Topic-open-endedness

Why recursion is overrated

Irit Meir

Humans can use language to refer to and describe endless varieties of situations, thoughts, ideas, and topics, actual or hypothetical. This capacity, which distinguishes human language from communication systems of other animals, is referred to here as *topic-open-endedness.* A key factor in explaining topic-open-endedness early in the life of a new sign language is the nature of the linguistic symbols, the words, and the human ability to extend their meanings – e.g., through metonymy and metaphor – to novel semantic domains, applying a finite lexicon to infinite situations and topics. Other early language properties such as predication and negation facilitate creativity and flexibility from the beginning. The property of recursion accounts for the creation of an infinite number of sentences from a finite set of words and rules. But it *cannot* account for the open-endedness of the *contents* of those sentences. Therefore, the importance attributed to recursion as the *sole* mechanism that is *uniquely human* is overrated.

Keywords: open-ended, recursion, meaning extension, young languages, symbols, predication, compositionality

1.   What is special about human language: Topic-open-endedness

In the past few decades, recursion has come to be regarded as one of the most fundamental properties of human languages and the human capacity for language. In Hauser et al. (2002), recursion was upgraded to the sole feature of FLN, the faculty of language in the narrow sense, which, according to the authors, consists of those features that are exclusively characteristic of human language, not shared by other human cognitive abilities or by other species. The reason for the importance attributed to recursion is that it is regarded as the property responsible for the open-endedness of human language, its capacity for 'discrete infinity', which distinguishes human language from animal communication systems (henceforth, ACSs).

However, discrete infinity, the ability to create an infinite number of sentences from a finite set of words and rules, is but one of the facets of language's open-endedness, and, I argue here, not the most important one. The importance of the open-endedness of human language lies not only in its ability to create an infinite *number* of sentences, but also in what we can *convey* with these sentences. Language allows its users to refer to endless varieties of situations, thoughts, ideas, and topics. By using language, we can refer to and describe any topic that we feel a need to express, situations that are detached from the here-and-now (allowing for *displacement*, cf. Hockett 1960), hypothetical situations, situations that will not or cannot take place, and novel situations. *We can always use language to relate to new situations.* This ability, called here *topic-open-endedness*, stands in marked contrast to ACSs, which express information revolving around survival: food and feeding, predator-prey relations, mating and reproduction, and signaling social hierarchies (Hauser 1996).

The paper makes several novel points. First, I argue that the uniqueness of human language lies in topic-open-endedness as much as in discrete infinity. Recursion does not facilitate topic-open-endedness, and therefore we should shift our focus of investigation and try to find factors that do contribute to it. Second, I suggest that a key factor in explaining topic-open-endedness is the special nature of linguistic symbols, the words, especially their ability to take on meaning extensions by means of processes such as metonymy and metaphor. Though meaning extensions have been studied thoroughly in the semantic literature, their important role in facilitating topic-open-endedness has not been previously acknowledged. I present three arguments to support these claims: (i) A thought experiment showing that recursion cannot account for topic-open-endedness, but that meaning extensions can (Section 2); (ii) Evidence that recursion is not necessary to account for the open-endedness of language, as languages can do without a syntactic mechanism for recursion and still express recursive thoughts (Section 3); (iii) Evidence from young languages that syntactic recursion is not found in early stages of a language; but even in its very early stages, a language can refer to novel and displaced situations, distinguishing it from ACSs (Section 4). Section 5 points to specific factors that contribute to topic-open-endedness, and Section 6 provides a brief summary, suggesting topic-open-endedness as a fruitful focus of future studies.

