FROM SILENT GESTURE TO ARTIFICIAL SIGN LANGUAGES

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1. Introduction

Language evolution can be described as the transition from something that is not language to something that is language. This definition allows us to remain agnostic about the mechanisms (biological or cultural) involved in the emergence of language. Moreover, the definition marks the boundary between language evolution and language change: the latter is a process that takes place when there is already a language (see the description in Scott-Phillips & Kirby 2010). Finally, language evolution is not something that only happened in pre-history: the emergence of new languages can be observed in the present day, with newly-emerging sign languages providing the best example of such a process.

In this paper we will sketch a methodology to study the transition from no- language to language. More specifically, we will show how combining different laboratory methods will allow us to observe the transition from 'silent gesture' (the behaviour observed in naive hearing participants who are asked to convey meanings while using only gesture) to artificial sign language. By allowing silent gesturing participants to interact and learn from one another via iterated learning, artificial sign languages emerge which, we will claim, share crucial properties with existing languages. Thus, the emergence of artificial sign language in the lab can help us to understand some of the mechanisms involved in the emergence of language in the human species.

2. Silent gesture: improvised communication in the lab

Silent gesture is the behaviour observed in naive participants who are asked to convey meanings (by describing simple events) while using only gesture and no speech. Constituent order in silent gesture is independent of the native language of the gesturer: Goldin-Meadow, So, Özyürek, and Mylander (2008) found that 'motion events' (such as 'captain swings pail' or 'boy tilts glass to mouth') are consistently ordered in SOV word order. Moreover, silent gesture shows structural variability based on the semantic properties of the message to be conveyed, a kind of variability that is not observed in full language: Schouwstra (2012) found that whereas motion events lead to SOV ordered strings, more abstract intentional events (such as 'man searches for guitar' or 'woman thinks of apple') are gestured in SVO order.

Silent gesture experiments can tell us something about the way in which people represent information in strings (linearly ordered messages) in the absence of language conventions. The fact that gesture sequencing is relatively consistent across participants, and independent of the dominant word order of their native language, suggests that silent gesture experiments can tell us something about cognitive biases that play a role in communication in the absence of conventional systems for constituent ordering.

3. From gesture to sign language in the lab

The communicative behaviour of silent gesturers is unidirectional: they only produce gesture sequences, but do not interpret them.[1] We will describe how the silent gesture method can be combined with the methodologies from the Iterated Learning paradigm, in order to study the evolution of silent gesture systems.

Iterated learning is the process by which an individual acquires a behaviour by observing a similar behaviour in another individual who acquired it in the same way (Kirby, Cornish, & Smith 2008). This definition captures two prominent types of cultural transmission, vertical and horizontal. Vertical transmission happens when new learners come into an existing linguistic community and acquire the linguistic system of that population. Horizontal transmission occurs within generations, through interaction between peers. Both processes have been studied in laboratory experiments. Vertical transmission has been shown to result in languages which become more learnable, more compressible, and thus more systematic (Kirby et al. 2008). Horizontal transmission, when studied in a graphical communication task, leads to the emergence of communicatively functional, efficient graphical conventions (Garrod, Fay, Lee, Oberlander, & MacLeod 2007). A combination of vertical and horizontal turnover shows that linguistic structure, the presence of regularities in the way in which complex signals are constructed to convey complex meanings, arises when both horizontal and vertical transmission are at work (Smith, Tamariz, & Kirby 2013; Kirby, Tamariz, Cornish & Smith, submitted). These findings demonstrate that we need to develop flexible experimental methodologies that allow us to investigate the relative contributions of horizontal and vertical transmission.

Experiments in the mixed paradigm proposed in this talk (silent gesture plus iterated learning) have a very natural starting point, beginning with the communicative gestures used when a single participant communicates solely according to his own cognitive biases. These individual-based gestures subsequently come under pressures for learnability and expressivity when participants interact with, and transmit their gestural repertoire to, other participants in dyadic, closed group and replacement designs.

1 Although interpretation experiments have been reported (Langus & Nespor 2010, Schouwstra 2012), in these publications production and interpretation were observed separately.

Combining silent gesture and iterated learning methods yields a suite of experimental methods that we can use to study how the products of the cognitive biases of individuals, through social transmission, develop into conventionalised language systems. In other words, it offers ways to create artificial sign languages in the lab. An additional advantage of studying emerging languages in the manual modality is that it gives us the possibility to compare it directly to natural data.

4. From gesture to sign language: natural data

Recently emerged sign languages, such as Nicaraguan Sign Language (NSL, Senghas & Coppola 2001) are a valuable source of information about language evolution in the real world, and potentially reveal mechanisms by which a fully conventionalized language emerges from earlier improvised forms of communication.

NSL is an example of a community sign language: a sign language that emerged over the past 30 years from the homesigns of deaf individuals that were put together in a group. Homesigns are spontaneous, improvised sign systems developed by deaf children who grew up in hearing families, and had no access to an existing conventional sign language. Although homesign is generally highly iconic and improvisation based, different homesign systems show some similarity in utterance structure. Like in silent gesture, semantic and pragmatic principles play a role in the organisation of utterances (Benazzo 2009).

NSL is structurally independent of the spoken languages that surround it, and has become more richly structured and increasingly systematic over the generations. Because much is known about the social dynamics under which it emerged, it is a valuable source of information about how different kinds of social transmission shape language. Laboratory studies in which silent gesture and iterated learning are combined offer a controlled environment in which phenomena observed in natural data can be studied in further detail.

5. Back to the lab: case studies in emergent structure

We will demonstrate the validity of our experimental methodology by showing that linguistic phenomena that have been observed emerging in this natural data also arise in the laboratory context. For example, Senghas, Kita, and Özyürek (2004) have noted that later signers of Nicaraguan Sign Language develop a way of signaling complex motion events by separating manner and path. For example, a ball rolling down a hill would be expressed using a roll gesture followed by a down gesture. Importantly, the same meaning early in the development of the language would have been expressed 'holistically' with manner and path signed simultaneously. We will show, using our iterated methodology, the same transition from holistic to compositional expression of manner and path arising in the lab. Intriguingly, we find this result does not arise universally—it is a solution to expressing events that is 'lineage specific', occurring in some runs of the experiment and not others. This is interesting because such a compositional strategy is also not universal across sign languages.

In addition to these specific syntactic properties of the emerging artificial sign systems, we will also look at the phonetics of the languages that evolve. We will give quantitative evidence (extracted directly from video) that the form of the signaling in our experiments is changing to become less pantomimic and more sign-like as the systems our participants use become conventionalized and energetically efficient. In order to quantify the efficiency of gestures, we calculate the amount of movement in each gesture video, based on pixel-by-pixel comparisons of adjacent video frames: gestures at later generations feature less movement. We can use similar techniques to quantify the extent to which a set of gestures exhibits systematic structure: we define the similarity between two gestures videos as the extent to which they involve similar movements (again, identified based on frame-by-frame comparison within each video), and then feed these similarity measures into standard techniques for quantifying systematic structure which we have developed for studying written miniature languages (specifically, the structure measure presented in Kirby et al. 2008).

By comparing the effects of horizontal interaction with vertical transmission, we will discuss the ways in which pressures from communication and from learning impact on the process that takes us from no language to language.

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