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## Vive la différence: Sign language and spoken language in language evolution

**Abstract:** Michael Arbib’s book proposes a scenario of language evolution that begins with pantomime, progresses to proto-sign, and then develops together with proto-speech in an “expanding spiral” to create a language-ready brain. The richness of detail in Arbib’s hypothesis makes serious appraisal of each of its aspects possible. Here I describe findings about established and emerging sign languages that bear specifically upon the interaction between sign and speech proposed in the Mirror System Hypothesis. While supporting the central role that Arbib attributes to gestural/visual communication in understanding language and its evolution, I point out some kinks in the spiral that potentially disrupt its smooth expansion. One is the fact that each modality relies on an entirely different motor system. Another is the type of relation that holds between the articulators and grammatical structure, which is radically different in each system as well. A third kink disrupts the proposed continuity between holistic pantomime (gestural holophrases) and signs. Given such differences, instead of a scenario in which speech grew out of sign, it seems more likely that the two modalities complemented each other symbiotically throughout evolution as they do today. If so, then the modern ability to spontaneously create sign languages reveals the extraordinary richness and plasticity of human cognition, and not an evolutionary stepping stone to speech.

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## Introduction

Michael Arbib’s book, *How the Brain Got Language*, takes on the monumental task of explaining the evolution of human language by carefully and systematically bringing together relevant pieces of the puzzle from several domains. One of the most important domains that he recruits in developing his hypothesis is visual language – gesture, and, in particular, sign language. This is important for two reasons. First, we are a species with not one but two complex and fully functional language alternatives. In order to understand human cognition, we

must seek answers to the question of how this versatility arose. Arbib's serious engagement with visual language and gesture is therefore a welcome step toward understanding language evolution. Second, sign languages are the only languages that arise *de novo* in the modern world, offering scientists possible clues to language evolution from observing the path of their emergence in real time, an opportunity that my colleagues and I have been privileged to exploit.

A large body of linguistic work on sign languages spanning over half a century eventually led the academic community to embrace the view that sign languages are languages in every sense of the word. I am honored to have been part of this enterprise, which is responsible for the inclusion of sign language in thinking about language evolution on the part of Arbib and others. However, consideration of sign language in an evolutionary context brings home the following realization: it is precisely the differences between the two systems that make the similarities so impressive, and that must also be accounted for in any evolutionary scenario.

The idea that our ancestors took advantage of a gestural mode, a central tenet of the Mirror System Hypothesis of language evolution, is very convincing. Even our relatives the apes use communicative gestures (Call and Tomasello 2007).<sup>1</sup> At the same time, from the point of view of sign language, some of the puzzle pieces in Arbib's Doctrine of the Expanding Spiral (DES) have a less comfortable fit. The doctrine is based on the following hypothesized evolutionary scenario: mirror system > simple imitation > complex imitation > pantomime > proto-sign and proto-speech (2012: 251) > language-ready brain. I wish to consider here, in the context of contemporary sign languages, both established and newly emerging, some unaccounted-for kinks in the spiral that disrupt the smooth expansion that Arbib proposes.

I will address three of these: (1) the radical split between the two articulatory systems for language; (2) the equally radical difference in the relation between the actions of articulators and the grammatical properties they convey in each modality; and (3) a basic distinction between pantomime and signs. I will develop these arguments in the context of an established sign language, Israeli Sign Language (ISL), in Section 1. In Section 2, I support the arguments with data from an emerging village sign language, Al-Sayyid Bedouin Sign Language (ABSL),

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**1** I must admit that I find dubious the argument that the voluntary and more flexible nature of gesture over vocalization in apes supports the primacy of gesture in human evolution, though it is commonly cited. Ape gesture is severely limited, as Arbib acknowledges, and is lacking the most essential property of human language: symbolization. It therefore reflects ape cognition, but does not support any connection to human language in my view.

and also bring support for the primacy of the word over both phonology and holophrases in language emergence.

First, a caveat. The subtitle of the book, *The Mirror Neuron Hypothesis*, is the basis for many of the ideas about language evolution developed in it. I will have nothing to say about mirror neurons, the organization of language in the brain, or whether mirror neurons are related to language or not. My comments are restricted to how the nature of the phenomena to be explained bear on the question of whether or not sign and speech could have been part of the same evolutionary chain.

