

An agent-based modeling approach to the evolution of stress pattern diversity in English

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We lay out a usage-based explanation for the evolution of stress pattern diversity in languages such as English and present it in the form of an agent-based model. We find that the predictions derived from such a model are in line with empirical corpus data. Thus, we hope to contribute to the overall theme of the conference by showing how agent-based models can help to integrate diachronic, usage-based and evolutionary modes of linguistic analysis.

Previous accounts have treated English word stress mostly as a function of phonological structure, particularly focusing on the effect of syllable weight (Chomsky, 1968; Hayes, 1982; Burzio, 1994). However, items like in (1) defy such explanations, as they are structurally equivalent in terms of weight but still take different stress patterns.

- (1) a. **lé**ntil vs. ho**té**l
b. **Cá**nada vs. ba**na**na
c. **ín**crease (N) vs. in**cré**ase (V)
d. **ré**search (N) vs. re**sé**arch (N)

Additionally, competence-centred approaches do not address the question why a language should accommodate diverse and variable stress patterns in the first place.

Building on insights from experimental research (Kelly & Bock, 1988), our model assumes that a word's lexical stress pattern is sensitive to the speech rhythm arising in the syntagmatic contexts it tends to occur in. Physiological and cognitive constraints (Lehiste, 1970; Pitt & Samuel, 1990; Peelle & Davis, 2012) favour an alternating rhythm in speech (Hayes, 1984; Selkirk, 1984; Schlueter, 2005). Through repeated cycles of speech production, perception and acquisition (Kirby & Hurford, 2002) or exemplar adjustment (Wedel, 2006), these preferences can affect lexical stress diachronically by biasing words or entire word classes towards those patterns which most successfully produce alternating rhythms in combination with other words (Kelly, 1989) (2).

- (2) a. the **ín**crease wórries us
b. híkes **ín**créase the cóst of living

In evolutionary terms (Croft, 2000), the rhythmic preferences operating at the level of phrasal phonology exert a selective pressure on lexical stress patterns, constantly testing their viability within their usage contexts.

We choose agent-based simulation as a method for probing this line of argumentation. The agent population in our model is made up of constituent types (i.e. a proxy for lexical items) defined by linguistic attributes, notably stress pattern, syllable weight and morpho-syntactic class. In each round of the simulation, a predetermined number of agents are probabilistically selected to occur and interact with one another within one of a range of possible syntagmatic contexts to form a rhythmic phrase. The phrase is evaluated with respect to prosodic criteria (rhythmic alternation and weight-to-stress) and the agents are rewarded or penalized accordingly. These payoffs continuously update the agents' fitness attribute, which in turn determines the agents' chances of successfully reproducing into the next generation.

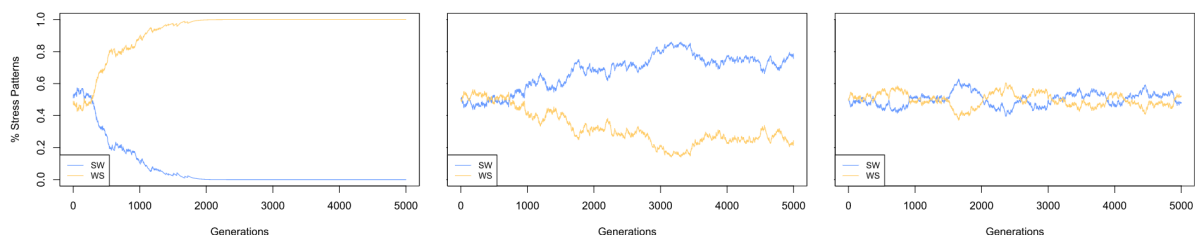


Fig. 1: Evolution of stress patterns in disyllables. ABS based on hypothetical languages with low (1a, left), moderate (1b, middle), and high proportions of monosyllables (1c, right)

The simulation suggests that stress pattern diversity will stably establish itself if the occurrence contexts of polysyllables also include monosyllabic material at a sufficiently high rate (Fig. 1). In such a setting, diverse rather than uniform lexical stress patterns will reduce the likelihood of rhythmically suboptimal clashes and lapses. This prediction matches empirical data derived from the Penn-Helsinki Parsed corpora of English (Kroch & Taylor, 2000; Kroch et al., 2004, 2016).

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