

FORM-MEANING COMPOSITIONALITY DERIVES FROM SOCIAL AND CONCEPTUAL DIVERSITY

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Language structure is often considered separate from its socio-cultural bearings (e.g., Chomsky, 1995). Such an assumption may obscure rich interaction between the structures present in a language and the social and conceptual circumstances in which they function. Recently, Wray and Grace (2007), drawing on earlier work by Thurston (1994), have argued for distinguishing two broad language types that reflect this interaction. *Esoteric* (inward-facing) languages are languages spoken within small groups and learned by relatively few outsiders. *Exoteric* (outward-facing) languages (of which English is an extreme example) are spoken by large groups, and learned by many adults as second languages. Exoteric languages tend to have more open-class words than esoteric languages, possess far simpler morphological systems and can often be well characterized by rule-based grammars. Semantics in exoteric languages are generally compositional—one can derive the meaning of the whole from the meanings of the parts. In contrast, esoteric languages have fewer open-class words, but complex morphological systems. They are highly context dependent, given to numerous exceptions that withstand regularization, and are often characterized by polysynthesis and morphologically-conditioned allomorphy.

Wray and Grace (2007) explain the correspondence between language usage (esoteric vs. exoteric) and language structure through evolutionary reasoning. They argue that the characteristics of esoteric languages, though undaunting to infants, lead to substantial difficulty for an adult outsider to learn. Esoteric usage thus marks in-group members by the speakers' ability to use this linguistic custom, having acquired it during childhood. However, an increasing need to interact with outsiders and about novel topics, insofar as it requires recombining existing elements into novel sentences that are understood by strangers, places a pressure on the language to become more transparent and compositional. This

makes the language easier to learn by new adult users. Compositionality, common to exoteric languages, is thus supported by a need to communicate with strangers. Compositionality also allows speakers to easily generate new meanings through recombination of familiar elements, allowing for comprehension without the need for extended in-group experiences. Thus, the property of compositionality, rather than an innate language universal, could be a product of out-group interaction—of “talking with strangers” (Wray & Grace, 2007). The current work tests this fascinating hypothesis in a computational framework.

We tested two predictions derived from Wray and Grace’s analysis. First, we expected that learning basic grammatical structure common to esoteric languages will be easy for naïve learners, but progressively harder to acquire by learners with experience in another language. In contrast, grammars common to exoteric-type languages should continue to be learnable by late learners. Second, because grammars common to exoteric languages have more transparent form-to-meaning mapping, we expected that networks exposed to these grammars should be better able to generalize their linguistic knowledge to novel contexts.

A fully-recurrent neural network was trained to map phonological forms to semantics. The networks were trained on sentences corresponding to schematic structures of esoteric and exoteric languages. The exoteric-type grammar consisted of a large vocabulary of lexical morphemes with fixed semantics and few closed-class morphemes which, rather than having fixed semantics, modified the semantics of neighboring open-class words. In such grammars context plays a limited role and there exists a transparent form-to-meaning mapping. The esoteric-type grammars consisted of a much greater proportion of closed-class words and a smaller lexicon. This greater number and prevalence of non-lexical morphemes meant that the lexical semantics were much more context-dependent. Results provided support for both predictions. First, naïve networks could learn esoteric and exoteric grammars to roughly equal proficiency. Critically, age of exposure mattered more for esoteric than exoteric grammars, with the former being disproportionately more difficult to learn by more “mature” networks. Second, as predicted, generalization to novel contexts was more difficult for esoteric compared to exoteric languages.

We aim to integrate two approaches to language and its evolution: anthropological theories of sociocultural influences on language, and psychological theories of computational mechanisms for language. In this integrated view, the structural characteristics of language have their origin in the interaction between sociocultural and computational constraints. Generative recursion, long considered foundational to the emergence of our linguistic abilities, may simply be derivative of this interaction.