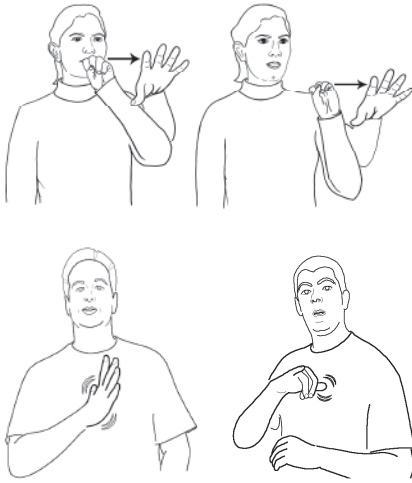
## 1 The grammar of the body in sign language

Linguistic research on sign languages has revealed many striking similarities to spoken languages, such as the existence of different levels of organization, each with its own primitives and principles of organization: sign phonology, morphology, syntax, prosody.

The initial breakthrough was Stokoe's discovery that sign languages have a level of structure comparable to phonology, in that features of handshapes, locations, and movements function as a finite set of discrete meaningless units in the creation of and distinctions between signs (Stokoe 1960). This was important, first, because it showed that the holistic-iconic appearance of many signs is misleading, and second, because it meant that sign languages are characterized by duality of patterning, a property considered to be a basic design feature of human language, necessary for creating a large lexicon (Hockett 1960). In Figure 1, two ISL minimal pairs are shown: SEND and TATTLE, distinguished only by features of location (chest vs. chin); and DANGEROUS and INTERESTING, distinguished only by features of hand configuration, such as selected fingers and their position. Later research showed that the meaningless units participate in a system in which their behavior is predicted by considerations of form (and not meaning), as in assimilation (Sandler 1989, 1993; Brentari 1998).

This discovery led to numerous other studies on all levels of linguistic structure, revealing many impressive commonalities with spoken language. Examples are embedded clauses, morphological complexity and allomorphy, licensed null arguments, wh-movement, and a conventionalized intonational system (see Sandler and Lillo-Martin 2006 for an overview). These commonalities are far from trivial – they are enough to have filled 24 out of 25 chapters of a book – and have therefore served to focus our attention on universal properties of language, shared by the two modalities.

However, the similarities are impressive precisely because sign languages are rooted in physical systems of production and perception that are distinct from



**Fig. 1:** ISL. SEND, TATTLE (distinguished by location); DANGEROUS, INTERESTING (distinguished by handshape).

those of spoken languages – a fact that is all too often only noted in passing (but see papers in Meier et al. 2002 and in Sandler and Lillo-Martin 2006: Ch. 25). Specifically, every visible and movable part of the body from the waist up, each with more than one degree of freedom, participates in conveying the linguistic structure of sign languages. Since these body parts are physiologically independent of one another, a multitude of articulations can co-occur simultaneously, each conveying a different element of linguistic structure or meaning.

As it is the hands that convey words, they are the articulators that also convey the complex morphology found in many sign languages, by varying types of movement, spatial reference points, and hand configurations. The hands producing signs are obviously critical in sign languages, but in what follows I will focus on articulators that have received less press to make the point, returning to the hands in Section 2.3.

## 1.1 Differences in the articulatory systems and their relation to language structure

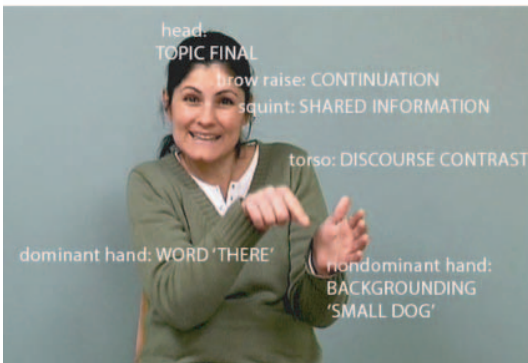
Here I use data from ISL to consider the first two kinks in the spiral – the articulatory system of sign language and its relation to grammar – both radically differ-

ent from those of spoken language. The third kink, between pantomime and (proto-)language, will be the topic of Section 2.2. ISL originated as a creole, formed through contact among sign languages and home sign systems brought to Israel by immigrants (Meir and Sandler 2008). Today it is used by about 10,000 deaf people in every aspect of life, and the type and complexity of its structure are comparable to those of other established sign languages.

