

Lepic, Ryan, Carl Börstell, Gal Belsitzman, and Wendy Sandler. (Accepted). Taking meaning in hand: Iconic motivations in two-handed signs. *Sign Language and Linguistics*. (36 pages)

Title:**Taking meaning in hand: iconic motivations in two-handed signs**Authors' names and affiliations:**Ryan Lepic<sup>1\*</sup>, Carl Börstell<sup>2</sup>, Gal Belsitzman<sup>3</sup>, Wendy Sandler<sup>3</sup>**<sup>1</sup> Department of Linguistics, University of California, San Diego, USA<sup>2</sup> Department of Linguistics, Stockholm University, Stockholm, Sweden<sup>3</sup> Sign Language Research Laboratory, University of Haifa, Haifa, IsraelAbstract (150):

Traditionally in sign language research, the issue of whether a lexical sign is articulated with one hand or two has been treated as a strictly phonological matter. We argue that accounting for two-handed signs also requires considering meaning as a motivating factor. We report results from a Swadesh list comparison, an analysis of semantic patterns among two-handed signs, and a picture-naming task. Comparing four unrelated languages, we demonstrate that the two hands are recruited to encode various relationship types in sign language lexicons. We develop the general principle that inherently "plural" concepts are straightforwardly mapped onto our paired human hands, resulting in systematic use of the two hands across sign languages. In our analysis, "plurality" subsumes four primary relationship types – *interaction*, *location*, *dimension*, and *composition* – and we predict that signs with meanings that encompass these relationships – such as 'meet', 'empty', 'large', or 'machine' – will preferentially be two-handed in any sign language.

Keywords (7):

iconicity, lexical patterns, two-handed signs, Al-Sayyid Bedouin Sign Language (ABSL), American Sign Language (ASL), Israeli Sign Language (ISL), Swedish Sign Language (SSL)

Text:**1. Introduction**

Although the individual users of a given language, spoken or signed, are often not aware of the etymology of the words in their language, it is nevertheless the case that each word has its own history (Malkiel 1967; Aronoff 2007). It is also the case that historical factors can conspire to produce words with overlapping forms and meanings in different languages. As a result, students learning a second language or travelers navigating a foreign country can be pleasantly surprised to successfully guess the meanings of foreign words they encounter, based on similar words in a familiar language. Greenberg (1957:37) provides four reasons why words for the same concept may be similar across languages: 1) shared history, where similar words are descended from a common ancestor; 2) language contact, where one language has borrowed a word from another; 3) shared symbolism, where similar words are independently motivated based on some aspect of the concept being named; or 4) coincidence, where words in different languages are similar simply by chance. An example of each type is shown in (1), using English as an example:

(3) Examples of similar words in English (Indo-European) and other languages:

a. English *dove* and Swedish (Indo-European) *duva* 'dove'

Cognates: English and Swedish words both come from Proto-Germanic *\*dūbōn* (OED 2013 "dove, n."; Hellquist 1922:108)

- b. English *taboo* and Tongan (Austronesian) *tabu* 'taboo'  
Borrowing: borrowed into English from Tongan ca. 1777  
(OED 2013 “taboo, n.”)
- c. English *cuckoo* and Hebrew (Afro-Asiatic) *kukiya* 'cuckoo'  
Onomatopoeia: both words for cuckoo evoke the sound it makes  
(OED 2013 “cuckoo, n.”)
- d. English *mess* and Kaqchikel (Mayan) *mes* 'mess, disorder, garbage'  
Coincidence: the words are similar by chance  
(Campbell 2004:127)

In the case of cognates and borrowed words, shared ancestry or past language contact can be confirmed and, in the case of coincidental overlap, disconfirmed, via historical records; the words in (1a), (1b), and (1d), for example, have been verified through archival research. Our interest here, however, is neither historical nor archival. Instead, we examine words that are similar in different languages because they draw on shared iconic symbolism, as in (1c).

Shared iconic symbolism is at work when the names for an object are similar in multiple spoken languages because they all reflect the sound the object makes, or when the names for an object are similar in multiple sign languages because they all reflect what the object looks like. In these cases, linguistic forms (signifiers, after de Saussure 1959) from different languages reflect a meaning or concept being expressed (the signified), and these relationships between form and meaning are therefore considered iconic. Shared iconic symbolism arises from our shared experiences in the world, as well as our shared ideas about how to use the linguistic resources available to us to symbolically represent concepts.

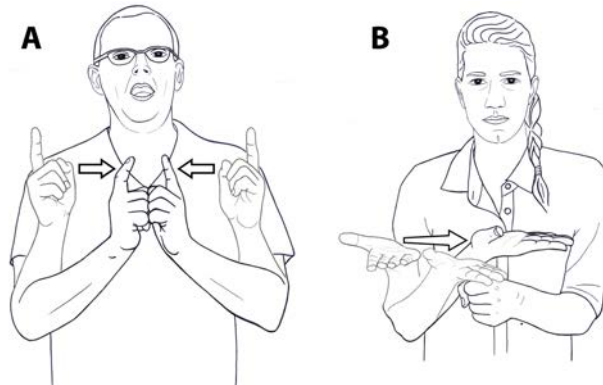
Though iconic words are often presumed to constitute only a small proportion of the words of any spoken language (cf. de Saussure 1959; Newmeyer 1992), iconicity is much more prevalent in sign language and can be expected to account for approximately 30% of the lexical similarity between two unrelated sign languages (Guerra Currie, Meier & Walters 2002; Al-Fityani & Padden 2010). This difference is due in part to the fact that sign languages are produced with the hands, face, and body, and are perceived by eye; the visual-gestural modality of sign language lends itself to iconic representation more robustly than the auditory-vocal modality of spoken language. Here, we argue that the iconicity found in sign language lexicons not only contributes to lexical similarity among sign languages, but can also reveal lexical semantic patterns in a way that the articulators of spoken language cannot. In particular, we demonstrate that the two hands are recruited to iconically encode various relationship types in lexical signs within and across languages.

The earliest research on sign language structure acknowledges iconicity in lexical signs, contrasting iconicity with transparency, conventionality, and arbitrariness. For example, Klima and Bellugi (1979:9–15) note that the forms of many signs can be said to be iconic, or motivated based on the concepts they denote. Iconicity does not, however, imply that signs are so transparent as to be readily understandable by those who do not sign. Klima and Bellugi find that non-signers cannot reliably identify the iconic motivation in a sign without first learning what the sign refers to; non-signers can relate forms to their meanings only when they have access to both to begin with. Klima and Bellugi similarly argue that iconically motivated signs are nevertheless conventional, as can be seen when comparing signs for the same concept across different sign languages (1979:21). Different sign

languages can have iconically motivated signs for one concept, but the phonological forms of these signs often differ because languages vary with regard to what aspects of the concept are to be represented and what formal elements are available for representing them. Frishberg (1975) further argues that time and historical change can erode the origins of iconically motivated signs, sometimes to the point that sign forms with historical iconic motivations can appear arbitrary to contemporary signers.

Researchers who downplayed the role of iconicity in sign language were no doubt influenced by the long-held, structuralist view of language, frequently attributed to Saussure (1959), that there is an inherently arbitrary relationship between form and meaning at the level of the word. However, in recent years, sign language researchers have begun to view the iconicity of lexical signs as an important key to understanding linguistic structure, rather than something to be dismissed or minimized (e.g. Taub 2001; Wilcox 2004; Perniss, Thompson & Vigliocco 2010; Meir et al. 2013). We therefore adopt a more contemporary view of iconicity to identify the iconic motivations that underlie the use of the two hands as primary articulators in natural sign languages. We understand iconicity to be a form-meaning correspondence that is fully compatible with other linguistic properties such as conventionality and systematicity.

Sign language lexicons are composed of one-handed and two-handed signs. Here we focus only on two-handed signs. Broadly speaking, two-handed signs fall into two categories: signs in which the two hands have the same configuration and movement (**Figure 1A**), and signs in which only one hand, the dominant hand, is active and the other, the non-dominant hand, behaves as a place of articulation (**Figure 1B**).<sup>1</sup> This bifurcation was initially established in Stokoe's (1960) structural analysis of the linguistic units in lexical signs. We follow van der Hulst (1996) in labeling these two sign types balanced and unbalanced, respectively.



**Figure 1.** (A) SSL MEET is a balanced sign, and (B) ASL FIRE-FROM-JOB is an unbalanced sign.

A large body of research on various sign languages has followed Stokoe's landmark study, uncovering systematic constraints and processes affecting the use of the two hands, these constraints and processes crucially being dependent on the form of a sign but apparently indifferent to its meaning, and therefore phonological in nature (e.g. Battison 1978; Bergman 1979; Bergman 1982a; Sandler 1989; 1993; Brentari & Goldsmith 1993; van der Hulst 1996; Brentari 1998; Meir & Sandler 2008; Crasborn 2011). Additional avenues of linguistic research have shown that sign languages exhibit conventional and systematic uses of the two manual articulators at all levels of linguistic structure, in addition to

<sup>1</sup> Illustrations of signs from ASL, ISL, and ABSL were created from digital media recorded in the Sign Language Research Laboratory at the University of Haifa, and illustrations of SSL signs were created from digital media from the online Swedish Sign Language Dictionary (Björkstrand 2008).

phonology, for example morphology (e.g. Bergman 1983; Kyle & Woll 1985; Padden & Perlmutter 1987; Padden 1988; Johnston & Schembri 1999; Aronoff, Meir & Sandler 2005), particularly the morphosyntax of classifier constructions (Supalla 1986; Wallin 1996; Pizzuto & Corazza 1996; Emmorey 2003; Benedicto & Brentari 2004); prosody (e.g. Nespor & Sandler 1999; Sandler 1999a; 1999b; 2006); and discourse structure (e.g. Liddell 2003; Vermeerbergen, Leeson & Crasborn 2007; Sandler 2012).

However, the semantic motivations that underlie the use of the two hands in sign language lexicons have mostly been overlooked (but see observations from Bergman 1982b; Brennan 1990; Johnston & Schembri 1999). Accordingly, here we shift our attention to individual lexical signs and, for the first time, focus exclusively on patterns of iconic motivation in two-handed signs, within and across sign language lexicons.

The analysis we present here draws primarily from three established and unrelated Deaf community sign languages: American Sign Language (ASL), Israeli Sign Language (ISL), and Swedish Sign Language (SSL). Though ASL, ISL, and SSL all have roots in Europe, we know of no genetic or historical relationships among them. ASL is historically related to French Sign Language (Woodward, 1976; Van Cleve and Crouch, 1989); ISL is a young language descended from sign languages of Europe (especially Germany), North Africa (especially Morocco and Algeria), and the Middle East (especially Egypt) (Meir & Sandler 2008); and there are no historical records of SSL being descended from another sign language, although it has itself influenced other sign languages, for example Finnish Sign Language (Ahlgren & Bergman 2006; Bergman & Engberg-Pedersen 2010). We also present data from a village sign language in the Middle East which initially arose in relative isolation, Al-Sayyid Bedouin Sign Language (ABSL).<sup>2</sup>

The paper proceeds as follows: we begin in Section 2 by demonstrating, on the basis of a sign language Swadesh list comparison, that the use of two hands in lexical signs is not random across ASL, ISL, and SSL. We hypothesize that meaning is a key factor in predicting lexical two-handedness, and in Section 3 we seek to explain the cross-linguistic distribution of two-handed signs that we observe in terms of the meanings that they convey. We then refine our hypotheses in Section 4, identifying semantic patterns that reoccur across different types of two-handed signs, and demonstrating that reference to the two hands is necessary to capture cross-linguistically significant generalizations. In Section 5 we demonstrate, on the basis of a picture-naming task, that the same patterns of two-handedness that are found among lexical signs in ASL, ISL, and SSL are also present in ABSL. In Section 6, we conclude from our investigation of two-handed signs in four unrelated sign languages that the two hands are used similarly across languages to iconically encode lexical semantic patterns. We also suggest that this systematic use of the two hands in sign languages can reveal lexical semantic structure that is present in all human languages, but is typically more opaque in the words of spoken languages.