2.   Topic-open-endedness: The role of meaning extensions

All languages are characterized by topic-open-endedness. What factors contribute to this special ability? I propose that a central factor is the flexibility of the sym-

bols that make up language, the words. Our ability to create and use symbols is at the heart of our special linguistic ability (Deacon 1997; Bickerton 2009). Words, vocal or manual signals that are associated with (or represent) a *concept* (Pinker & Jackendoff 2005), are crucial for using language to refer to entities of various kinds (humans, animals, objects), actions, states, emotions, abstract concepts and more. The ability to create new words, employed constantly and incessantly by language users, is the basis for our capacity to apply language to novel situations. Yet, even a very large lexicon is finite at any given point in time for any given individual, while the number of types of situations, entities and concepts we want to refer to is infinite. What happens when we encounter a situation we have no words for? We can create new words, and we often do. But more often, we extend the meanings of the words we have, to cover those new needs. So, interestingly, although the meaning of words may be precise (a property called 'semanticity' by Hockett (1960) as one of the 13 'design features' he proposed to distinguish human language from other communication systems), the relation between signals and their meaning is not altogether fixed. *It is this flexibility that underlies our ability to refer to novel entities and situations.*

I demonstrate the power of this flexibility through a thought experiment. Consider two languages, L_A and L_B. The two have identical very limited lexical vocabularies, shown in Table 1, and the same sentence structures. They differ in the following: only L_A has a recursive mechanism: it can embed a constituent within the same kind of constituent (signaled by a complementizer (COMP) in the example here, but other means are possible too, of course), creating embedded structures of potentially infinite length. In addition, each word has precisely one meaning in all uses; neither polysemy nor any other meaning extension is possible. L_B does not have a mechanism for recursion. However, it allows for polysemy in use, specifically metonymy and metaphor. Crucially, both languages are compositional and generative: both have the ability to combine words to create larger units, such as phrases and sentences.

Table 1. Vocabulary of both languages, L_A and L_B

Nouns	Verbs	Adjectives	Prepositions	COMP
man, woman, dog, head, house, sky, water, apple	*eat, run, say, write, walk*	*small, white, big*	*in, after, to*	*that* (only in L_A)

Here are some situations that both languages can refer to: (1) *The man/woman/dog ate an apple.* (2) *The man/woman/dog runs after the man/woman/dog– runs in the house – runs to the house/apple/man/woman/dog/water.* (3) *The woman/man/dog/house/apple is big/small/white.* (4) *The big/small/white*

woman/man/dog runs/eats/reads/writes etc. In addition, L_A can produce embedded structures such as: (5) *The woman/man said to the man/woman that …*(any of the above sentences). (6) *The woman said that the man said that the woman said that …*(any of the above). So, formally, L_A is infinite: it can produce an infinite number of sentences. L_B, lacking the mechanism of recursion, cannot do that.

However, let's consider a situation where speakers of each of the languages want to refer to an animal other than a dog, perhaps a cat or a donkey. L_A does not provide its speakers with any means for doing this, since it forbids polysemy or meaning shifts. L_B speakers, on the other hand, can use the word *dog* to refer to other animals as well, simply by extending its denotation, as small children often do. They can also create expressions such as *small-dog* for 'cat' and *big-dog* for 'donkey'. L_A speakers can also create combinations like *small dog* and *big dog*, but they can only mean a small or a big dog, respectively, since the word *dog* cannot be extended to other animals. L_B speakers can also create compounds like *sky-dog* and *water-dog* for 'a bird' and 'a fish' (or any other water animal), respectively. Similarly, the meaning of *apple* can be extended to other fruits and vegetables; the meaning of *head* can be extended to denote 'the top part of X', or the spatial relation 'on'. So, speakers of L_B can say *dog head house*, meaning 'the dog is on the house'. They can create new verbs such as *head-say* for 'think', *water-eat* for 'drink', and new adjectives such as *head-big* 'smart', *head-small* 'stupid'. If they want to refer to something new, or clean, they can use the word *white* to refer to all three properties – white, new, and clean. They can also use *white-sky* for 'clouds', *white-water* for 'alcoholic/intoxicating beverage', *white-dog* for 'a sheep', and *white-say* to 'saying good things, praising'.