Figure 2 gives us an inkling of how the system works. Above and beside the figure is a list of general grammatical properties conveyed in many sign languages by actions of each articulator, as shown by linguistic research. The picture is extracted from a particular ISL sentence, and the specific functions/meanings that are conveyed in it appear in white letters on the articulators that convey them. The sentence means ‘The little dog that I found last week (over there) ran away’ and is glossed DOG SMALL INDEX I FIND LAST WEEK INDEX (**‘there’**) // ESCAPE. The double slash marks here separate the topic of the sentence from the comment. The indices are pointing signs used as referential loci in the system (Lillo-Martin and Klima 1990). The picture is excerpted from the last word of the topic of the sentence, INDEX, meaning ‘there’.

**eyeballs:** gaze (pointing; questioning; referential shift)

**head:** topic marking; constituent boundary marking; question marking; prominence; continuation/dependency; referential shift;



**upper face (brows, eyelids, cheeks):** information status (questions; shared information; focus, etc.); utterance type and constituent boundary marking (with blink); character perspective

**lower face (tongue, lips, cheeks):** adj., adv. modification; mouthing of spoken words

**torso:** referential shift; discourse contrast

**hand(s):** words (phonology; morphology); phrase final prominence; rhythm; boundary strength

**nondominant hand:** phonological element in words; independent classifier morpheme; discourse backgrounding

**Fig. 2:** Articulators of sign language and grammatical functions associated with their actions. (ISL)

The head is tilted forward to mark the end of the sentence topic. Facial expression generally functions as intonation, and brow raise here indicates continuation to the next constituent of the sentence, while squinted eyes signal shared information between the signer and the addressee (they both know about the dog found last week). Torso tilt contrasts the discourse units of topic and comment. Now we

get to the hands. The dominant hand (the preferred right hand for this signer) is signing the word ‘there’ (INDEX). The non-dominant hand retains the configuration of the earlier (two-handed) sign SMALL (DOG), and in this way keeps the dog in the discourse background until the end of the topic constituent.

Each of these articulations has a linguistic function or meaning. So, in the moment pictured, we have all at once: two signed words, ‘there’ and ‘small (dog)’; topic marking; continuation marking; shared information marking; and backgrounding. If a sign were inflected – for verb agreement, for example – this would add yet another simultaneous element to the display.<sup>2</sup> On the sentence comment, ‘ran away’ (not pictured), each and every one of these articulations changes its configuration, with the hand configurations and movements most salient because of their size and movement in different patterns to different locations on and around the body. The visual impression of spontaneous fluent sign language is one of rapidly changing complex patterns.

Contrast this with spoken language articulation, also consisting of an impressive array of coordinated, rapidly changing actions of articulators (Browman and Goldstein 1992). If we compare only manual signs with words, we do find some measure of similarity in the sense that each consists of smaller meaningless parts. But that is where the similarity ends. Entirely different sets of physical articulators and motor actions are recruited in speech, and, unlike the sign language case, the gestures of the vocal tract articulators are by and large not directly perceived. Nor is there a correspondence between a given articulator and grammatical functions. Nearly all of the grammatical functions described above must be carried by linearly ordered strings of sounds, morphemes, and words. Even intonation, while simultaneously occurring with sonorant sounds, consists of linear sequences of high and low tones. While the actions of the articulators overlap with one another in spoken language, the kind of simultaneity of **grammatical** structure found in sign languages and only partly revealed in (2) is impossible in the spoken medium.

This brings to the fore two kinks in Arbib’s DES: a different motor system controls language in each modality, and the relation between that system and the grammar is different as well. Considering the fundamental differences in motor systems, I am mindful of the reasoning of experts in the relation between motor control and cognition (Donald 1991; MacNeilage 2008) who insist on the importance of the evolution of the supporting motor system in the evolu-

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<sup>2</sup> Verb agreement has somewhat linear structure, as it is marked by moving the hand, configured for the verbal sign, between points in space. However, the direction in which the hand is facing gives away the spatial information even without the movement, so that a snapshot at any moment in the trajectory would reveal the beginning and endpoint of the sign.

tion of language to the extent that “mental representation cannot be fully understood without consideration of activities available to the body for building such representations . . . [including the] dynamic characteristics of the production mechanism” (Davis et al. 2002). In the case of spoken language, the speech system seems so specialized as to have required a long and complex evolutionary process (see Fitch 2010) and, in order for vocalization to have survived a process of this kind, it makes sense to assume that it was of benefit to the species throughout.