## 2. Distribution of two-handed signs in three sign languages

Though we may have intuitions about how any sign language could take advantage of the iconic potential of the two hands in constructing a conventional stock of lexical signs — for example, to represent the two parties involved in ASL COOPERATE or to depict volume in ASL CLOUD — in order to test these intuitions, we must determine whether there is an iconically motivated pattern of lexical two-handedness cross-linguistically. Without such evidence, we run the risk of telling folk-etymological

<sup>2</sup> Our use of the terms *Deaf community sign language* and *village sign language* follows Meir, Sandler, Padden, and Aronoff (2010). We also clarify this distinction in sections 4 and 5.

"just-so" stories. Our first task, then, is to assess whether the division of concepts between one- and two-handed signs is random across sign languages. If meaning plays no role in determining whether a sign will be two-handed, then we would expect signs for similar concepts in unrelated sign languages to vary randomly with respect to whether one or two hands are used to articulate the sign.

## 2.1 Materials

We approach this question using the extended Swadesh list for sign languages, which was developed as part of the ECHO project (Crasborn et al. 2007; Woll et al. 2010), and which we refer to as "the SL-Swadesh list" here.<sup>3</sup> Swadesh lists are intended for cross-linguistic lexical comparison, and catalog common concepts expected to have conventional linguistic labels across languages. The SL-Swadesh list that we use here contains 301 concepts, including concepts related to deafness and sign language. In our study, we removed numbers and country names, which we anticipated might pattern differently from other lexical signs. In particular, we expect that signs for numbers will be similarly influenced by the iconicity of the fingers across sign languages, and that signs for country names may be similar across languages due to international contact among Deaf people. For example, ASL has two variant signs for the country names GERMANY and ITALY; in both cases, one sign is native to ASL while the other is borrowed from the national sign language of the country in question.

## 2.2 Method

Signs for the 256 remaining SL-Swadesh list concepts (see the Appendix) were collected using the SSL ECHO dataset (Bergman & Mesch 2004) and available dictionaries (Tennant & Gluszak Brown 2010 for ASL; Savir 1992 for ISL; Björkstrand 2008 for SSL). We also consulted with Deaf native signers of ASL, ISL, and SSL, who translated to their sign language from written English, Hebrew, or Swedish words. For each concept in this preliminary study, for each of our three sign languages, we recorded only whether the citation form of the sign was "two-handed" or "not two-handed". One-handed signs, signs derived via fingerspelling (Battison 1978; Wilcox 1992), and concepts for which there is no single, conventional sign, but rather a multi-sign paraphrase, were all coded as "not two-handed".<sup>4</sup>

## 2.3 Results

In ASL, 151 of the signs for our 256 concepts (59%) are two-handed, while in ISL 112 (44%) are two-handed, and in SSL 116 (45%) are two-handed. It might seem, on the basis of this description alone, that two-handedness is a chance phenomenon: for each of our three languages, roughly half of the test concepts are associated with a two-handed sign.

Additional examination suggests, however, that two-handedness is not random across languages. If two-handedness were indeed a chance factor, we would expect that a given concept would have a two-handed sign form in three different languages only about 13% of the time (32 out of 256 concepts). We find more than twice the amount of overlap for two-handedness than we would expect to find due to chance; 72 of the 256 test concepts (28%) are associated with two-handed signs in all three of our

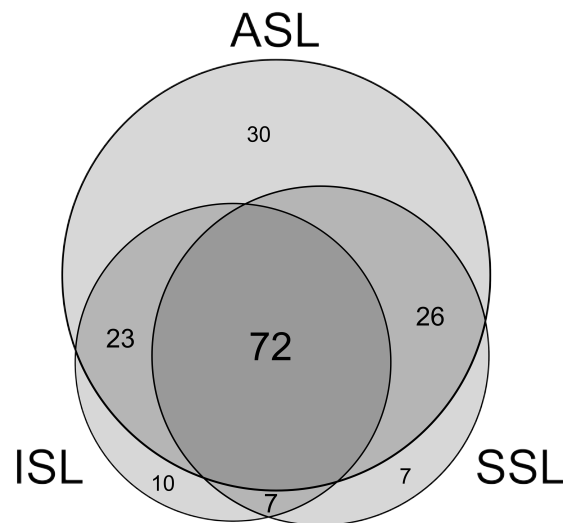
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<sup>3</sup> We here refer to the sign language case study within the larger European Cultural Heritage Online (ECHO) project. The ECHO project was an initiative of the EU to promote the sharing of scientific data within the humanities, and the sign language case study sought to establish conventions for collecting and annotating data across sign languages by creating a small-scale corpus for three sign languages: British Sign Language (BSL), Sign Language of the Netherlands (NGT), and Swedish Sign Language (SSL) (Crasborn et al. 2007).

<sup>4</sup> Fingerspelled signs may also be two-handed, however. For instance, ASL #OFF and #BACK, derived from fingerspelling (as indicated by the #-notation) and signed with both hands, denote a breakup and reconciliation, so it is not the case that fingerspelling, even in languages that use one-handed fingerspelling systems, necessarily gives rise to one-handed signs (we thank Carol Padden for bringing this to our attention). Nevertheless, we do not analyze fingerspelled signs here.

languages. This difference between the amount of overlap that we would expect among three languages and what we actually observe is statistically significant according to a standard binomial test ( $p < 0.001$ ).

We observe a similarly significant overlap in "not two-handed" signs, as well, with 77 out of 256 concepts (30%) coded as "not two-handed" in all three languages. However, we reiterate that, because some of the "not two-handed" entries in our data are due to fingerspelled words and multi-sign paraphrases, "not two-handed" should not be interpreted as a direct code for "one-handed" here. We see no *a priori* reason why a complementary analysis to the one we develop in this paper should not also apply to one-handed signs, perhaps especially to one-handed signs that contact the body, which may treat the body as a place of articulation in much the same way that some two-handed signs treat the non-dominant hand as a place of articulation. However, it may also be the case that one-handedness is simply the default in some sense. We leave a systematic semantic analysis of one-handed signs for future research.



**Figure 2.** 72 out of 256 signified meanings have two-handed signifier forms in ASL, ISL, and SSL.

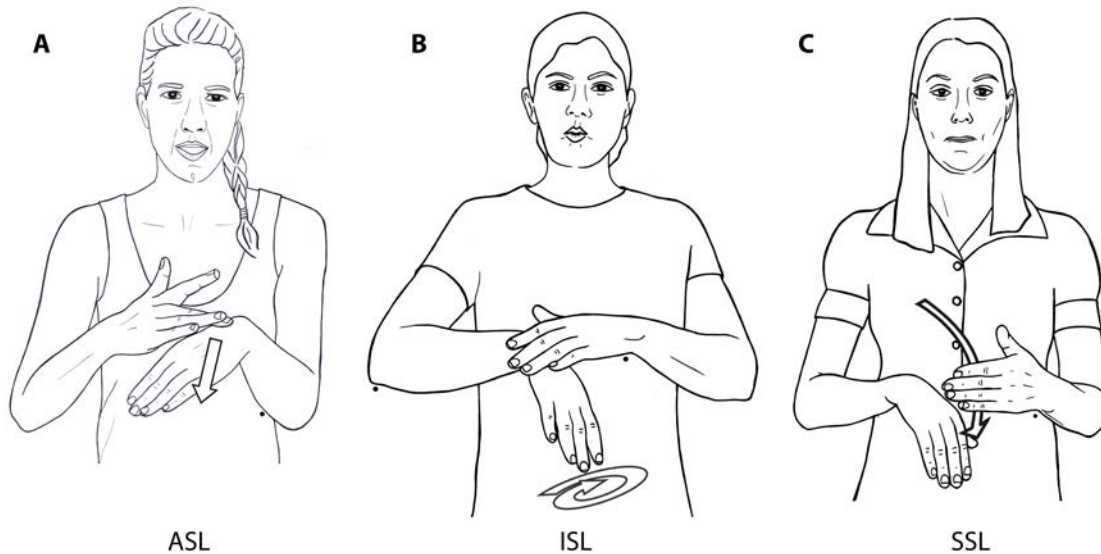
In addition to the 72 concepts that have two-handed sign forms in all three languages, we observe that some concepts are associated with two-handed signs in only one or two sign languages. The number of concepts associated with two-handed signs in all three of our languages, as well as the number of concepts that are associated with two-handed signs in only one or two of our languages, is represented in the proportional Venn diagram in **Figure 2**, in which each number corresponds to the number of concepts that are lexicalized as two-handed signs for the given section of the data. For example, of the 112 concepts associated with a two-handed sign in ISL, 72 concepts have two-handed sign forms in ASL, ISL, and SSL, 23 concepts have two-handed signs in ASL and ISL only, 7 concepts have two-handed signs in ISL and SSL only, and the remaining 10 concepts have two-handed signs in ISL alone.

## 2.4 Discussion

Because they rely on some notion of translational equivalence, cross-linguistic lexical comparisons are predisposed to neglect language-specific factors, including polysemy, synonymy, and nuances of usage. Swadesh list comparisons and dictionary studies should therefore always be interpreted conservatively. These results from multiple languages present an interesting pattern to be explained: something about a

given sign's meaning is relevant for whether the corresponding sign form is two-handed. However, the results alone offer no hint as to what the determining factor(s) may be.

In examining our collected SL-Swadesh signs for concepts with two-handed sign forms in all three languages, we identified, as expected, signs that are identical or nearly identical in form, for example the ASL/ISL/SSL signs MEET (**Figure 1A**), WRITE, and STAND. However, we also found signs that have phonologically distinct forms, but nevertheless draw upon what we intuitively feel is a similar kind of iconic mapping. A good example of the latter is EMPTY, realized in ASL, ISL, and SSL (**Figures 3A,B,C**) with the non-dominant hand representing a surface or container, and the dominant hand articulating on it to indicate that the surface or container is bare. Similarly, though their exact phonological specifications differ, in ASL, ISL, and SSL, SIGN involves an alternating movement of both hands, representing signing hands in action, and INTERPRET involves the hands repeatedly twisting with respect to one another, evoking the sense of transforming or translating one thing to another via the two hands.



**Figure 3.** EMPTY is a two-handed sign in (A) ASL, (B) ISL, and (C) SSL. All three languages use the two hands to indicate a vacant space on a surface or in a container.