All these semantic shifts that L_B uses are very familiar. Languages use meaning extensions, such as metonymy and metaphor, to refer to new situations. There is nothing new in these examples. In fact, they are quite trivial; we are so used to them that they have escaped our radar when we try to explain what is so special about language. But the point is that these processes play a central role in our ability to use language to convey a novel concept or situation – *any* concept or situation. Therefore, although L_A is infinite in the mathematical sense, it is rather limited when it comes to referring to new situations. L_B may be finite from a mathematical point of view, yet it is so much richer than L_A in terms of its expressive capabilities; it is not limited by its vocabulary to specific topics. The comparison between these two artificial languages shows that even with a very limited vocabulary, a communication system (L_B) can exhibit topic-open-endedness, making it much more language-like than ACS-like. Without the capability for topic-open-endedness, a communication system (L_A) is much less language-like, even if it is mathematically infinite.

3.   Expressing recursive thoughts: Is syntactic recursion necessary?

Meaning extensions, and not recursion, can explain how we use a finite vocabulary to refer to an infinite number of situations and thoughts. Yet maybe there are types of thoughts that can only be expressed by a recursive mechanism. For example, is recursion necessary for expressing complex, recursive thoughts, that is, propositions embedded in other propositions, another aspect of the infiniteness of language? It turns out that this is not the case. Recursive thoughts can be expressed by parataxis, putting one utterance after another, rather than by syntactic recursion or embedding. Evans & Levinson (2009: 443) show that content conveyed by an embedded structure (e.g., a conditional clause), can also be conveyed by non-embedded syntactic structures: "Consider that instead of saying, 'If you move, he'll shoot,' we could say, 'You move and he'll shoot.'" In the former case we have syntactic embedding. In the latter the same message is conveyed, but the "embedding" is in the discourse understanding – the semantics and the pragmatics, not the syntax.[1]

Similarly, in Al-Sayyid Bedouin Sign Language (ABSL), a village sign language[2] of Israel that emerged in the Al-Sayyid community in the early 30s of the 20th century (Sandler et al. 2005; Meir et al. 2010), reported speech, another instance of recursive thoughts, is conveyed by several means, none of which involves syntactic recursion. One way is to cite the content of the speech, without explicitly indicating who said it. In a narrative told by a first-generation signer of ABSL, he signs the following dialogue: – GUN GIVE-ME 'Give me the gun'; – SWEAR (BY-)GOD, NO 'I swear by God's name, no!' (Sandler 2012). The signer does not embed the reported content in another clause. The fact that these utterances are instances of reported speech is indicated by his mimetic body posture and by the general context and shared background. There is no syntactic mechanism involved here, yet the semantic function of reported speech is conveyed.

Another way of expressing reported speech is by mentioning the speaker, and the content of the speech: MOTHER: COME-BACK 'Mother [said], "Come back home."' Again, there is no syntactic embedding, as there is only one clause, and a noun preceding it, nor is there any prosodic marking indicating the relation

---

1.   The author takes the position that only overt markers convincingly signal syntactic embedding in emerging languages, and does not wish to hypothesize elaborate syntactic structure for which there is no overt evidence.

2.   Village sign languages typically arise de novo in small villages where there may be several or even over a hundred deaf people (as in Al-Sayyid) due to genetics and marriage patterns.

between the two elements, as shown in Figure 1.[3] The embedding is clearly inferred from the semantics or pragmatics. Everett (2012:196) mentions precisely the same mechanism for reporting speech in Wari', an Amazonian language.

Figure 1. Pragmatic embedding in reported speech. MOTHER: COME-BACK, 'Mother said, "Come back home."'

A third generation ABSL signer (one generation younger than the signer in Figure 1) uses the sign SAY to introduce reported speech when she signs, FATHER SAY: WHY YOU LONG-TIME SEE NONE WHY? This mechanism is very similar to direct speech in English: 'Your father said, "Why haven't we seen you for such a long time, why?"'