Unlike the vocal tract, specialized for speech, the human hand is not specialized for sign language. The dexterity required to manipulate objects has been present in primates for tens of millions of years. And in humans, the hand is very similar to those of other primates, and has had the same morphology for a million years or more (Tocheri et al. 2008). For these reasons, it is likely that sign language built on pre-existing manual capabilities (Susan Larson (p.c.)). There is no obvious reason to think that the structure and actions of the rest of the articulators involved in producing sign language are specialized for language either. At the very least, these observations demonstrate that the two systems are distinct, and that the gap between them has yet to be bridged.

Now, it is not impossible that the representation of meaning came from the gestural mode, with vocal phonological organization co-developing over time, as Arbib suggests (see also Goldstein et al. 2006). However, here lies another kink in the spiral. My claim is that the gulf between holistic imitation of body action on the one hand, and symbolization on the other, is just as steep in the gestural as in the vocal modality, and that this presents a challenge for the DES.

## 1.2 The gap between pantomime and language

The abundance of iconicity in the words and the grammar of sign languages sometimes leads to the supposition that signs are conventionalized pantomime. But from the sign language point of view, iconicity and pantomime are not synonymous, and any connection between pantomime and sign is indirect and complex.

To focus the distinction, I define pantomime as a reenactment of an event, in which the body represents the actual human body. There is however a distinction between enactment – imitating body action with body action – and symbolization – using the body to represent an action or object of any other kind (Sandler 2009). This distinction is a kink in the spiral, and Arbib rightly acknowledges how hard it is to smooth it out. But the inclusion in his definition of

pantomime such actions as tracing or representing the shape of an object with the hands exacerbates the headache rather than alleviating it. The reason is that such actions entail abstract symbolization and not reenactment. With this distinction, Arbib's claim that pantomime presents the rich semantics needed for language loses a lot of its punch, and leaves open the question of which modality first facilitated symbolization in humans.

Contrast the excerpt of sign language shown in Figure 2 with an example of a pantomimic expression by a second generation signer of ABSL, in which the whole body is involved, enacting an event.



**Fig. 3:** Pantomime. 'I covered myself with my coat.' (ABSL)

Some signs do resemble pantomime, for example, signs denoting actions of human hands such as eating or cutting or shooting a gun. But as soon as the hands represent something other than the hands, such as the feet for 'jump', the eyes for 'see', or meandering mental activity for 'dream' (shown in Figure 4 from ABSL), we are talking about symbolization, not pantomime.



**Fig. 4:** DREAM (ABSL)



Huge proportions of any sign language lexicon are grounded in this type of symbolization, in which the hands do not represent the hands, and iconicity is exploited symbolically and **metaphorically** (see Taub 2001; Meir 2010) – a pretty fancy human achievement that is unlikely to have been part of the earliest communicative repertoire. The rest of the body can sometimes stand for the human body in the grammar of established sign languages, but remains stationary and independent of the symbolic use of the hands, and is thus not pantomimic (Meir et al. 2007, 2013). As we have already seen (Figure 2), actions made by the body in sign languages typically do not represent their own behavior in actual human activities, instead providing grammatical structure.<sup>3</sup>

Iconicity is a driving force not only in sign language lexicons, but in sign language grammar as well. But here too the relation between form and meaning in sign languages is multifaceted, difficult to characterize, and far more complex than most references to it in evolutionary theorizing imply. The ways in which specific iconic elements are selected and codified vary greatly within and across sign languages (Taub 2001; Perniss et al. 2010); and, interestingly, different iconic strategies can compete in the construction not only of the lexicon but of grammar as well (Meir et al. 2013). Although present in spoken language too, iconicity determines language form far more pervasively in sign languages than in spoken languages, whose form is generally, though not exclusively, arbitrarily related to meaning.

