language.
11. As explained in section 2, in order to determine whether variation in certain hand-configuration features was influenced by variation in other features, we examined each case of variation in relation to other relevant formational aspects, as discussed by Crasborn (2001). We found that, in the data collected for all three languages, some of the differences in flexion indeed resulted from variation in other features. Removing those cases of variation from the analysis reduced the cross-linguistic differences in mode measures for this feature, but it did not affect the qualitative ranking of mode values across languages.
12. In this study we did not include non-manual components, such as facial expressions and mouthing, which in some languages may be part of the lexicalized form.
13. A dictionary of ABSL signs is being compiled at the Sign Language Research Lab in Haifa. At this point, however, the dictionary is not available to ABSL signers.



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