In all three cases, the signer expresses recursive thoughts, the embedding of one proposition (the content of the saying) in another (the saying event). But none of the ABSL mechanisms encodes syntactically the recursive nature of these propositions. These data, and the data presented in Evans & Levinson (2009), provide evidence that syntactic recursion is not necessary for expressing recursive thoughts or messages (Jackendoff (2011); see also Gil (2009) for Indonesian/Malay).

Furthermore, in many languages it is not clear that recursion leads to discrete infinity. In some languages, e.g., Kayardild (Evans & Levinson 2009: 442), recursion is limited to one cycle of application. Other languages use embedded structures very rarely, e.g. polysynthetic languages, in which the complexity resides in the morphology rather than in the syntax (see Evans (2003) and Mithun (1984) for specific languages). Finally, even in languages where recursive structures are very common (e.g., English), center embedding beyond two levels is almost non-existent, and tail embedding usually does not exceed three or more levels in actual language use (Heine & Kuteva 2007: 297). Taking all the evidence provided in

---

3. The analysis adopts the theory of sign language prosody according to which systematic face and body actions correspond to prosodic/intonational cues (Sandler 2010).

this section together, we conclude that recursion cannot carry the full burden of accounting for the open-endedness of human language.

4.   The diachronic perspective: The view from young languages

We turn back to what we claim here is the central aspect of the open-endedness of language, topic-open-endedness. Further evidence for its centrality comes from novel and very young languages. Studies of such communication systems show that even at very early stages of their emergence, languages exhibit topic-open-endedness. Even homesign systems, gestural communication systems invented by deaf children with no exposure to a conventional sign language, can exhibit this property (Goldin-Meadow 2003, 2005). The literature of pidgins and creoles – new languages created through contact among speakers of existing languages who have no common language – provides abundant examples of displacement (see, e.g., Holm 1989). Studies of early stages of young sign languages in Israel show that first and second generation signers tell stories of the history of their community, talk about diverse topics such as folk remedies, social security rights and health issues, and plan future actions and events (Sandler et al. (2005); Kastner et al. (2014); Meir et al. (2016); see also Ergin (2017) for Central Taurus Sign Language in Turkey).

These languages are often described as having very little syntax, and no mechanism for syntactic embedding, as in the reported speech example in Figure 1. Other studies show that markers of embedding may develop over time. In some cases, embedding is marked by prosodic cues, e.g., a specific facial expression and a forward body posture (see Sandler et al. (2011) for the development of systematicity in the prosodic marking in ABSL). In another emerging village sign language of Israel, Kafr Qasem Sign Language (Kastner et al. 2014), embedding is signaled by means of temporal and spatial shortening of the movement of the predicate to mark it as secondary to (dependent on) the main predicate. Similar findings are reported for Nicaraguan Sign Language (Kocab et al. 2016).

In other cases, overt markers of subordination can develop over time. Dachkovsky (2018) traced the development of relative clauses in three generations of Israeli Sign Language signers. The first generation did not have a consistent way of marking relative clauses. The second generation marked relative clauses by a specific facial expression interpreted as intonational – eye squint. In the third generation, a pointing sign, usually used as a demonstrative pronoun, developed into a syntactic marker of relative clause boundaries (Dachkovsky 2016, this volume). Similar developments of embedded structures have been reported for many spoken languages (Heine & Kuteva 2007: ch. 5).

The main point here is that syntactic marking of subordination often develops over time in languages. Languages often have a 'non-subordination' stage in their history, developing the means for overtly marking subordination over time, by grammaticalization (which involves phonetic, semantic and morpho-syntactic changes). Yet, no language that I know of has ever been reported as having a stage of 'topic-finiteness', that is, a stage in which the language users were confined to a closed set of topics. And it is this characteristic that makes them distinct from ACSs – that makes them language. In other words, a language without recursion is still a language, whereas a language without topic-open-endedness is not.

