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Languages are culturally transmitted through a repeated cycle of learning and communicative interaction, a process known as iterated learning. Previous work has shown how different features of linguistic structure evolve from the trade-off between different competing pressures acting on language learning and communication such as compressibility and expressivity (Kirby, Cornish, & Smith, 2008; Perfors, Tenenbaum, & Regier, 2011; Lupyan & Dale, 2015; Regier, Kemp, & Kay, 2015; Kirby, Tamariz, Cornish, & Smith, 2015). In Kirby et al. (2015), compositional miniature artificial languages evolve as a result of their transmission across "generations". Where both compressibility and expressivity pressures are in play, signals in later generations are composed of atomic units, each mapping to a specific dimension of the meaning to be conveyed. However, the complexity of the languages which evolve in these experiments is necessarily limited by the objects (meanings) people were learning labels for. In particular, the sets of objects to be labelled do not require a language which exhibits hierarchical constituency and syntactic categories. In this paper, we increase the complexity of the meanings to be conveyed by including motion events that comprise shape, number, motion and aspect. The events are composed by a focal object which performs the action and optionally, an anchor object which remains static. By increasing the complexity of the meaning space, we expect the same mechanisms involved in the evolution of simple compositionality to lead to richer syntactic structure more closely resembling that found in real languages.

We ran an Iterated Artificial Language Learning study and manipulated the expressivity pressure. We designed a monadic condition (N=32) with an artificial pressure for expressivity, and a dyadic condition (N=80) with communication as a natural pressure for expressivity. Following Kirby et al. (2015) we use the transmission chain paradigm. Participants were trained on a set of meaning-signal mappings, and then tested on their ability to recall that language. The first participants in a chain were trained on a non-compositional randomly generated language. Subsequent participants were trained on the language produced by the

previous participants. The test phase of the monadic condition involved typing descriptions for motion event scenes using the language learned previously; participants were not allowed to reuse the same description for different meanings, introducing an artificial pressure for expressivity. The test phase in the dyadic condition required participants to communicate with their partner in the language that they previously learned; members of a dyad alternated between describing meanings for their partner, and interpreting descriptions provided by their partner.

In accordance with previous results, we found a significant increase in learning success and structure in both conditions along the evolution of compositional structure. Moreover, constituency was hinted at by the emergence of morphologically complex N-like and V-like syntactic lexical categories. These categories were used to form hierarchically compositional sentential structures with meaningful word order.

Despite the qualitative similarity of the results in the two conditions, we found that condition significantly affected the evolution of structure: languages in the dyadic condition became structured more rapidly and their level of structure was consistently higher. The levels of complexity in the emergent compositional systems were significantly different between conditions: the systems in the monadic condition showed higher system complexity on average and less transparent morphosyntactic structures (i.e. they exhibit functional elements such as category markers, and non-adjacent dependencies, not found in the dyadic condition).

Compositionality operating at the levels of morphology and syntax evolved through the trade off between compressibility and expressivity. Nevertheless, the difference in complexity found between the two conditions points to the need for further investigation into the nature of the pressure for expressivity in these experiments. In the dyadic condition, the need to maintain communication may lead to a conservative approach. If participants find a solution that works, they stick with it. In the monadic condition, the pressure for expressivity is quite different. The need to avoid reuse of the same description for different meanings leads to an anti-conservative approach, with participants actively generating novel signals. Future work should investigate whether an analog of this tendency to innovate is at play in real languages, and consequently whether a pressure for novelty needs to take its place alongside compressibility and expressivity in the evolution of complex linguistic structure.

References

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