In section 3.3, we provide a semantic analysis for a selection of the signs that are two-handed in all three sign languages in our SL-Swadesh list study, and show that semantic considerations can explain the use of two hands for certain of these signs. However, we do not claim that meaning is the sole determining factor for whether a sign will be made with one hand or two. Such a claim presupposes that all lexical signs will have an identifiable and reliable iconic motivation, which remains to be tested empirically. It is furthermore well known that some sign languages allow for some flexibility between certain one- and two-handed signs. Lexically two-handed signs may sometimes undergo a process of "weak drop" (Padden & Perlmutter 1987), in which a two-handed sign becomes one-handed. Conversely, lexically one-handed signs are occasionally articulated with the non-dominant hand "mirroring" the posture and movement of the dominant hand, yielding a two-handed sign (Nilsson 2007). Siple (1978) also notes the historical tendency for one- and two-handed signs to change according to perceptual considerations: two-handed signs located near the face, and therefore signed in the center of the visual field, can become one-handed, while one-handed signs located lower on the body, and signed at the edges of the visual field, can become two-handed.



These previous studies have looked at synchronic and diachronic patterns in individual sign languages. On the basis of the preceding SL-Swadesh list study, we conclude that there is also a cross-linguistic pattern to be explained for two-handed signs. We propose that part of the explanation for this pattern requires referring to the meaning of the sign as a motivating factor. The next section seeks to make these intuitions about the motivated link between meaning and form more explicit.

### 3. Mapping meanings to two-handed forms

If we assume that our senses and experiences help us conceptualize and categorize the world (Rosch 1978; Langacker 1990; Wilson 2002), and that iconicity is the construction or perception of a motivated link between referent concepts and linguistic forms (see Perniss, Thompson & Vigliocco 2010 for a review), then many of the uses of the two hands in sign language lexicons are unsurprising, and indeed expected. Our experiences in the world and the availability of two manual articulators in the sign modality interact to produce iconic two-handed signs. In this section we develop a general principle that the components of an inherently "paired" or "plural" concept can be straightforwardly mapped onto our paired human hands, resulting in recurrent uses of the two hands in lexical signs across sign languages.

Though straightforward, the creation and interpretation of iconic forms is neither simple nor trivial. Taub (2001) argues that the cognitive process of creating a form that resembles its referent minimally involves several sub-processes. Accordingly, we draw on Taub's analogue-building model for analyzing iconic signs. The analogue-building model outlines the processes through which iconic linguistic forms are coined, and begins with the understanding that concepts are associated with a wealth of sensory (visual, auditory, kinesthetic) images and general encyclopedic information. This idea is also found in other cognitive theories, for example prototype theory, in which referents can be categorized by the features they share, and, as a result, certain features can crucially distinguish one referent from other, related referents (cf. Rosch 1978); such features may therefore be seen as optimal candidates for iconic representation.

The first stage of the analogue-building model, then, is to select a single image from among many possible candidates to represent the target concept. The second stage is to schematize the selected image, breaking it down and rearticulating it in terms of essential, representable semantic elements. The final stage of the analogue-building model is to encode the schematized image using an appropriate, i.e., structure-preserving and phonologically valid, linguistic form. Emmorey (2014) has also described this process of linking a linguistic form and (the mental representation of) a referent in terms of *structure mapping*, drawing on processing evidence to support Taub's more etymological perspective.

A crucial point here is that the selection of an image to represent a given referent is not deterministic; the images we are discussing here are mental representations constructed from the basis of sensory experiences with real-world referents, rather than objective characteristics of the referents themselves, and so we expect to find variation regarding how they are selected and schematized. However, as we are most interested in how sensory images associated with certain concepts are mapped onto the two hands, in the following subsection we outline in detail how certain prototypical images can be selected and schematized in a way that encourages the use of the two hands in lexical signs.

#### 3.1. Conceptual images and two-handed signs

To start with a relatively concrete example, the concept 'bicycle' has several visually and experientially salient features. For instance, a prototypical bicycle minimally consists of several component parts, among them a seat, two wheels, two pedals, and the handlebars. Similarly, our interactions with bicycles often include sitting in the seat, moving the wheels by pedaling with one's feet, and steering using the

handlebars. These visual/kinesthetic images (and many more) are likely to contribute to our mental representation of the concept 'bicycle'. Using this as our starting point, we can generate several possible ways to iconically denote a bicycle: the two hands could represent wheels as two entities in a spatial configuration relative to each other, or the two hands could represent the paired handlebars or the pedals, which are also manipulated using our paired hands and feet, respectively. One direct way to link any of these paired aspects of the concept 'bicycle' is through coordinated action with our two hands. This is what we observe for ASL BICYCLE; the two hands move alternately to represent the paired pedals as they are moved by paired human feet. Bicycles are human-made artifacts with an intended use, and accordingly, a very salient aspect of the concept 'bicycle' involves how it is manipulated by a human body. For this reason, we predict that BICYCLE will be two-handed in this way, at above chance rates, cross-linguistically. This hypothesis finds initial support in the fact that BICYCLE is a two-handed sign in ISL and SSL, as it is in ASL.

Another example is the concept 'rain', which also has several visually and experientially salient features, such as the feeling of rain dampening one's skin, the knowledge that an appropriate amount of rain is crucial for sustained plant and animal life on Earth, and the visual image of multiple individual drops of condensed moisture falling from the sky over a large area. One direct way to represent this final facet of the concept 'rain' is through the coordinated action of the fingers on each of our two hands, specifically, with the fingers representing individual drops of rain, and the two hands together representing a wide, even distribution. This is, again, exactly what we observe for ASL RAIN; the two hands move in unison, extended fingers on each hand representing multiple individual raindrops continuously falling uniformly from the sky over a large area. Because the visual image of raindrops falling over a large area is not the only sensory image associated with the concept 'rain', we would not want to say that all sign forms for the concept 'rain' should necessarily be two-handed. However, we do predict that, cross-linguistically, the sense of spatial distribution inherent to 'rain' will be conveyed through the coordinated use of the two hands at above chance rates, because such an important part of how we conceptualize 'rain' and other meteorological phenomena involves their large size and volume relative to the human body. This hypothesis is supported by the fact that RAIN, like many other weather signs, is two-handed in our three sign languages.

A third example draws on the observation that concrete objects have characteristic shapes and are often comprised of salient symmetrical elements. For example, the concept 'house', along with connotations of living quarters or domestic family life, can be associated with the visual image of a prototypically inclined roof, as seen in children's drawings in much of the Western world. Viewed from the front, a prototypical house's roof consists of two slanted lines, joined at the top and sloping down- and outwards away from each other. This distinctive shape lends itself to a two-handed depiction in which each hand represents a symmetrical dimension of the roof of a prototypical house: the fingertips on each hand meet to form a peak, and the hands themselves slope outward and away from each other. Indeed, this is the basis for HOUSE in many sign languages, including ASL, ISL, and SSL. Here the symmetry of a prototypical house's image is mapped onto the hands as symmetrical articulators. It would of course be possible to trace the outline of a house, or of any given shape, with one hand. However, we hypothesize that the availability of two hands to represent the corresponding sides of a symmetrical shape simultaneously predisposes HOUSE, and other signs that trace a visual image, to be two-handed.

Taking a less concrete concept as a final example, we can follow the same line of reasoning. Although the concept 'depend' is an abstract notion, from its usual definitions (i.e., OED 2013 “depend, v.”), we can observe some general patterns: "dependence" causally relates one situation or entity to

another, or implies that one situation or entity is contingent on another. The concept 'depend' therefore implies two aspects of a relationship, a "depender" and a "dependee", which can be linked to each of the two hands. This is, again, exactly what we observe for *DEPEND*: in ASL the two hands move together, extended index fingers touching to represent the subordinate relationship between two entities, one resting on the other; the ISL sign is similarly two-handed, except with different handshapes. Because we are talking about statistical and prototypical tendencies, rather than absolute universals, we expect to find some counter-examples, and here we do. SSL *DEPEND* is one-handed, but this is because its form is influenced by the SSL manual alphabet: SSL *DEPEND* is a so-called initialized sign, articulated with a B-handshape that matches the initial letter of the written Swedish word *bero (på)* 'depend (on)'. Here, the SSL sign is borrowed from (written) Swedish instead of formed on the basis of an iconic motivation. We predict that if the sign were not borrowed in this way, it would indeed be iconically motivated, and furthermore would likely be two-handed.<sup>5</sup> We similarly predict that *DEPEND* will be a two-handed sign at above chance rates cross-linguistically, because the two hands are available to encode the two parts of the relationship that the concept 'depend' entails. Note that, unlike the entities represented in *BICYCLE*, *RAIN*, and *HOUSE*, the two entities involved in the *DEPEND* are not related to each other in exactly the same way. We shall see in section 4 that this asymmetry has phonological consequences.

We have suggested in the preceding discussion that many concepts are associated with sensory images consisting of salient component parts or configurations of entities. We have also predicted, based on these aspects of their meaning, that these concepts will tend to co-occur with two-handed signs across languages. What these concepts have in common is an implied, inherent relationship, either between or among entities, and, accordingly, we argue that certain relationship types can act as a trigger for two-handedness across sign languages. Following Taub's analogue-building model, we can say that concepts like 'bicycle', 'rain', 'house', and 'depend' are associated with images that can be schematized in terms of relationships between or among entities, and that the members of such relationships can be directly encoded with each of the two hands in sign language. However, we acknowledge that *relationship* is a very inclusive term. The relationships that we have in mind here are best defined in terms of associations between exactly two entities, and in terms of associations among more than two entities. In order to be more precise regarding this point, we now turn to two relevant topics from cognitive linguistics and lexical semantics.

Talmy (1978; 2000) notes that languages often represent spatial and temporal relationships in terms of a conceptually movable entity, the Figure, and its relation to a prototypically static reference entity, the Ground. The Ground is typically the reference point for the Figure, which is at once of greater concern than the Ground and also more dependent on it. Talmy's insight that Figure and Ground relationships find expression in linguistic forms, though originally developed to explain recurring patterns in spoken languages, is directly applicable to the formation of sign language classifier constructions. In many classifier constructions, one hand can represent the Ground, and the other, the Figure, with the relationship between the hands representing the physical relationship between the two entities (Talmy 2003).<sup>6</sup> Because the Figure and Ground are inherently paired, and defined in terms of

<sup>5</sup> Indeed, we note that an SSL sign with a more literal meaning of 'dependency', the iconically motivated sign *HANG-ON*, is two-handed as expected, with one hand subordinate to the other.

<sup>6</sup> Classifier constructions combine conventional handshapes representing classes of entities with different movement patterns to create morphologically and syntactically complex forms (see Emmorey 2003). Classifier constructions are not typically analyzed as lexical signs, and are not necessarily constrained by the same phonological considerations that hold over lexical signs (Sandler & Lillo-Martin 2006). In classifier constructions, each of the two hands can represent a distinct referent and the interaction of the two hands represents the relationship between the two referents, however, not all classifier constructions are two-handed, and not all two-handed classifier constructions represent Figure and Ground simultaneously (Özyürek, Zwitserlood & Perniss 2010; Pfau & Aboh 2012).

one another, we expect lexical signs that denote Figure/Ground relations to be encoded with two-handed lexical sign forms. That is to say, in sign language, the two hands are available to represent the Figure, the Ground, and the relationship between them, in the classifier system and the lexicon alike.<sup>7</sup> Therefore, we expect that sign languages will use the two hands to introduce lexical Figure/Ground relationships. A simple example can be seen with the concept 'near', in which the Ground is a fixed reference point and the Figure is an entity positioned in close proximity to the established reference, regardless of whether concrete or abstract entities are involved. In ASL, ISL, and SSL, NEAR involves the non-dominant hand in a fixed position and the dominant hand moving to reduce its distance from the non-dominant hand. ASL and ISL DEPEND, discussed above, also find a clear motivation in Talmy's conception of Figure/Ground relationship in terms of a conceptually movable entity and its relation to a prototypically static reference entity. Here, the non-dominant hand represents the static object, the Ground, and the dominant hand, representing a conceptually movable object, is the Figure. The contacting interaction of the two hands then reflects the dependency relation between the two entities.