5.   Topic-open-endedness: Symbols, meaning extensions, and compositionality

So far, I have motivated and supported the claim that what makes a communication system a language is first and foremost topic-open-endedness, and if we want to understand language we should try to account for that, rather than only for discrete infinity, which, as we saw, some languages may do without. From an evolutionary perspective, we have to explain how the capacity for topic-open-endedness evolved.

I cannot make any specific suggestions to solve this mystery, and I know of no satisfactory suggested scenarios in the literature. What I would like to do here is to suggest some possible directions for exploration, by bringing to the forefront several properties that I believe enable topic-open-endedness. If we can trace the evolution of any of these properties, we will make a great leap forward. I suggest that two sets of properties are involved in this feat: the nature of the symbols and compositionality. The first has been the focus here; the second will only be mentioned briefly.

Humans have the capacity to create symbols, even without exposure to conventional symbols. This is evident in homesign systems, where deaf children invent signs that were not used by their caregivers (Goldin-Meadow 2003), and in young sign languages, whose developing vocabulary is a testimony to this capacity (Meir et al. 2016). In the manual-visual modality, many of these signs are iconic; humans, unlike other primates, have the capacity to create iconic symbols (Sandler 2009: 253). Humans may use iconic signs to refer to abstract notions by means of metonymy – iconically depicting an object, entity or action related to the abstract concept (e.g., wheat harvesting for 'year', shown in Figure 2a, and a handshake for 'holiday' in ABSL).

In addition, humans extend the meanings of the words in their lexicons to refer to and express novel situations, by means of metonymy and metaphor. For
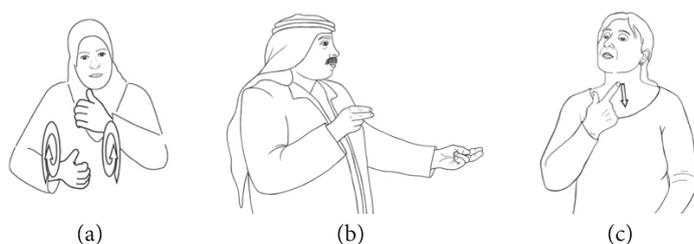
Figure 2. (a) Meaning extension in the abstract sign YEAR in Al-Sayyid Bedouin Sign Language (from HARVEST-WHEAT). (b) Metonymy in ABSL: RIFLE for 'man with a rifle'. (c) Metaphorical extension in Algerian Jewish Sign Language: WANT (from THIRSTY, Meir et al. 2016).

example, in a narrative of a first-generation ABSL signer, he uses the signs for RIFLE (Figure 2b) and CUCUMBER metonymically, to refer to people: the man with the rifle, and the man that grows cucumbers. Metaphorical extensions are also evident in the creation of signs and in creating meaning extensions, such as using the sign THIRSTY to mean WANT in Algerian Jewish Sign Language (Figure 2c, Meir et al. 2016). For treatments of metaphor in sign languages, see among others, Taub (2001), Meir (2010), and Meir & Cohen (2018).

Spoken languages are not different from sign languages in this respect. They also extend the use of their words to novel entities and situations. A glance at any item in a dictionary would make this point. There are hardly any items that have only one sense. Even a grammatical word such as *the* has four senses or functions, with several sub-functions in each (Meriam-Webster online dictionary);[4] the word *cat* has seven senses, and the word *run* has over 50 senses or meanings. The exact number of senses or meanings may be hard (or even impossible) to determine, but this is precisely the point: we use our finite set of words in novel and creative ways to refer to an infinite number of concepts and situations. This is a different facet of von Humboldt's famous saying that language "makes infinite use of finite means."

