

Communication increases the expressivity of emergent languages in an open-ended meaning space

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The meaning spaces typically used in iterated learning experiments (e.g. Kirby, Cornish, & Smith, 2008) are unlike natural language, which is characterized by open-ended structure. Some recent experiments have used continuous spaces (e.g. Perfors & Navarro, 2014; Silvey, Kirby, & Smith, 2013), but these do not fully address the open-ended nature of meaning. We have constructed a meaning space based on randomly generated triangles that is continuous, high-dimensional, open-ended, and not pre-determined by the experimenter. Participants in our experiments learned an artificial language describing these 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. The set of stimuli that participants were tested on was different at every iteration. This experimental paradigm models discrete infinity (see Studdert-Kennedy, 2005 for some discussion), since a finite set of symbols is used to describe an infinite and ever-changing set of meanings. In our first experiment, the emergent languages arbitrarily divided the meaning space into a small number of categories based on the size and shape of the triangle stimuli. Our second experiment added dyadic communication to the paradigm which greatly increased the expressivity of the languages. These more expressive languages made more nuanced distinctions by making use of compositional structure. This suggests that communicative pressures are required for compositionality to arise in more complex, higher-dimensional meaning spaces.

Kirby, S., Cornish, H., & Smith, K. (2008). Cumulative cultural evolution in the laboratory: An experimental approach to the origins of structure in human language. *Proceedings of the National Academy of Sciences of the USA*, 105(31), 10681–10686. doi:10.1073/pnas.0707835105

Perfors, A., & Navarro, D. J. (2014). Language evolution can be shaped by the structure of the world. *Cognitive Science*, 38(4), 775–793. doi:10.1111/cogs.12102

Silvey, C., Kirby, S., & Smith, K. (2013). Communication leads to the emergence of sub-optimal category structures. In M. Knauff, M. Pauen, N. Sebanz, & I. Wachsmuth, *Proceedings of the 35th annual conference of the Cognitive Science Society* (pp. 1312–1317). Austin, TX: Cognitive Science Society.

Studdert-Kennedy, M. (2005). How did language go discrete? In M. Tallerman, *Language origins: Perspectives on evolution* (pp. 48–67). Oxford, UK: Oxford University Press.