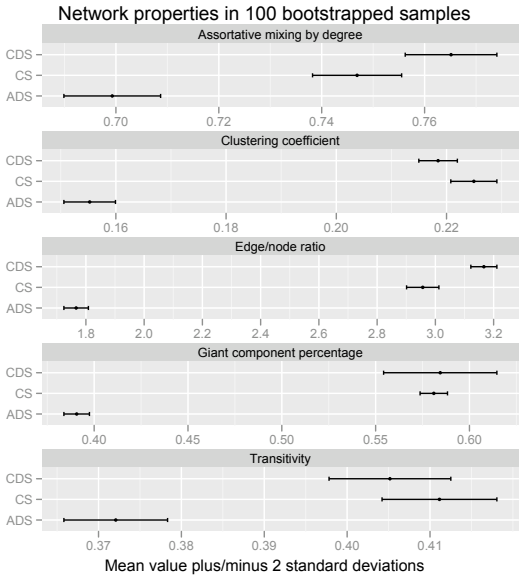
Global properties of the phonological network in child and child-directed speech

Matthew T. Carlson (carlsonmt@uchicago.edu), Morgan Sonderegger, Max Bane; U. Chicago

We take a graph-theoretic approach (e.g. Arbesman et al. 2010) to analyzing phonological neighborhood structure in child and child-directed speech. Unlike previous analyses that have focused on neighborhood density as a property of individual words (e.g. Charles-Luce & Luce 1990; 1995; Coady & Aslin 2003; Dollaghan 1994; Storkel 2004), we use phonological neighborhoods to define global properties of entire lexicons, opening a new perspective on the role of phonological similarity in children's vocabulary development. We investigate whether children's early lexicons are characterized by dense or sparse neighborhood structure as compared to adult-directed speech (ADS). Since child-directed speech (CDS) exhibits a number of properties (e.g. prosodic, syntactic) held to facilitate language acquisition, we also test whether the sub-lexicon used for CDS presents favorable phonological conditions for language acquisition.

We compare the network structure of the child and CDS lexicons from a speech corpus from 60 parent-child dyads (child age: 14-46 months; Huttenlocher et al. 2007) to the lexicon from an ADS corpus (Pitt et al. 2007). The network for each lexicon was constructed using all distinct orthographic word types as nodes, with edges between phonological neighbors or homophones. We base our comparison on properties that have previously been studied in phonological networks (Kleinberg 2000; Watts et al. 2002). These include edge-to-node ratio, clustering coefficient, transitivity, and assortative mixing by degree. It has been argued that high values of these measures tend to correspond to networks that are stable and searchable, i.e. whose structure remains intact even as nodes are removed, and whose nodes are efficiently accessible from each other. Such properties might also benefit lexical acquisition.

The child lexicon generally had higher values for these properties (Figure) than ADS, suggesting that children favor a lexicon with more robust neighborhood structure than the adult lexicon. In addition, based on these measures, the phonological network structure of CDS was more similar to child speech than to ADS. We argue that comparison by global graph-theoretic properties can shed new light on how neighborhood structure impacts child lexical development.



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