Iterated learning in an open-ended meaning space

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Iterated learning experiments (e.g. Kirby et al., 2008) typically use small, discrete meaning spaces. This is unlike natural language which is capable of discretizing a continuous and unbounded set of possible meanings into categories. Additionally, one criticism of the iterated learning paradigm is that the experimenter supplies participants with predigested meanings, rather than allowing them to emerge in the cultural evolutionary process. Some recent experiments have explored using continuous spaces (e.g. Perfors and Navarro, 2014; Silvey et al., 2013), but these do not fully address the open-ended nature of meaning, since they rely on a small, fixed set of stimuli.

We have created a meaning space based on randomly generated triangles that is continuous, high-dimensional, and open-ended. The dimensions of the space were not determined by the experimenter *a-priori* – instead it is the task of the participants to decide what the salient dimensions are. The triangle stimuli were generated by randomly selecting three coordinates in a 480×480-pixel space, which allows for 6×10^{15} possible stimuli. The set of stimuli that participants are tested on changes at each generation, such that no two participants are ever exposed to the same stimulus during their test or communication phase. This experimental paradigm models discrete infinity (see e.g. Studdert-Kennedy, 2005), since a finite set of symbols is used to describe an (essentially) infinite and ever- changing set of meanings.

Participants in our experiments first learned an artificial language describing a set of triangles. The first participant in a transmission chain was taught words that were generated from a finite set of syllables. Subsequent participants were trained on the output of the previous participant in the chain.

In our first experiment, the number of words used to describe the stimuli collapsed dramatically after only a few generations. Within a few more generations, systems emerged that arbitrarily divided the space into a small number of categories. Although our technique for uncovering the structure in the languages was able to consider multiple geomet- rical properties, the systems that emerged pertained primarily to the size and shape of the stimuli, ignoring features such as rotation and location.

Our second experiment added dyadic communication to the paradigm which greatly increased the expressivity of the languages. These more expressive languages appear to make more nuanced distinctions by making use of compositional linguistic structure. This suggests that communicative pressures are required for compositionality to arise in more complex, higher-dimensional meaning spaces.