

Recursion In Humpback Whale Song

Malcolm Kennedy^{*1}

^{*}Corresponding Author: mmk50@cam.ac.uk

¹Department of Theoretical and Applied Linguistics, University of Cambridge, Cambridge, United Kingdom

The most salient quality of humpback song is the repetition of subroutines within the larger routine that is the entire song — as well as the repetition of the song itself. Payne and McVay (1971, henceforth P&M) use this to posit a syntactic object smaller than the entire song but larger than its atomic sound units, called a *phrase*. P&M implicitly establish *repeatability* as a diagnostic of phrasehood: phrases are delineable from surrounding material because units internal to a phrase repeat to the exclusion of other units: if a song consists of two adjacent phrases [AB][CD], the sequences ABAB and CDCD will be attested, and crucially, BCBC will *never* be attested. This constituency test parallels those used in linguistic syntax, like co-ordination and pro-form replacement, and gives a means of falsifying posited constituents and proposing new ones. I extend this reasoning to *phrase-internal* structure, and show that surface-level repetition phenomena in certain phrases cannot be explained without multiply-embedded, binary-branching hierarchical structures, with a depth of three phrasal layers in at least one case. I support this analysis computationally by building probabilistic context-free grammars (PCFGs) embodying this recursive structure, and comparing their fit to the data with that of various baseline PCFGs. I propose that humpback song must be the result of a recursive mental operation akin to the syntactic structure-building operation Merge (Chomsky, 1999), which would make humpbacks the only known species capable of Merge. I will explore what evolutionary insights might be provided by the existence of syntax in a non-linguistic cognitive system like humpback song, particularly in light of proposals like Katz & Pesetsky (2009) that language and music might share a common mental syntax.

Chomsky, N. (1999). *Derivation by phase*. Cambridge, MA: MIT.

Katz, J., & Pesetsky, D. (2009). *The identity thesis for language and music*. Draft Published Online, : lingBuzz/000959.

Payne, R. S., & McVay, S. (1971). Songs of humpback whales. *Science*, 173(3997), 585–597.
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