Modern humans are good at both elementary pantomime and iconic representation of symbols, and in co-speech gesture we create iconic images freely. For example, in describing a situation in which a person chases someone swinging an umbrella, the speaker might form the hand in a grasping shape and swing it from side to side (McNeill 1992). In fact, the imagistic complement provided by gesture is so important that sign languages recruit a system of iconic mouth gestures to augment the linguistic system similarly to the way in which iconic manual gestures accompany spoken language (Sandler 2009).

However, the construction of a sign language – both lexicon and grammar – though based on iconic elements, is an intricate and elaborate process that is neither like its spoken language counterparts nor like pantomime. The critical features that make sign languages **languages** are the creation of symbols – something that no ape can do (see note 1) – and their manipulation in a rule-

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<sup>3</sup> An exception to this is in more stylized or performative kinds of signing in which parts of the body do mimetically represent a person's body (Dudis 2008). Apart from those shown in Figure 2, other grammatical roles for the body in sign languages, include representing the grammatical role of subject or of first person (Meir et al. 2007).

governed grammatical system (Deacon 1997). Pantomime and symbolization are distinct on this view, which places a kink between pantomime and proto-sign in the proposed spiral.

In a newly emerging contemporary sign language as well, pantomime and sign language are distinct, in both articulatory and grammatical form. We see in this language that the emergence of both articulation and grammar is gradual, and, to some extent, articulation and grammar are linked in a modality specific way. This newly emerging language begins neither with pantomimic holophrases nor with phonology. Its first linguistic building block is the word.

## 2 An emerging sign language: ABSL

ABSL originated about 75 years ago when four deaf children were born into a single household. Because of consanguineous marriage patterns and a high birth rate, genetic deafness spread, so that today there are about 150 deaf people in a village of about 3,500, where many hearing people also sign (Sandler et al. 2005). My colleagues Mark Aronoff, Irit Meir, Carol Padden and I have been studying this language for a decade and have been repeatedly surprised regarding what appears early and what doesn't, and about how grammar arises. Clearly, this language arose in modern humans, and does not directly recapitulate phylogeny. And I've argued here that signed and spoken languages are in some important ways different. Nevertheless, this in no way overrides the many core similarities between the two, and judicious evaluation of the emergence of a contemporary sign language can provide useful clues to the evolution of the human language capacity.

ABSL is a fully functional language, in which signers freely discuss folk remedies, wedding plans, vocations, schooling, etc., in real time with no apparent difficulty. In our work, we see indications of how structure begins to accrue and regularize at each level (see Sandler et al. (to appear) for a current overview). Here I will restrict comments to ways in which the emergence of ABSL exposes the kinks in the spiral observed above.

### 2.1 Recruiting the bodily articulators

The naïve but natural expectation might be that new sign languages will pantomimically recruit bodily articulations to create holistic expressions rapidly. But in a recent study I found that this is not the case (Sandler 2013). Using the grammar of the body approach sketched in Section 2 and schematized in Figure

2, I analyzed parts of narratives across signers from four age groups or 'strata'. The study is based on a small sample, so that the generality of the results is tentative, but they are nevertheless informative.

I found that articulations of parts of the body are recruited in stages, to provide increasingly complex articulatory and grammatical organization as the young Bedouin sign language becomes increasingly structured. The only first generation signer from whom we have data (a videotaped story) uses only the hands to convey words, with the rest of the body uninvolved linguistically. The man uses a few whole-body pantomimic expressions, apparently for dramatic effect, for example, to enact one man striking another with a sword and the other man blocking it. But most of his utterances consist of one or two words, and most of these are symbolic signs not derived from pantomime. In the same story, he uses a sign for HIT which is not derived from the pantomimic form in any obvious way. The handshape is arbitrary, and iconicity is seen in the relation between the two hands and the movement of one on the other (a relation not seen in the pantomime of the same action). HIT is a symbolic sign, not a pantomime.

Our data do not reflect an initial holophrastic stage. In our first-generation signer, one-word utterances, such as RUN. HIT. SHOOT, predominate. Each sign is word-like, and in fact still exists in the language of later strata. The qualitative and formational distance from pantomimic expressions to symbolic signs and their manipulation stands out, even at this early stage in the emergence of a sign language.

With each stratum, articulators are added and, with them, concomitant grammatical complexity, as shown in Table 1. The order in which the articulations are systematically activated across strata in ABSL shows us directly the order in which the associated grammatical functions arise. That the articulatory and grammatical organization take place in tandem underscores the differences between the signed and spoken modalities.

