

The speed-curvature power law in speech

Stephan Kuberski, University of Potsdam

The power law relation between speed of movement and trajectory curvature is a celebrated law of human motor control. Since its original demonstration, observations of the law have been reported for a multiplicity of effector systems engaged in a vast variety of movement types (locomotion, drawing, writing, eye motion, etc.). The ubiquitous presence suggests that the speed-curvature power law may be a common feature of biological movement in general, yet only a few attempts have been made to assess its presence in speech.

In this talk, I present electromagnetic articulometry data from a metronome-driven speech elicitation paradigm explicitly designed to unleash articulatory movements of a wider kinematic range than found in any previous assessment devoted to the law. Analysis of the data in their full three dimensions reveals strongest evidence for a power law relation between speed and curvature in speech. Moreover, the power law's exponent (one of the key parameters of the law) is shown to systematically vary just in ways as reported from other areas of human motor control. If time permits, I place these results in the context of models of speech production.

The talk is based on the following work:

Kuberski and Gafos (2019). "The speed-curvature power law in tongue movements of repetitive speech". *PLOS ONE* 14(3), 1–25. doi: [10.1371/journal.pone.0213851](https://doi.org/10.1371/journal.pone.0213851).

Previous assessments of the law in speech:

Tasko and Westbury (2004). "Speed-curvature relations for speech-related articulatory movement". *Journal of Phonetics* 32(1), 65–80. doi: [10.1016/S0095-4470\(03\)00006-8](https://doi.org/10.1016/S0095-4470(03)00006-8).

Perrier and Fuchs (2008). "Speed-curvature relations in speech production challenge the $1/3$ power law". *Journal of Neurophysiology* 100(3), 1171–1183. doi: [10.1152/jn.01116.2007](https://doi.org/10.1152/jn.01116.2007).

Tomaschek, Arnold, Bröker, and Baayen (2018). "Lexical frequency co-determines the speed-curvature relation in articulation". *Journal of Phonetics* 68, 103–116. doi: [10.1016/j.wocn.2018.02.003](https://doi.org/10.1016/j.wocn.2018.02.003).