It is not clear how the ability for meaning extension developed in the course of language evolution. The study of ape gestures might be a possible starting point. It has been suggested that ape gestures show greater flexibility than facial expressions and vocalizations in terms of the behavioral contexts they occur in, and therefore the interpretation of gestures needs to take into consideration a larger combinatorial context (Pollick & de Waal 2007). Furthermore, ape gestures may show the buds of metonymy. When an ape scratches his body in a particular way

---

4. https://www.merriam-webster.com/dictionary/the

to request to be scratched at this spot, the directed scratch is associated with the intended action by metonymy: it represents the entire event of scratching, including an agent different from the communicator (Pika & Mitani (2009); see also Hobaiter & Byrne (2014) for a large inventory of meaningful gestures in chimpanzees). These gestures are instructions for actions rather than referential symbols, but they nonetheless make use of metonymy. Though the path from these gestures to the wide use of meaning extension in human language is still a mystery, at least there is a possible evolutionary precursor to start from (Liebal & Call 2012).

The second set of properties that are needed to account for topic-open-endedness is related to the notion of compositionality, our ability to combine symbols to create novel utterances whose meaning can be calculated on the basis of the meanings of their components and the way they are combined (Frege 1892[1952]). This ability is crucial in order to create a system with generative power. A good deal has been written about compositionality, and we limit our brief remarks here to predication and negation.

A specific kind of semantic relation which is based on compositionality is predication, the ability to 'say something about something', to attribute a property, an action or an event to a referent. Bickerton (e.g., 1990, 2009) has acknowledged and emphasized the importance of predication for human language and the evolution of syntax, and tried to suggest possible evolutionary precursors, but these are analogical (e.g., the behavior of foraging ants), and very different qualitatively from what we find in human languages. Others have suggested that predication is a development within homo sapiens, built on neural machinery that underlies other systems, such as CV syllable structure (Carstairs-McCarthy 1999) or the inherent asymmetry between the hands when manipulating tools (Krifka 2008). While the origin of predication is unclear, its significance in language cannot be emphasized enough. Predication is crucial for achieving displacement, since it enables us to separate a protagonist from the event it is performing or undergoing, and to place a situation in time with respect to speech time and therefore to detach events from the here-and-now. Even in the first generation of ABSL, predication is clearly expressed. Figure 3 shows HORSE FALL 'The horse fell down', in the narrative of a first generation ABSL signer.

Related to predication is negation. As far as I know, among natural communication systems, only human languages have the ability to negate, to state that something does not exist or did not happen, an important aspect of topic-open-endedness. Though ACSs may express related notions such as refusal or forbidding, these are still manipulative in nature and are not used as an assertion. Yet in the young language of Al-Sayyid, negation is expressed directly. A negation sign meaning 'none' (Figure 4) occurs in the sentence mentioned in the first section of
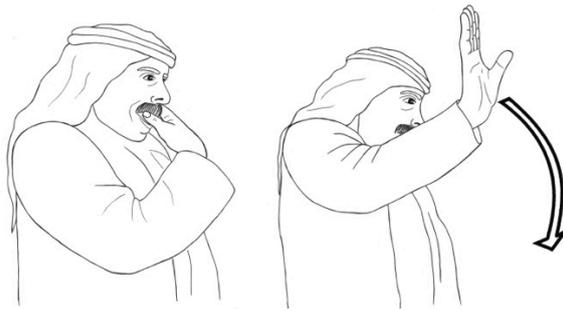
Figure 3. Predication. HORSE FALL, 'The horse fell down', in the narrative of a first generation ABSL signer.

this paper, FATHER SAY: WHY YOU LONG-TIME SEE <u>NONE</u> WHY? 'Your father said, "Why haven't we seen you for such a long time, why?"'

Figure 4. The negating sign NONE in ABSL.

6.   Conclusion

Here, I have contrasted recursion with attested mechanisms facilitating infinite use of finite means in language emergence. I have shown that use of symbols, meaning extensions and compositionality, including predication and negation, are all found at the very early stages of language, enabling them to exhibit topic-open-endedness, and setting them apart from other ACSs. If we want to character-ize and understand human language and how it evolved, we should address these properties, shifting the focus from recursion.

References

Bickerton, Derek. 1990. *Language and species.* Chicago: The University of Chicago Press. https://doi.org/10.7208/chicago/9780226220949.001.0001

Bickerton, Derek. 2009. *Adam's tongue: How humans made language, how language made humans*. New York: Hill and Wang.