However, as we have seen, not all two-handed signs involve a relationship between Figure and Ground, or even between two distinct entities. Instead, signs like ASL/ISL/SSL BICYCLE, HOUSE, and RAIN are motivated in the sense that the two hands represent multiple component parts or the boundaries of an overall, typically symmetrical, shape. We suggest that these concepts have some sense of inherent plurality in common. Here we use plurality in a conceptual or morphosemantic sense, rather than a traditionally inflectional or morphosyntactic sense, following Acquaviva (2008). Acquaviva offers lexical plurality as a unifying label for many otherwise idiosyncratic-seeming configurations of form (plural morphology) and meaning (plural lexical semantics). One such configuration can be seen with English *books* 'more than one book', *wines* 'varieties of wine', and *looks* 'human physical features'. These words all exhibit regular English plural morphology, but their differing semantics in relation to their uninflected bases would seem anomalous without an additional theory of plurality at the level of lexical representation. Over the course of several case studies, Acquaviva explains that cross-linguistic patterns of lexical plurality result from interactions between linguistic (grammatical and lexical) knowledge and non-linguistic (ontological and perceptual) principles of part-structure conceptualization. Such interactions include, for example, the conceptualization of objects as either masses or countable entities, and patterns of possible plural forms (cf. Wierzbicka 1988; Wisniewski 2010). Relevant for our argument here is Acquaviva's reasoning that lexical plurality is, at its core, a sense of 'not-one', and his identification of several intrinsically plural conceptual domains, some of which are known to be associated with fixed plural forms (i.e. *pluralia tantum*) in spoken languages, as well, including artificial and internally complex objects, weather and environment types, diseases, periods of time, and activities involving multiple actions or participants (cf. Delbrück 1893:147–165; Corbett 2000:175–176; Koptjevskaja-Tamm & Wälchli 2001:630).<sup>8</sup> We expect lexical signs that encode inherently plural concepts, such as those identified by Acquaviva, to be preferentially encoded as two-handed signs across sign languages, because the two hands are themselves inherently plural and are also readily available for this semiotic purpose.

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<sup>7</sup> Pizzuto and Corazza (1996:186) suggest that certain lexical signs have internal structure similar to that of classifier constructions, such as the sign CHASE, which can be said to have the two verbal arguments represented by each of the two hands. Indeed, this particular view of lexical structure could be seen as a natural extension of a more general position, shared by the authors of this paper, that lexical signs are often coined through the lexicalization of classifier constructions (e.g. Valli & Lucas 1995; Johnston & Schembri 1999; Emmorey 2002). Space considerations prohibit further discussion of the parallels between classifiers and lexical signs, and we focus only on iconicity in two-handed lexical signs here.

<sup>8</sup> An anonymous reviewer notes that *pluralia tantum* tends to overlap with *lexical plurality*, however, following Acquaviva, we consider *lexical plurality* to be a wider and more useful level of categorization than *pluralia tantum* (cf. Acquaviva 2008:15), and so have adopted the term *lexical plurality* in this paper.

In sum, we propose that a central motivation for two-handedness is the plurality inherent in relations between entities or, metaphorically, between ideas. We discuss Figure/Ground and lexical plurality together here because both relationship types have been independently motivated in other studies, and both crucially imply 'more than one'. We argue that this sense of 'more than one' is what is relevant for the formation of two-handed signs cross-linguistically. Figure/Ground relationships and canonically reciprocal actions, like 'near', 'depend', or 'meet', represent a very direct kind of mapping, where each of exactly two conceptual entities can be represented by each of the two hands. However, other kinds of lexical plurality are less direct; signs for internally structured concepts like 'house' and 'bicycle' are encoded with two-handed signs, not because exactly two entities are involved, but rather because we only have two hands. The use of two hands in certain signs to denote lexically plural concepts therefore sometimes represents a compromise: humans have exactly two hands, and we recruit them to represent paired elements that are inherent to many lexically plural concepts.

### 3.2. Analogue-building and lexical patterns

In the preceding subsection, we identified concepts that we intuitively feel are well-suited to be paired with two-handed sign forms, and reviewed independently-motivated semantic patterns that entail relationships between two or more entities. In this section, we draw these two strands together and articulate them following Taub's (2001) model of iconic mapping, which provides a way to make the motivated relationship between form and meaning in sign language explicit. There will always be aspects of a concept that cannot be directly mapped onto the articulators, if for no other reason than that the articulators are finite and discrete. We have also suggested that this limitation on the articulators can explain why the two hands are used to denote lexically plural concepts, despite the fact that duality and plurality are not strictly equivalent notions.

Taub's model also allows us to capture the intuition that recurrent mapping patterns between signs are instances of the same lexical pattern. For example, Meir and colleagues (Meir 2010; Meir et al. 2013) have adapted Taub's analogue-building model to capture other lexical patterns present in sign language lexicons. In what they term the "body as subject" lexicalization pattern, recurrent references to parts of the human body can be understood as lexically denoting human actions and senses. An example is the sign EAT. In many sign languages, this sign involves moving the hand toward the mouth, with the hand configured as if holding an object. The iconic mapping for EAT, or set of correspondences between form and meaning, is shown in **Table 1**.<sup>9</sup>

**Table 1.** Iconic mapping for ASL/ISL/SSL EAT (after Meir 2010)

Form	Meaning
Location: mouth	agent (eater)'s mouth
Dominant hand: "flat O" handshape	agent holding food
Movement: inward toward mouth	putting an object into the mouth
Movement: repetition	an ongoing process

In the iconic mapping for ASL/ISL/SSL EAT, the formal location of the signer's mouth represents the aspect of the meaning of 'eat' that implies that the "eater" has a mouth. However, unlike in spoken language, in many sign languages, the iconicity of the signer's mouth actually restricts the sign's use in at least two ways. First, the sign form cannot leave the signer's body to indicate eating events by people other than the signer; that is, the verb EAT is anchored to the signer's body, and has the same form

<sup>9</sup> In this and the following tables, the characters O, 1, and 5 stand for specific phonological handshapes. However, the exact labels for these handshapes are not relevant for the larger point we wish to make regarding iconic mappings in sign language, so we do not discuss them in detail.

whether the signer is describing her own eating or another person's. In both cases, the signer's mouth represents an agent's eating, though not necessarily the signer's (Meir et al. 2013). Second, the mouth location, as part of a human body, restricts this sign to be used with animate agents only. Although "the acid ate the key" is an acceptable use of the word *eat* in English, the ASL/ISL equivalents with the sign EAT are inappropriate. The metaphorical use of *eat* in English is an extension of one semantic component of 'eat', namely 'consumption', but the ASL sign EAT profiles a different semantic component, 'the physical process of putting food in one's mouth' (Meir 2010).

In this way, the iconicity of lexical signs can reveal semantic patterns that may be more opaque in the words of spoken language. Meir and colleagues (2013) additionally discuss examples of the ASL and ISL signs DREAM ("a dream coming from the head"), KNOW ("knowledge in the head"), and ANGRY ("rising anger experienced in the chest") as making similar use of the human body to instantiate the "body as subject" pattern cross-linguistically. These examples demonstrate that iconic patterns can be exemplified through recurrent form-meaning mappings among signs within and across languages. As a result of these recurrent iconic mappings, parts of the body may also come to be systematically associated with a particular semantic value in a given language, as the examples in (2), from Meir et al. (2013), illustrate:

- (2) Iconic ISL signs in which the body corresponds to an argument participating in the event
- a. 'psych' verbs in which the chest corresponds to the location of the experiencer: HAPPY, LOVE, SUFFER, UPSET, BE-FED-UP-WITH, HURT
  - b. 'mental activity' verbs in which the temple or forehead corresponds to the mind of the experiencer: KNOW, REMEMBER, FORGET, LEARN, WORRY, THINK, UNDERSTAND
  - c. 'perception' verbs in which the eyes, ears, or nose represent the sense organs of the experiencer: SEE, LOOK, HEAR, LISTEN SMELL
  - d. verbs of 'saying' in which the mouth represents the mouth of the agent: TALK, SAY, ASK, ANSWER, EXPLAIN, SHOUT, WHISPER

As Meir and colleagues have demonstrated, the iconic mapping component of the analogue-building model allows us to account both for the component parts of an iconic sign and for recurrent mappings across groups of signs. With this in mind, we return to two-handed signs. Consider the iconic mapping for the sign MEET (**Table 2**), which is identical in ASL, ISL, and SSL, and, we suspect, in many other sign languages as well (see **Figure 1A**).

**Table 2.** Iconic mapping for ASL/ISL/SSL MEET

Form	Meaning
Dominant hand: "1" handshape	a human agent
Non-dominant hand: "1" handshape	a human agent
Movement: dominant and non-dominant hands approach each other in a single movement	human agents approaching each other, a telic action

In the sign MEET, two distinct entities are mapped onto the two hands, and the overall relationship between the two hands reflects the reciprocal and interacting relationship implied by 'meet'. Thus, the relationship between the paired elements in the meaning of 'meet' are mapped onto the paired hands as formal articulators. As we explain in section 4, we find that predicates that are often encoded as two-handed signs include those in which a) two referents have an equal/reversible relationship, b) two referents are spatially configured relative to one another, or c) one referent contacts the other. For prototypically reciprocal actions like 'meet', two referents physically approach each other. For spatial

predicates like 'near' or 'depart (from)', specific configurations of referents are profiled. For prototypically transitive actions like 'hit' (cf. Hopper & Thompson 1980), one referent contacts the other.

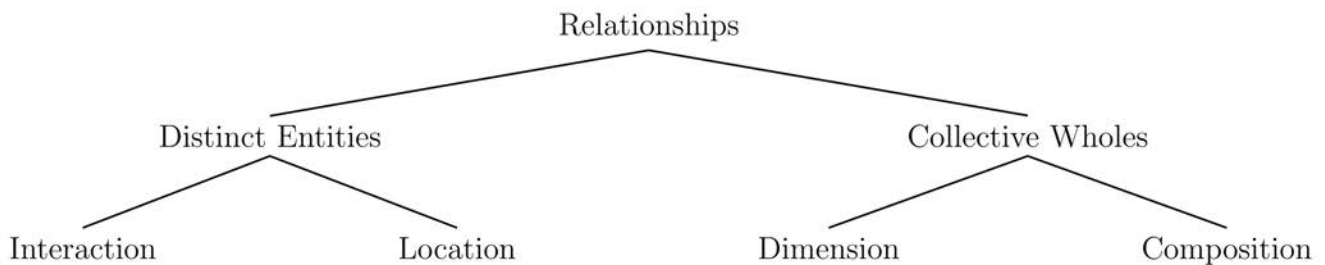
Compare these predicate types with prototypical predicates of transfer, like ASL GIVE or TELL: although they also feature multiple referents/arguments, they are not encoded with a two-handed form. Instead, the interaction between agent and recipient is typically expressed through orientation and movement between two "referential loci" (cf. Meir 2002). In verbs of transfer, then, two locations may be recruited to encode the arguments involved, rather than the two hands. Verbs of transfer may still be two-handed, however, following from other motivations not rooted in argument structure, for instance using the two hands to represent the handling of a large object; SSL GIVE uses the two hands in this way to represent aspects of the theme argument, but not the relationship between agent and recipient.

