Experiments in the Emergence of Combinatorial Structure: Considering the Limitations of Articulation Space Proxies

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In real languages, articulation spaces can be the vocal tract in spoken language, or the gestural space used in sign language.

Work on the emergence of combinatorial structure uses articulation space proxies.

Ideal proxies should be:

- continuous spaces from which discrete signals can emerge under the set of conditions under investigation
- sufficiently dissimilar from actual articulation spaces to avoid influence from pre-existing linguistic knowledge

Recent experiments used:

- Slide whistles (Verhoef 2012)
- Graphical representations (Del Guidice 2012)

Can these experimental results be extrapolated to different modalities?

Can the physical dimensions of an articulation space affect the emergence of combinatoriality?

Al-Sayyid Bedouin Sign Language has no phonological patterning (Sandler, Aronoff, Meir, & Padden, 2011). This could be due to physical differences between articulation spaces in spoken & sign languages.

Iterated Learning Experiment Restricting Articulation Space

2 slide whistle conditions:

- Restricted (with stopper)
- Unrestricted

Participants in the first generation of both conditions heard an initial set of signals created within the restricted articulation range.

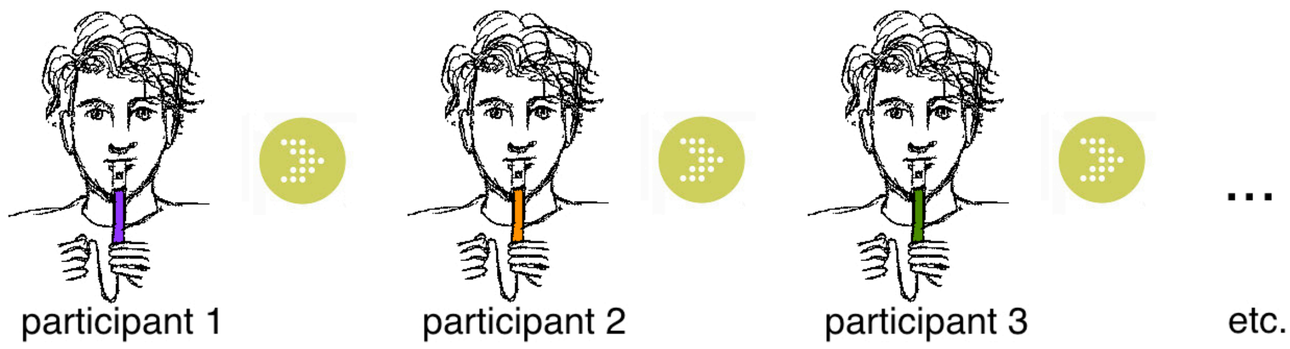

Figure 1. Participants learned a set of 12 whistled signals and reproduced them from memory. Their reproductions became the input for the next participant (generation) in a transmission chain.

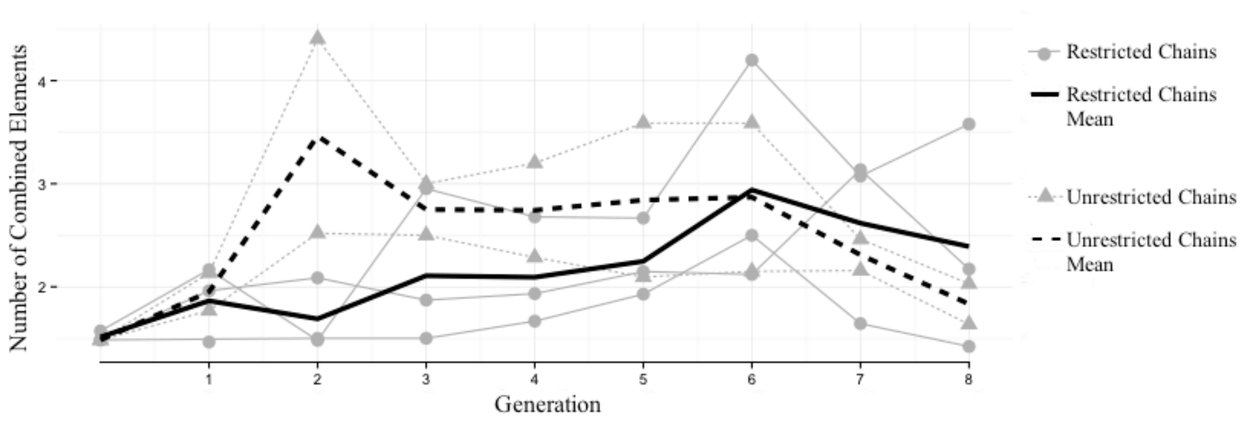

Figure 2. Number of element combinations repeated in participants' output within and across chains. Both conditions show initial emergence of combinatoriality, but only in the restricted condition does the generation predict the level of combinatoriality R2= .14, F1;22 = 4.728, p<.05.

The results show that in the restricted condition there is a more consistent growth of combinatorial structure (Figure 2). As size of articulation space can have an effect, it is important to consider physiological factors in phonological evolution. Combinatorial structure is not only subject to the cognitive biases.

Experimental design problems

The size and dimensionality of an articulation space can affect the structure that emerges from it.

Larger articulation spaces allow for a greater number of distinct signals without the need for combinatoriality.

Some articulation spaces allow for more iconicity than others.

Certain signal trajectories are more likely within some articulation spaces.

Problems with attributing emerging structure to cognitive biases when it could just be an effect of modality.

What's next?

Agent-based modeling representing signals using points or trajectories in a manipulable N-dimensional feature space a la de Boer & Zuidema (2010).

Further experimental work looking at the dimensionality of an articulation space using leap motion technology.

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