Carstairs-McCarty, Andrew. 1999. *The origins of complex language*. Oxford: Oxford University Press.

Dachkovsky, Svetlana. 2016. *The development of a relative clause marker from a deictic gesture in Israeli Sign Language*. Talk presented at Annual Meeting of the German Linguistic Society (DGfS), Workshop 7: Sign language agreement revisited: New theoretical and experimental perspectives, Konstanz.

Dachkovsky, Svetlana. 2018. *Grammaticalization of intonation in Israeli Sign Language: From information structure to relative clause relations*. Haifa: University of Haifa PhD dissertation.

Deacon, Terry. 1997. *The symbolic species: The coevolution of language and the brain*. New York: Norton.

Ergin, Rabia. 2017. *Central Taurus Sign Language: A unique vantage point into language emergence*. Somerville, MA: Tufts University PhD dissertation. Available at: https://search .proquest.com/openview/69f73091abbc97d1d2997408076c5301/1?pq-origsite =gscholarandcbl=18750anddiss=y

Evans, Nicholas. 2003. *Bininj gun-wok: A pan-dialectal grammar of Mayali, Kunwinjku and Kune*. Canberra: Pacific Linguistics.

Evans, Nicholas & Steven Levinson. 2009. The myth of language universals. *Behavioral and Brain Sciences* 32. 429–492. https://doi.org/10.1017/S0140525X0999094X

Everett, Dan. 2012. *Language: The cultural tool*. New York: Pantheon Books.

Frege, Gottlob. 1952. On concept and object. In Peter Geach (trans.), *Translations from the philosophical writings of Gottlob Frege*, 42–55. Oxford: Blackwell. [Original. 1892. *Vierteljahrsschrift für wissenschaftliche Philosophie* 16. 192–205].

Gil, David. 2009. How much grammar does it take to sail a boat? In Geoffrey Sampson, David Gil & Peter Trudgill (Eds.), *Language complexity as an evolving variable*, 19–33. Oxford: Oxford University Press.

Goldin-Meadow, Susan. 2003. *The resilience of language: What gesture creation in deaf children can tell us about how all children learn language*. New York: Psychology Press.

Goldin-Meadow, Susan. 2005. What language creation in the manual modality tells us about the foundations of language. *Linguistic Review* 22. 199–225. https://doi.org/10.1515/tlir.2005.22 .2-4.199

Hauser, Marc. 1996. *The evolution of communication*. Cambridge, MA: MIT Press.

Hauser, Marc, Noam Chomsky & Tecumseh Fitch. 2002. The faculty of language: What is it, who has it, and how did it evolve. *Science* 298. 1569–1579. https://doi.org/10.1126/science.298 .5598.1569

Heine, Bernd & Tania Kuteva. 2007. *The genesis of grammar: A reconstruction*. New York: Oxford University Press.

Hobaiter, Cat & Richard W. Byrne. 2014. The meanings of Chimpanzee gestures. *Current Biology* 24. 1596–1600. https://doi.org/10.1016/j.cub.2014.05.066

Hockett, Charles F. 1960. The origin of speech. *Scientific American* 203. 88–111. https://doi.org/10 .1038/scientificamerican0960-88

Holm, John. 1989. *Pidgins and Creoles*. Vol II. Cambridge: Cambridge University Press.