The use of the two hands in a sign like MEET also differs from the use of two hands in a sign like RAIN, which also typically has a similar form across sign languages; here it is not two distinct entities, but rather a multitude of entities that are mapped onto each of the two hands (**Table 3**).

**Table 3.** Iconic mapping for ASL/ISL/SSL RAIN

Form	Meaning
Dominant hand: "5" handshape	multiple drops of rain
Non-dominant hand: "5" handshape	multiple drops of rain
Location: high in signing space	the sky
Movement: dominant and non-dominant hands repeatedly move downward	many drops of rain repeatedly falling from the sky, an ongoing event

Instead of a direct mapping between two entities and two hands, as in MEET, for RAIN we instead see two manifestations of plurality. First, multiple fingers on each hand represent multiple drops of rain, and second, the two articulating hands further represent these multiple drops of rain falling over a large area. Comparing the iconic mappings for MEET and RAIN, we again see that the two hands can be recruited to convey either 'exactly two' or 'more than one'. On the basis of the preceding discussion, then, we propose the following hypotheses about the lexical semantics of two-handed signs, summarized in the diagram in **Figure 4**.



**Figure 4.** Four relationship types are predicted to motivate two-handed signs cross-linguistically.

Under our proposal, the semantic features that motivate two-handed signs across languages will represent relationships of two main sorts: 1) relationships between two distinct entities, and 2) relationships among multiple elements forming a collective whole. We also suggest that each of these two categories can be further divided: comparing ASL/ISL DEPEND ("one entity reliant on another") with ASL/ISL/SSL NEAR ("one entity in close proximity to another"), we can see that DEPEND uses the two hands to represent two interacting entities, while NEAR uses the hands to highlight a more spatial relationship. Accordingly, we divide relationships between distinct entities into the categories of

*interaction* between or relative *location* of the entities. Comparing ASL/ISL/SSL RAIN ("precipitation over a large area") with ASL/ISL/SSL BICYCLE ("the moving pedals of a bicycle"), we can also see that RAIN uses the two hands to represent a wide spatial distribution, while BICYCLE uses the two hands to represent component parts of the denoted object. We therefore divide relationships among the parts of a collective whole into the categories of *dimension* and *composition*.

This hierarchy and its categories are by no means exhaustive, nor are they necessarily intended to represent mutually exclusive options. They represent a first attempt to account for relationship types in two-handed signs. However, positing these categories leads us to the statements in (3), one for each of the four main form-meaning relationship types for two-handed signs shown in the hierarchy in **Figure 4**.

- (3) Four relationship types are predicted to motivate two-handed sign forms:
- Interaction*: Paired, interacting entities are mapped onto each of the two hands.
  - Location*: Paired entities and their locations are mapped onto each of the two hands.
  - Dimension*: Boundaries of an entity's shape/volume are mapped onto the two hands.
  - Composition*: Component parts of an entity are mapped onto the two hands.

In this section, we have sought to characterize four relationship types inherent to concepts whose meanings naturally find expression in two-handed signs. We propose that relations such as those shown in **Figure 4** are likely to be encoded by two-handed signs across sign languages. The mapping statements in (3) describe how this encoding is predicted to happen, with the two hands either representing exactly two entities, or more broadly symmetrical or plural entities.

### 3.3 Plurality in signs for SL-Swadesh concepts

As an initial illustration of our analysis, in **Table 4** we categorize a small sample of SL-Swadesh list signs that we found to be two-handed signs in ASL, ISL, and SSL (section 2) according to the relational factors we propose in our taxonomy.

**Table 4.** Iconic motivations for SL-Swadesh list concepts with two-handed sign forms in ASL/ISL/SSL

Concept	Motivation	Mapping Type
'argue'	ASL/ISL/SSL: "two people with opposed points of view"	ASL/ISL/SSL: <i>interaction</i>
'meet'	ASL/ISL/SSL: "two people facing and approaching each other"	ASL/ISL/SSL: <i>interaction</i>
'empty'	ASL/ISL/SSL: "indicating a vacant space with respect to an object"	ASL/ISL/SSL: <i>location</i>
'stand'	ASL/ISL/SSL: "two legs on a flat surface"	ASL/ISL/SSL: <i>location</i>
'family'	ASL/ISL/SSL: "delimiting the space occupied by a group of people"	ASL/ISL/SSL: <i>dimension</i>
'road'	ASL/ISL/SSL: "two sides of a road extending forward"	ASL/ISL/SSL: <i>dimension</i>
'awake'	ASL/ISL/SSL: "opening two sets of eyelids"	ASL/ISL/SSL: <i>composition</i>
'tortoise'	ASL/SSL: "body and shell of a tortoise" ISL: "body and legs of a tortoise"	ASL/ISL/SSL: <i>composition</i>
'night'	ASL: "location of sun relative to the horizon" ISL/SSL: "falling ambient darkness covering the eyes"	ASL: <i>location</i> ISL/SSL: <i>dimension</i>



Though we often observe shared iconic mappings in ASL, ISL, and SSL signs for the same concept, we can see from **Table 4** that not all sign languages will necessarily highlight the same relationship inherent to a given concept. For example, NIGHT is mapped differently in ASL and in ISL/SSL. However, we emphasize that any of the four conceptual relationship types we have listed, when salient for an image selected to represent a given concept, is predicted to be associated with a two-handed sign.

As another example, our proposal predicts that WINDOW is likely to be a two-handed sign in multiple sign languages, because 'windows' usually have a prototypical shape comprising identifiable component parts, and they are typically handled by humans in a particular way. However, here we see again that there can be multiple paths to two-handedness. In ASL WINDOW, the dominant hand represents the movement of a pane of glass relative to the immobile frame or wall, represented by the stationary non-dominant hand; the ASL sign therefore uses a *location* mapping. In SSL and ISL WINDOW, the two hands together trace the distinctive outline of a window, a *dimension* mapping. Still other sign languages are predicted to employ the two hands to represent how humans open windows, by manually moving the glass pane away from the window frame, which would be a *composition* strategy. In this case, how a window is opened, through the human action of lifting or pulling with both hands, is a kinesthetic image that metonymically represents the concept 'window' itself. In each of these cases, the characteristics of a prototypical window are contributing to the conceptual representation of 'window', which, we argue, drives the use of the two hands for this concept in multiple sign languages.

We also see in **Table 4** a pattern that we have already seen with the sign RAIN, concerning the interplay between the fingers and hands when representing inherently plural concepts. In the case of RAIN, the two hands and the fingers on each hand work together to represent lexical plurality, with the fingers on each hand representing multiple drops of rain, and the two hands together representing a wide distribution. The lexical plurality inherent to the concept 'rain' is therefore encoded through exhaustive recruitment of all available manual articulators. Here as well, for ASL/ISL/SSL STAND, the hands and fingers can represent different aspects of plurality simultaneously. In addition to the *location* mapping strategy that we have identified to describe the relationship between the two hands (i.e. one hand representing the legs of a person, and the other a flat surface on which the person stands), another mapping strategy is employed to express plurality, namely an extended index and middle finger on one hand representing two human legs. We might formulate this mapping strategy as "matched component parts are mapped onto two fingers of one hand", a type of iconic representation that has been noted by, e.g., Friedman (1977:9). We note that several different handshapes can be used in this way, and they share the feature of selecting two fingers, or two groups of fingers, to encode duality/plurality.

A nice example of how the use of two fingers overlaps with the use of two hands can be found with DOWNHILL-SKIING: both ASL and SSL use the two legs and paired skis as the basis for an iconic mapping, but ASL uses a two-handed sign, each hand extending and bending the index finger (i.e. two single-finger handshapes), while SSL uses a one-handed sign, with the index and middle fingers of one hand extended and bent (one dual-finger handshape). ASL therefore represents the two legs with the two hands, while SSL represents the two legs with two fingers on one hand. That the two fingers can be recruited for similar functions as the two hands opens up avenues for additional research into iconic patterns in sign lexicons, but we leave the issue open for future research.

Another related phenomenon, which we will mention only briefly here, concerns the interaction between the body and hands in signs for paired body parts. Our proposal predicts that signs for paired

body parts will be preferentially two-handed, as in ASL *HANDS*, in which the paired hands represent paired hands, and in ASL *LUNGS*, in which the hands trace the symmetrical outline of two paired lungs. However, signs which involve pointing at the referent body part seem to pattern in the opposite direction: ASL *EARS* involves pointing at or touching only one ear, and ASL *EYES* involves pointing at each eye in turn. We suspect that this class of exceptions has to do more with the function of pointing, and is driven by a corresponding constraint against pointing at two things simultaneously, but other than to suggest that pointing signs may constitute an important class of one-handed signs, we provide no analysis of them here.<sup>10</sup>

In section 4, we further investigate some of the ways in which meanings are mapped onto different phonological classes of two-handed signs. The analysis follows from our set of SL-Swadesh list signs that were found to be two-handed in ASL, ISL, and SSL, a subset of which are analyzed in **Table 4**. However, we will draw almost exclusively on additional signs that emerged from subsequent work with sign language dictionaries (Tennant & Gluszak Brown 2010 for ASL; Savir 1992 for ISL; Björkstrand 2008 for SSL) and from interviews with native signer consultants of ASL, ISL, and SSL.

#### 4. Meaning and phonological form in two-handed signs

The preceding sections have approached iconicity in two-handed signs from the perspective of the meaning or concept in question first. Here we instead categorize two-handed signs by their phonological characteristics. This complementary approach helps us to refine our analysis by illustrating recurring semantic patterns across different types of two-handed signs.

As is well documented in the literature on sign language phonology, the broadest categorization among two-handed signs is based on whether the non-dominant hand acts as an articulator in the sign or serves as a place of articulation for the dominant hand. These balanced and unbalanced categories are in turn composed of additional formational subgroups, according to the postures and movements of the two hands relative to one another.<sup>11</sup> Because these formational subgroups are relevant for explaining phonological and prosodic regularities in sign language grammars (e.g. Battison 1978; Nespor & Sandler 1999; Sandler 2006), the two hands have traditionally been treated as phonological elements, and, by definition, meaningless for the purposes of the grammar.

However, here we take a fresh look at some of the phonological subcategories of two-handed signs, and identify recurring semantic motivations for the two hands in each. Although we are appealing to phonological, particularly movement-based, classifications of signs to facilitate discussion here, any of the broad principals we proposed in section 3 can theoretically motivate any of the two-handed phonological forms that we describe. Though we identify recurrent pairings of form and meaning among two-handed signs, we find that there is no strict 1:1 correspondence between the phonological, typically movement-based, subcategories we will discuss here and the conceptual categories we have identified. The main reason for this is that specific details of phonological form are likely to be determined by

<sup>10</sup> An anonymous reviewer adds that it may be the case that in certain body-part signs, body contact as a phonological feature may override the semantic motivation to have a two-handed sign, which also promises to be an interesting hypothesis for future studies.