## 2.2 Words first

One of the contentious issues in evolutionary perspectives on language is what the starting point is – phonology (e.g. MacNeilage 2008), lexical invention (Donald 1993), or holophrases (e.g. Wray 1998; Arbib 2012). In the early strata of ABSL, we see neither an abundance of holophrastic pantomime, nor evidence of an organized phonological system. The emergence of ABSL suggests that the word is primary.

Our study of vocabulary items in ABSL revealed a good deal of variation, not only in the sign selected to represent a concept, but also in the production of the

**Table 1:** Increase in linguistic gestures and grammatical complexity across four strata of ABSL signers (from Sandler to appear).

Stratum	HANDS	HEAD	FACE	BODY	NONDOMINANT HAND
I	X				
II	X	X			
III	X	X	X		
IV	X	X	X	X	X
<hr/>					
Stratum	WORDS	COMPLEX SENTENCES	DISCOURSE REFERENCE/COHESION		
I	Signs				
II	Signs	– Unsystematic clause linking			
III	Signs	– Complex sentences – Embedding	– Illocutionary force – Parentheticals – Referential shift		
IV	Signs	– Complex sentences – Two degrees of embedding	– Illocutionary force – Parentheticals – Double Referential shift – Contrasting two referents in a discourse – Backgrounding		

same sign by different signers, or even by the same signer at different times. We found significantly more variation in ‘pronunciation’ of signs in ABSL than in ISL or American Sign Language (ASL), and we also found that the variation crossed what are major phonological category boundaries that are contrastive in more established sign languages (Israel and Sandler 2011). Findings like this, together with the absence of minimal pairs and other criteria led us to the conclusion that ABSL has not yet developed a fully crystallized phonological system across the community (Sandler et al. 2011). We concluded further that signers were targeting the production of an iconic image for a word rather than combinations of meaningless phonological components.

It is certainly possible that the iconicity inherent in manual signs allows a language to get farther in building up a lexicon without duality of patterning than would be the case in a spoken language. This in turn might be considered an argument in favor of gestural origins. However, another possibility

is that, in spoken languages as well, language can emerge in advance of phonology.

Discriminating a large number of holistic auditory signals would certainly put pressure on the system, and, at some point, limit the growth of a lexicon, as many authors have noted (Hockett 1960; Pinker and Jackendoff 2005). However, no one knows how many words you actually need for effective language, whether signed or vocalized. If intonation – most likely a primitive capacity that precedes language (see Fitch 2010) – were allowed into the system, it is conceivable that, in the vocal modality as well, functional language with words at the core could have developed before duality of patterning (de Boer et al. 2012).

### 3 Conclusion

It is remarkable that we evolved to become a species with the potential for two language systems, and Michael Arbib's Mirror Neuron Hypothesis takes this potential seriously. The Doctrine of the Emerging Spiral provides an engrossing exploration of how gesture and vocalization, almost certainly both present in the earliest hominids, might have interacted in the evolution of language.

In my view, major structural differences in articulatory underpinnings and grammatical form, and in the relation between the two in each modality, present obstacles for Arbib's proposal that speech grew out of sign. My interpretation of the data from sign language identifies three kinks in the spiraling path he proposes. The first two are between proto-sign and proto-speech: radically different motor systems and disparate types of relations between the articulators and the grammatical form of language in each modality. The third is between pantomime and (proto-)sign, disrupting the path from holistic imitation to symbolization.

Under the right conditions, modern humans spontaneously integrate a number of cognitive and motoric systems to create a sign language in a relatively short time, using a vastly different motor system apparently not selected for this purpose by evolution, to produce languages that are at once similar to and different from spoken languages. Sign language communities promote highly creative and intellectually complex cultural *milieux* (Padden and Humphries 2006), as well as vivid aesthetic forms such as poetry. The foundations of sign languages can be found in non-linguistic co-speech gesture (hands, face, and body), in modality-based cognitive organization, and in certain core modality-neutral aspects of cognitive and grammatical organization that also underlie spoken languages. Sign languages are thus critical to our understanding of human language and cognition, and their existence reveals the extraordinary richness and plasticity of the human mind. *Vive la différence.*

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