Jackendoff, Ray. 2011. What is the human language faculty? Two views. *Language* 87(3). 586–624. https://doi.org/10.1353/lan.2011.0063

Kastner, Itamar, Irit Meir, Wendy Sandler & Svetlana Dachkovsky. 2014. The emergence of embedded structure: Insights from Kafr Qasem Sign Language. *Frontiers in Psychology* 5. 1–15. https://doi.org/10.3389/fpsyg.2014.00525

Kocab, Annemarie, Ann Senghas & Jesse Snedeker. 2016. Recursion in Nicaraguan Sign Language. In A. Papafragou, D. Grodner, D. Mirman & J.C. Trueswell (Eds.), *Proceedings of the 38th Annual Conference of the Cognitive Science Society*, 1343–1348. Austin, TX: Cognitive Science Society. Available at: https://mindmodeling.org/cogsci2016/papers/0239/index.html

Krifka, Manfred. 2008. Functional similarities between bimanual coordination and topic/comment structure. In Regine Eckardt, Gerhard Jäger & Tonjes Veenstra (Eds), *Variation, selection, development. Probing the evolutionary model of language change*, 307–336. Berlin: Mouton de Gruyter.

Liebal, Katja & Joseph Call. 2012. The origins of non-human primates' manual gestures. *Philosophical Transactions of the Royal Society B* 367(1585). 118–128. https://doi.org/10.1098/rstb.2011.0044

Meir, Irit. 2010. Iconicity and metaphor: Constraints on metaphorical use of iconic forms. *Language* 84(4). 865–896. https://doi.org/10.1353/lan.2010.0044

Meir, Irit & Ariel Cohen. 2018. Metaphor in sign languages. *Frontiers in Psychology* 9. 1025. https://doi.org/10.3389/fpsyg.2018.01025

Meir, Irit, Wendy Sandler, Carol Padden & Mark Aronoff. 2010. Emerging sign languages. In Marc Marschark & Patricia E. Spencer (Eds.), *Oxford handbook of deaf studies, language, and education*, Vol. 2, 267–280. Oxford: Oxford University Press.

Meir, Irit, Wendy Sandler, Yifat Ziv Ben-Zeev, Sara Lanesman & Meyad Sarsour. 2016. How does a lexicon emerge in a new language? Insights from village sign languages of Israel. *Iyunim be Safa ve-Hevra* 8(1–2). 11–43 (in Hebrew).

Mithun, Marianne. 1984. How to avoid subordination. *Berkeley Linguistic Society* 10. 493–509. https://doi.org/10.3765/bls.v10i0.1937

Pika, Simone & John C. Mitani. 2009. The directed scratch: Evidence for a referential gesture in chimpanzees? In Rudolf Botha & Chris Knight (Eds.), *The prehistory of language*, 166–180. Oxford: Oxford University Press. https://doi.org/10.1093/acprof:oso/9780199545872.003.0009

Pinker, Steven & Ray Jackendoff. 2005. The faculty of language: What's special about it? *Cognition* 95. 201–236. https://doi.org/10.1016/j.cognition.2004.08.004

Pollick, Amy S. & Frans B.M. de Waal. 2007. Ape gesture and language evolution. *The National Academy of Sciences* 104. 8184–8189. https://doi.org/10.1073/pnas.0702624104

Sandler, Wendy, Irit Meir, Svetlana Dachkovsky, Carol Padden & Mark Aronoff. 2011. The emergence of complexity in prosody and syntax. *Lingua* 121. 2014–2033. https://doi.org/10.1016/j.lingua.2011.05.007

Sandler, Wendy, Irit Meir, Carol Padden & Mark Aronoff. 2005. The emergence of grammar: Systematic structure in a new language. *The National Academy of Sciences* 102(7). 2661–2665. https://doi.org/10.1073/pnas.0405448102

Sandler, Wendy. 2009. Symbiotic symbolization by hand and mouth in sign language. *Semiotica* 174(1/4). 241–275.

Sandler, Wendy. 2010. Prosody and syntax in sign languages. *Transactions of the Philological Society* 108(3). 298–328. https://doi.org/10.1111/j.1467-968X.2010.01242.x

Sandler, Wendy. 2012. Dedicated gestures in the emergence of sign language. *Gesture* 12(3). 265–307. https://doi.org/10.1075/gest.12.3.01san

Taub, Sarah. 2001. *Language from the body. Iconicity and metaphor in American Sign Language.* Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511509629