<sup>11</sup> In balanced signs, the two hands normally have identical handshapes, and in unbalanced signs, the hands may have different handshapes, thus resulting in three types of signs: type I (balanced signs), type II (unbalanced signs with identical handshapes), and type III (unbalanced signs with different handshapes) (Battison 1978). Balanced signs also comprise several movement types: the hands can move alternately, or move in a mirror image of one another, or the non-dominant hand can 'shadow' the dominant hand (Prillwitz et al. 1989; van der Hulst 1996). Two additional unbalanced signs types are those in which the hands move together, as in ASL *SHOW* and *EXCEPT* (Sandler 1995), or contact once and then contact again with reversed dominance, as in ASL *JESUS* and *COMFORTABLE* (Padden & Perlmutter 1987).

aspects of the relation to be conveyed that are selected as most salient in a particular language, a choice that could be determined by cultural factors or by chance, and also by language-specific phonological inventories and constraints. We therefore do not attempt to account for selection biases regarding particular handshapes and movements, which can differ from language to language, and are best left to future research. Our focus here is solely on systematic uses of the two hands across sign languages.

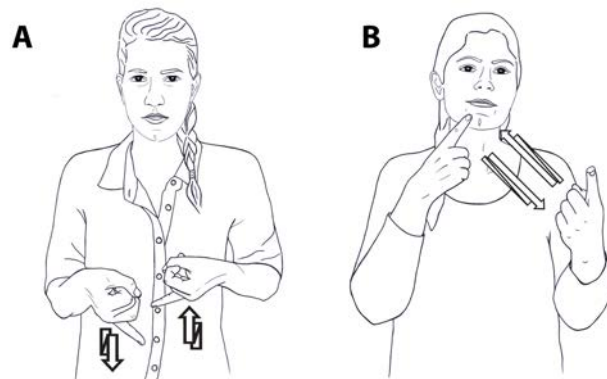
In this preliminary analysis, we limit our discussion to a few common phonological subgroups within the categories of balanced and unbalanced signs, and argue that recurrent conceptual motivations determine the use of the two hands in each group. We begin by discussing two types of balanced signs, those with alternating movements and those with symmetrical movements. We then consider three different types of unbalanced signs, depending on when during the sign's articulation the dominant hand contacts the non-dominant hand. At the end of this section, **Table 5** provides a summary with several example signs.

#### 4.1. Balanced signs

We begin with balanced signs, those in which both the dominant and non-dominant hands are active articulators. In balanced signs, the two hands typically have the same handshape and orientation, and move in the same way at the same locations, relative to each hand. Here we discuss two types of balanced signs: those with alternating movements, and those with symmetrical movements.

##### 4.1.1. Alternating movement signs

Alternating movement signs are two-handed signs in which the hands have identical handshapes and synchronized movements, but the movements of the hands are inverted relative to one another. We observe that in many alternating movement signs the two hands often represent paired, corresponding components of a larger whole, such as paired body parts or objects associated with paired body parts. Typically in these signs the alternating movement also represents an alternating movement as in ASL HIGH-HEELS, where each hand represents one of a pair of shoes in a walking motion (**Figure 5A**). We also observe that in alternating signs the two hands can represent paired participants in an event, as in ISL NEGOTIATE, where each hand represents lines of communication alternating between two participants in the act of negotiating (**Figure 5B**).

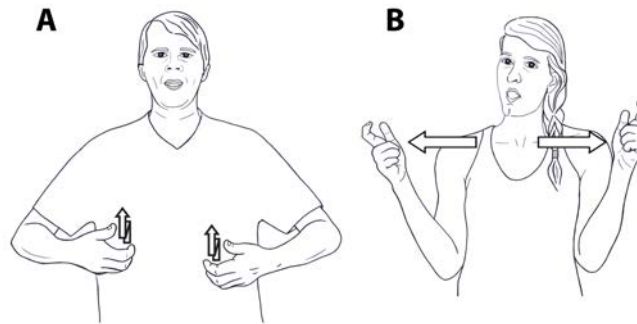


**Figure 5.** (A) ASL HIGH-HEELS is an alternating sign in which component parts are mapped onto each of the two hands (a *composition* mapping strategy), and (B) ISL NEGOTIATE is an alternating sign in which interacting entities are mapped onto each of the two hands (an *interaction* mapping strategy).

##### 4.1.2. Symmetrical movement signs

In contrast to alternating movement signs, symmetrical movement signs are two-handed signs in which the hands move simultaneously, in a synchronized fashion, in a mirror image of one another. Similar to

alternating movement signs, symmetrical movement signs often use the two hands to represent paired, corresponding components of a larger whole, such as paired body parts or objects associated with paired body parts. An example of this is SSL MONKEY, where each hand represents one of the denoted animal's hands as they scratch its body (**Figure 6A**). We also observe that in symmetrical signs the two hands can represent the boundaries of a volume, as in ASL LARGE, where the two hands move away from each other to convey a large shape (**Figure 6B**). Symmetrical signs also typically denote synchronized movement of objects or entities, as in SSL MEET, where each hand represents a participant simultaneously coming together in a meeting event (shown above in **Figure 1A** and **Table 2**).



**Figure 6.** (A) SSL MONKEY is a symmetrical sign in which component parts are mapped onto each of the two hands (a *composition* mapping strategy), and (B) ASL LARGE is a symmetrical sign in which boundaries are mapped onto each of the two hands (a *dimension* mapping strategy).

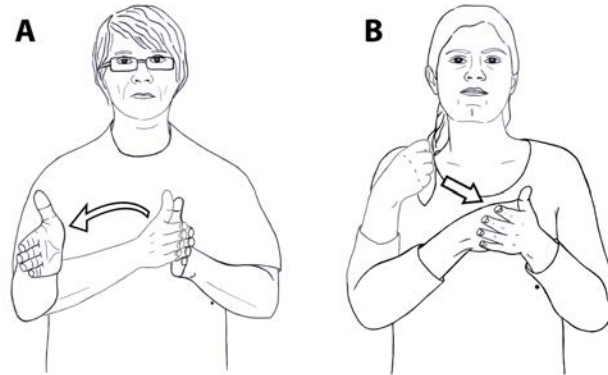
To summarize, in balanced signs the two hands can represent paired, interacting entities, component parts of a whole entity, or boundaries of a whole entity's shape or volume. For the first two categories, the choice of either symmetrical or alternating movement is determined by the perceived behavior of the entities or component parts in question, whereas in the case of boundaries, symmetrical movement evokes the typically symmetrical shape of the entity or volume. **Table 5** at the end of this section provides additional examples of balanced alternating and symmetrical movement signs from ASL, ISL, and SSL.

#### 4.2. Unbalanced signs

We now turn to unbalanced signs, in which one hand moves and the other typically acts as a place of articulation. We limit the discussion here to a few representative examples of the semantic-phonological sub-patterns we have identified, in the interest of space, focusing on three types of unbalanced contact signs, initial, medial, and final contact; however, additional unbalanced signs are provided in **Table 5** at the end of this section. From a purely phonological point of view, the fact that the dominant hand can contact the non-dominant hand either as the initial location, during the movement, or as the final location of a sign's articulation was one of the motivations for sequential segments in Sandler's model of ASL phonology (Sandler 1989; Sandler & Lillo-Martin 2006). From a semantic point of view, Wilbur (2008) has proposed that properties inherent to lexical verbs, such as telicity, correlate with point of contact in unbalanced signs. An example is ASL HIT, a telic event with a defined end state, as well as a defined motion from a source to a goal. These two factors are compatible with a final contact movement pattern. Here we blend these approaches, to encompass both verbs and nouns, and demonstrate more generally that the two hands play comparable roles across these movement patterns.

When we compare initial, final, and medial contact signs in ASL, ISL, and SSL, we can see that the two hands often represent the two entities of a Figure/Ground relationship, as discussed in section 3.

We observe that the segmental timing of contact and movement can establish the boundaries of a shape, or, more abstractly, a period of time, as in SSL SEMESTER (**Figure 7A**). The movement of the two hands in an unbalanced sign can also reflect the movements and locations of real-world entities, concrete or abstract, as in ISL END, where one hand represents a physical boundary and the other hand collides with the boundary (**Figure 7B**). Finally, the two hands can represent the interaction of individual entities, as in ASL FIRE-FROM-JOB, where non-dominant hand represents the person being fired, and the dominant hand represents the action of the person doing the firing (shown above in **Figure 1B**).<sup>12</sup>



**Figure 7.** (A) SSL SEMESTER is an initial contact sign in which boundaries are mapped onto each of the two hands (a *dimension* mapping strategy), and (B) ISL END is a final contact sign in which relative locations are mapped onto each of the two hands (a *location* mapping strategy).

### 4.3. Interim summary

From this survey of different phonological classes of two-handed signs, we have seen that there are identifiable, recurrent patterns as to how the two hands are used, and moreover that focusing only on broad movement types alone could potentially miss important generalizations about how the two hands are used similarly in particular groups of signs across sign languages. Importantly, our analysis suggests that the use of two hands, as well as other related aspects of phonological form, in two-handed signs can be determined mainly by meaning and not by form-based, meaningless phonological principles. **Table 5** provides additional examples that illustrate the patterns that we identified in this section and demonstrate their generality.

<sup>12</sup> English uses a ballistics metaphor of "firing" for removing somebody from their job, while, as can be seen in **Figure 1B**, ASL uses a decapitation metaphor (see <http://www.lifeprint.com/asl101/pages-signs/f/fire.htm> for a brief discussion). The point here is not about the metaphor but rather that in ASL FIRE-FROM-JOB is a two-handed sign in which one hand represents the (held) patient and the other hand represents the (instrument of the) agent.

**Table 5.** Iconic motivations for two-handed signs in ASL, ISL, and SSL

Mapping Strategy	Two hands represent...	Sign Language(s)	Sign	Motivation	Phonological Subgroup	Phonological Group
interaction	two active participants	ASL/ISL/SSL	COMMUNICATE	"two lines of communication"	alternating movement	balanced
		ASL/ISL/SSL	MINGLE	"two groups interacting"		
		ISL/SSL	OPPOSE	"two conflicting sides"	symmetrical movement	
		ASL/ISL/SSL	WAR	"two groups battling"		
		ASL/SSL	TOGETHER	"two parties coming together"		
	active and inactive participants	ASL/ISL	APPREHEND	"capturing a person"	final contact	unbalanced
		ASL/ISL	KICK	"leg striking a barrier"	medial contact	
		SSL	CAT	"stroking an animal"		
		ASL/SSL	ABUSE	"repeatedly striking a person"		
		ASL/SSL	KILL	"maiming a body"		
	comparable alternatives	ASL/ISL/SSL	COMPETE	"two candidates for first place"	alternating movement	balanced
		ASL/SSL	MAYBE	"considering two options"		
		ISL/SSL	WEIGHT	"weighing two options"	symmetrical movement	
		ASL/ISL	EQUAL	"two entities on the same level"		
SSL/ISL		SAME	"two identical options"			
location	relative locations in space	ASL/SSL	SUPERFICIAL	"indicating the top layer"	continuous contact	unbalanced
		ASL/SSL	FROM	"originating from a source"	initial contact	
		ASL/ISL/SSL	MAXIMUM	"reaching the top"	final contact	
		ASL/SSL	PARTICIPATE	"entering a group/container"		
		ISL	ESCAPE	"passing under a barrier"	medial contact	
	relative locations in time	ISL	MONTH	"continuous span on a calendar"	continuous contact	
		ASL/SSL	AHEAD-OF	"prior to a set point"	initial contact	
		ASL	FROM-NOW-ON	"continuing from a set point"		
		SSL	UNTIL-NOW	"moving forward to a set point"	final contact	
		ASL/ISL	EARLY	"deviation from a set point"	medial contact	
dimension	a spatial distribution	ASL/ISL/SSL	BOIL	"continuous movement of a substance"	alternating movement	balanced
		SSL	AMBIANCE	"moving through an extended surface"	symmetrical movement	
		ASL/ISL/SSL	DESERT	"a vast surface"		
		ASL/ISL/SSL	SNOW	"moving down over a large area"		
		ASL/SSL	SPREAD OUT	"dispersing over an area"		
	the edges of a volume	ASL/ISL/SSL	FORM-GROUP	"bringing together in one place"	initial contact	
		ASL/ISL/SSL	BOWL	"a rounded, concave container"		
		ASL/ISL/SSL	WIDE	"an increasingly wide shape"		
		SSL	MORE	"an increasingly tall shape"		
composition	paired human body parts	ASL/ISL/SSL	SIGN	"two signing hands"	alternating movement	balanced
		ASL	TEXT/SMS	"typing with both thumbs"		
		ASL/SSL	ADOPT	"taking up with both hands"	symmetrical movement	
		ASL/ISL/SSL	LUNGS	"outlining each lung"		
		ISL/SSL	STOP	"raised hands form a barrier"		
	animal body parts	ISL	ANIMAL	"paws stalking forward"	alternating movement	
		ASL/ISL/SSL	GORILLA	"hands pounding the chest"	symmetrical movement	
		ASL/ISL/SSL	BUTTERFLY	"paired wings"		
		ASL/ISL/SSL	MOOSE	"paired antlers"	continuous contact	
		ASL/ISL	PORCUPINE	"quills grow from body"		
	object parts	ASL/ISL/SSL	ROBOT	"moving humanoid arms"	alternating movement	balanced
		ASL/ISL/SSL	MACHINE	"interlocking gears"		
		ASL	SET-UP	"erecting walls of a structure"	symmetrical movement	
		ASL/SSL	BERRY	"stem and fruit"		
ASL/ISL		ELECTRIC-SOCKET	"socket and prongs"	final contact		

Up until this point, we have analyzed three sign languages to form and assess our hypotheses about how the two hands can be recruited to encode semantic patterns in sign language lexicons. However, the three Deaf community sign languages we have been working with, ASL, ISL, and SSL, while genealogically unrelated, are similar in the sense that they are used throughout relatively large communities in their respective countries, as well as in multiple social and educational settings.

Village sign languages contrast with Deaf community sign languages both in the circumstances under which they arise and in how they are used. Village sign languages typically result from genetic deafness within small communities, and their use is more limited to interaction within families and among other villagers with a good deal of shared context (see Meir et al. 2010; Meir, Israel, et al. 2012; Zeshan & de Vos 2012). One such young village sign language, ABSL, has been claimed not have a fully crystallized phonological level of linguistic structure comparable to those found in more established sign languages (Sandler et al. 2011). ABSL therefore provides an interesting test case for our hypothesis, as we expect to find a pattern of two-handedness nevertheless, one that is based on meaning.

## **5. Testing two-handedness in a new language**

In the preceding sections, we have analyzed lexical signs from three sign languages to investigate the correspondence between the two hands as articulators and the semantic characteristics that reoccur across two-handed signs. We have also suggested that these semantic motivations are relevant in constructing sign language lexicons. In this section, we describe the results of a picture-naming task that we developed to address this question in a fourth sign language, Al-Sayyid Bedouin Sign Language (ABSL).

ABSL arose approximately 80–100 years ago in the Bedouin village of Al-Sayyid, which is located in the Negev Desert of present-day Israel. The social conditions that lead to the emergence of ABSL initially arose when four deaf siblings were born in one family, and then for genetic reasons and due to endogamous marriage patterns, deafness became widespread in the community (Scott et al. 1995). Today there are about 130 deaf people in the village, and many hearing people also use the language on a daily basis (Kisch 2008; 2012). ABSL has grown in this relatively insular community over several generations of signers, and it has been the focus of a series of studies of sign language emergence (e.g. Sandler et al. 2005; Aronoff et al. 2008; Padden et al. 2010; Meir, Israel, et al. 2012; Sandler et al. 2014). We are fortunate to be able to work with members of the ABSL language community, and ABSL is useful for testing our hypotheses for a few key reasons. First, ABSL had not been considered in formulating our hypotheses, which were primarily based on the lexicons of ASL, ISL, and SSL. Second, although ASL, SSL, and ISL are not known to be related, they have shared social characteristics and are they all either European or influenced by European sign languages. Though many of the younger generations of ABSL signers have been exposed to some ISL signs in school, the ABSL lexicon is not derived from ISL (Kastner et al. 2014), nor has ABSL come into contact with any European sign language. Finally, as mentioned above, it has been claimed that ABSL does not, at this point at least, have a fully crystallized phonological level of linguistic structure. Instead, Sandler and colleagues argue that ABSL signs are typically more holistically structured around a semantic prototype (2011). This claim makes ABSL uniquely suited to address the central hypothesis of this paper, that semantic rather than phonological considerations can drive the use of two hands in sign language lexicons.

### **5.1 Materials**

We developed a picture-naming task to test the generality of the observations we developed in section 3. We first compiled a list of concepts that seem well matched with the semantic features of our identified

categories, and thus are predicted to be likely catalysts for two-handed sign forms. For example, 'argue' is predicted to be two-handed under (2a) *interaction*, 'empty' is predicted to be two-handed under (2b) *location*, 'large' is predicted to be two-handed under (2c) *dimension*, and 'electric socket' is predicted to be two-handed under (2d) *composition*.

However, our use of a picture-naming task, designed to avoid using a spoken/written meta-language task for elicitation, also necessarily ruled out many concepts, particularly abstract ones, which cannot be reliably conveyed by static pictures; this was especially true for transitive and reciprocal actions. In the end, we composed a test list of 42 target concepts.<sup>13</sup> Following the same procedure as outlined for our SL-Swadesh survey in section 2, we checked that our test concepts do indeed correspond to a high proportion of two-handed signs in ASL (97%), ISL (87%), and SSL (84%), satisfying us about their appropriateness for use in our picture-naming task. We also developed a list of 25 distractor concepts, using two main criteria: some distractors were selected after consulting the ABSL dictionary (Meir, Sandler, et al. 2012), with the goal of arriving at a list of items that is unbiased toward one- or two-handed signs; other distractors were chosen because they do not immediately follow from our semantic hypotheses and, accordingly, we have no predictions about whether they should be signed with one or two hands, e.g., 'boy' or 'lemon'.<sup>14</sup> We then compiled a set of pictures, one for each target and distractor concept. The pictures were a mix of photographs and line drawings taken from the internet.

## 5.2 Method

All pictures were represented on individual slides in a PowerPoint presentation, in one randomized order. Five male, native deaf signers of ABSL, aged 20–30, participated in the picture-naming task. Participants were asked to look at the pictures in the elicitation material one at a time, and to provide the ABSL sign for what was in the picture. The elicitation session was videotaped, and signs referring to the target concepts were coded as being either "two-handed" or "not two-handed". Two coders independently coded the ABSL responses, with 93% agreement between them.

## 5.3 Results and Discussion

An example of a two-handed sign elicited in response to one of our target concepts is shown in **Figure 8**. We predicted that ABSL ARGUE will likely be two-handed, because the two hands are available to represent the two disagreeing parties that 'argue' implies, and this prediction is borne out in our picture-naming task. In analyzing the ABSL signs that result from our picture-naming task, we observe, consistent with previous descriptions of ABSL (Meir et al. 2004; Sandler et al. 2011), that there is a good deal of lexical variation among signers. For example, our task elicited three different signs for ENVELOPE: tracing the outline of an envelope with two hands (a *dimension* strategy), inserting one flat object into another (a *location* strategy), and sealing an imagined envelope shut with both hands (a *composition* strategy). Many of the sign variants that we observe are clearly ABSL signs, by which we mean that they are phonologically distinct from ISL signs. For example, ISL ENVELOPE uses a different

<sup>13</sup> Our target concepts for the ABSL picture-naming task were: 'arguing', 'big(ger)', 'blowing dust', 'clouds', 'coffee beans', 'cooperating', 'depleted', 'desert', 'dirt', 'electric socket', 'empty', 'envelope', 'exchange (clothes)', 'exchange (money)', 'fall down', 'fire', 'fork', 'full', 'knife', 'lie down', 'mountain', 'mountain range', 'paint', 'rain', 'read', 'same (pair of birds)', 'same (matching clothes)', 'same (identical twins)', 'sand', 'sea', 'settled dust', 'small(er)', 'smoke', 'snow', 'spoon', 'stamp', 'stand up', 'sunrise', 'sunset', 'tornado', 'wind', and 'write'. Distractor concepts were: 'airplane', 'boy', 'camel', 'carrot', 'cow', 'cucumber', 'donkey', 'egg', 'family', 'flower', 'garlic', 'girl', 'goat', 'hammer', 'hookah', 'horse', 'lemon', 'moon', 'mouse', 'policeman', 'scorpion', 'sheep', 'sun', 'tomato', and 'tree'.

<sup>14</sup> We surveyed the 136 single-unit signs in the ABSL dictionary and found that 73 (54%) are one-handed, and 63 (46%) are two-handed. It seems at a first pass, and consistent with ASL, ISL, and SSL, that the distribution of one- to two-handed signs is roughly 50/50 for this language.

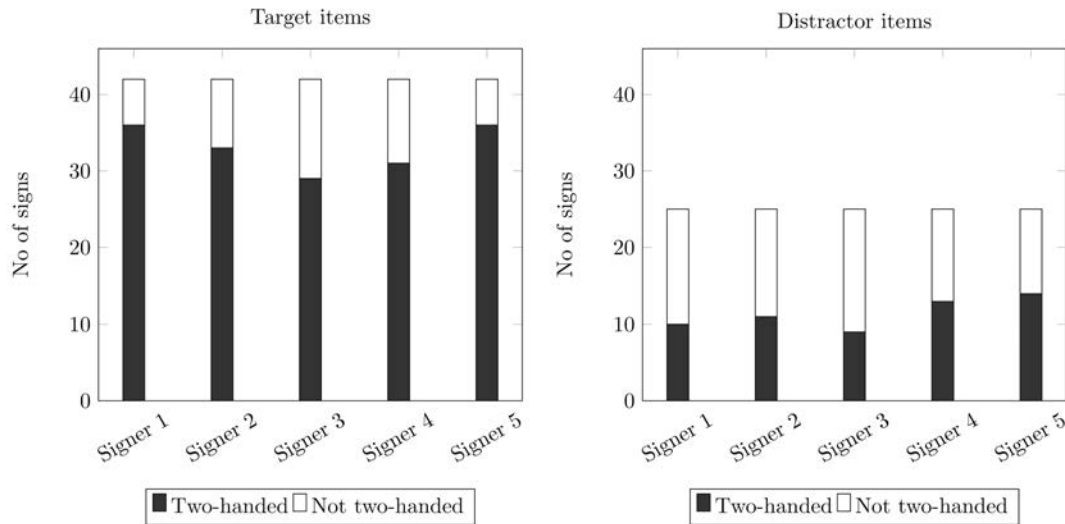


*composition* strategy: one hand represents the top flap of an envelope folding down to cover the other hand, representing the bottom flap.



**Figure 8.** ABSL ARGUE is an alternating sign in which interacting entities are mapped onto each of the two hands (an *interaction* mapping strategy).

However, ABSL signs for other concepts draw upon the same motivating image as ISL, resulting in signs that look similar in ISL and ABSL. ISL and ABSL ELECTRIC-SOCKET ("socket and prongs") and FORK ("piercing with tines") differ only by the selected handshape, and ISL and ABSL DESERT ("a grainy expanse") and FIRE ("flickering flames") differ only by direction of movement. For these signs, it is difficult to determine with confidence whether the ABSL sign is borrowed from ISL or if both languages have independently selected the same motivating image for forming the sign. For other concepts, some ABSL signs are similar to ISL, but have a similar form in ASL and SSL as well, such as WRITE ("moving an implement across a flat surface") and BIG(GER) ("an increasingly wide shape"), making it difficult to determine in some cases whether the ABSL sign has been borrowed from another sign language. Accordingly, here we have not sought to classify individual signs as either borrowed or iconically motivated. Interestingly, however, and most importantly for our study, though signers may differ with regard to handshape or movement used when signing about a particular target concept, most of the variants we see for our target items are signed with two hands. We find, as predicted, that our target items are largely signed with two hands, and that our distractor items are more evenly split, as is illustrated in **Figure 9**.



**Figure 9.** Target concepts are preferentially realized as two-handed signs for ABSL signers.

Generalizing across participants, we observe that 33 out of our 42 target concepts are expressed with a two-handed sign form for 4 or more of our participants, corresponding to roughly 81% of the items. The results of this follow-up study suggest that we have, in fact, identified semantic features that foster the preferential use of two-handed signs, cross-linguistically. We conclude that certain types of concepts are prototypically structured in ways that are in turn naturally represented with a two-handed mapping strategy, along the lines of our mapping statements in (3), above. These results also indicate that the iconic mapping strategies that we have identified are available at an early stage in the formation of a sign language lexicon, even in a language without a phonological level of linguistic patterning. These initial results with a relatively small set of concepts seem promising, and provide a natural point of departure for further research into the iconic uses of the two articulators in sign language lexicons. For example, future research will determine whether these strategies, which for the most part correspond to relations among concrete objects, are also extended to use with more abstract concepts in ABSL, as we have shown to be the case for more established sign languages.

## 6. Discussion and conclusion

We have sought to identify the iconic motivations that underlie the use of two hands in lexical signs, by comparing across four sign languages. We began by noting an interesting pattern to be explained, namely that the use of two hands in lexical signs is not random across ASL, ISL, and SSL. The explanation we offer is that meaning is a key factor, though of course not the only factor, in predicting two-handedness. We refined and tested our hypothesis in a variety of ways: appealing to independently motivated notions of lexical plurality (Acquaviva 2008) and Figure/Ground relations (Talmy 2003); comparing different phonological classes of two-handed signs from ASL, ISL, and SSL; and finally, through the use of a picture-naming elicitation task in ABSL. We have proposed that in unrelated sign languages, the occurrence of two-handed sign forms is not randomly distributed across concepts or solely subject to meaningless phonological constraints alone.

Instead, we have shown that sign languages opportunistically recruit the two hands to lexically encode four primary relationship types, which we have described as relationships of *interaction*, *location*, *dimension*, and *composition*. Iconicity in sign language provides a way to map inherently plural relationships onto a visually salient form, and the two hands, as paired articulators, directly manifest aspects of plurality: using two hands instead of one is an iconic representation of the notion of

'more than one'. Moreover, this iconicity is not random, but it is in fact structured by several interacting cognitive or representational strategies. In some cases, these mappings are realized in such a way that distinct entities or their locations are directly mapped onto the two hands, and in others we see the two hands represent either physical boundaries of objects or the subparts that comprise a unified whole. Our observations are consistent with the characterization of other iconic lexical mapping strategies offered by Padden et al. (2013; 2014), that sign languages make use of "patterned iconicity" to build categories of related signs into their lexicons.

We have shown that it is possible to appeal to iconic motivation to account for two-handedness in sign language lexicons and to supplement phonological accounts that traditionally ignore meaning. The analysis we propose is not intended to be exhaustive or exceptionless, but rather to capture a range of tendencies across sign language lexicons. Our aim has been to provide a useful basis for more formal and comprehensive treatments, for a wider range of languages, in future research.

Our perspective on two-handed lexical signs complements previous studies of iconic motivation, which have examined iconicity of sign language to better understand phonological patterns (van der Kooij 2002; Napoli & Wu 2003) and semantic structures (e.g. Taub 2001; Guerra Currie, Meier & Walters 2002; Wilbur 2008; Schlenker 2011; Schlenker, Lamberton & Santoro 2013) in human language. Our perspective is also consistent with studies showing that doubling of the articulator in underlyingly one-handed signs functions as a morphological process of pluralizing certain concepts (cf. Kyle & Woll 1985; Johnston & Schembri 1999), and that other kinds of doubling, like reduplication, can also iconically express both verbal and nominal plurality in both spoken languages (cf. Bybee, Perkins & Pagliuca 1994) and signed languages (cf. Fischer 1973; Klima & Bellugi 1979; Pfau & Steinbach 2006).

Our findings furthermore align with broader investigations of iconicity in language structure, such as accounts of competing iconic motivations in verb forms (Meir et al. 2013), and complementary iconic strategies for marking semantic categories in sign language lexicons (Padden et al. 2013; 2014). The emerging picture demands that linguists adopt a more sophisticated view of iconicity in sign language, and in human language in general (cf. Perniss, Thompson & Vigliocco 2010).

One domain in which this more nuanced view of iconicity must be adopted concerns the line between phonology and morphology. Sign language linguistics has traditionally maintained a very classically structuralist view of sub-lexical structure (Bloomfield 1933; Stokoe 1960; Liddell & Johnson 1989), such that all word-internal structure should be characterized either in terms of combinations of meaningless phonemes or in terms of combinations of meaningful morphemes. However, as Johnston & Schembri (1999) have argued, iconicity often blurs this distinction, a view that is strongly supported by the iconic patterns we have described in this paper. It is not immediately clear, for example, whether or how two-handed signs can be uniformly and fruitfully decomposed exhaustively into discrete, meaning-bearing elements; nevertheless, because they deal with systematic correspondences between meaning and form, the patterns we describe could be considered morphological. Here it is also important to note that spoken languages also have meaningful lexical elements that are not morphemes, e.g., phonaesthemes in English (Bergen 2004; Kwon & Round 2015) and ideophones, which are attested in a variety of typologically diverse languages (Dingemanse 2012).

The theoretical implications of characterizing all such phenomena as "morphemes" must be left outside the scope of this paper. However, Lepic (2015) argues that the prevalence of iconically motivated patterns in signed language, not just among two-handed signs, but indeed throughout signed

lexicons, motivates a shift in the way we think about lexical patterns. He argues that word-internal structure should not only be viewed in terms of independently meaningful parts. Instead, it is profitable to understand the lexical system as one in which existing, related whole words give rise to more abstract patterns. This view of morphological structure is also in line with more recent advances in the field of spoken language morphology (Hay & Baayen 2005; Blevins, Ackerman & Malouf in press), which take the word, rather than the morpheme, to be the primary organizing unit in morphology.

It is clear that the rich and nuanced interaction between iconic motivation and linguistic structure, and the way that it surfaces in sign language, has only just begun to receive the attention it deserves. We have shown here that sign languages use the iconic resource of the two hands to directly reveal a variety of semantic relationships that exist in any lexicon, spoken or signed. Viewed from this perspective, it is hard to imagine that sign languages would construct their lexicons in any other way.

Appendix: 256 concepts collected from the ECHO sign language Swadesh list (Woll et al. 2010)

(for a) long time	ear	lightning	silent (a.)
accuse	eat	lion	sing
afraid	egg	live (v., not be dead)	sister
afternoon	email (v.)	live somewhere	sit (v.)
angry	empty	look	sky
animal	evening	love	sleep (v.)
answer (v.)	fall (v.)	make	smile (v.)
apple	family	man	SMS (v.)
argue	far (far away)	many	snake
ashamed	fat (person)	marry	snow (v.)
ask	father	meat	some (vs. few vs. many)
aunt	fax (v.)	meet (persons)	son
autumn	fingerspell (v.)	midnight	sour (a., taste)
awake	few	mobile phone (cell phone)	speak
bad	finished	month	spring
bear	fire (n.)	moon	stand (v. to be standing)
because	fish (n.)	morning	star
best	float (v.)	mother	steal
better	flower (n.)	mountain	stone
big	fog	mouse	straight (direction)
bird	forbidden (a.)/not allowed	must (v.)	summer
birth	freeze (v., of object)	my	sun
black	fruit	name	surprised
blood	full (of bottle etc.; not empty)	narrow	sweet (a., taste)
blue	future	new	tall (person)
book	get up (get out of bed)	nice	teach (educate)
breathe	girl	night	teacher
brother	god	no (say no)	tease

brown	good	noise	telephone
but	grandfather	noon	there is (existential)
buy	grandmother	not	thin (person)
can	green	not yet	think (contemplate)
cannot	grey	nothing	thirsty
car	hair	now	thunder
cat	hand	number	tired
chair	hard of hearing	old	tortoise
child	happy	oral(ism)	tree
choose	hare	parents	trick (v)
CI (cochleair implant)	hate	past (time)	uncle
clothes	headache	pay	understand
cloud	hearing (n., person)	people	visit (v.)
cold (a.)	hearing aid	person	walk (to go by foot)
colour	hear (v.)	play (v.)	want
computer	here	purple	water
count (things: how many are there)	hot (not cold)	rain (v.)	week
crazy (mad)	house	read	what
dance	how	red	when
dark	hunger	remember	where
date (calender)	husband	right (a., correct)	which
daughter	I	river (of considerable size)	white
day	idea	road	who
Deaf (a., of person)	if	sad	why
Deaf-blind	ill (a., sickness)	salt (n.)	winter
Deaf club	intelligent	same	wolf
die	internet	say	woman
different	interpreter	school	worse
dinner	jealous	sea	worst
dirty	kill	see	write
discuss	know	self	wrong
dog	language	sell	year
dream (v.)	laugh (v.)	sharp (like a knife)	yellow
drink (v.)	learn	shout	yes
drive (car)	lie (v., to tell a lie)	shy	you
dry (a.)	light (not dark)	sign (v.)	your

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Acknowledgments:

We are grateful to all of our consultants, particularly Debbie Menashe and Tory Sampson, and the participants in our ABSL elicitation task, for sharing their languages with us. Debbie Menashe created the sign illustrations presented here. We thank Mark Aronoff, Irit Meir, Hope Morgan, Corrine Occhino-Kehoe, and Carol Padden for their helpful and encouraging comments on this paper. We thank the people who attended the Theoretical Issues in Sign Language meeting in London on July 12, 2013, for constructive discussion and criticisms, and the people who attended the Work in Progress seminar in Stockholm on October 3, 2013, for valuable questions and suggestions. This work was funded by Israel Science Foundation grant 580/09, National Institutes of Health grant R01 DC006473, and European Research Council Grant 340140.