

TASK DYNAMICS

Khalil Iskarous

Research Scientist
Haskins Laboratories

Task Dynamics is an explicit computational model of the speech production system, which applies the dynamical systems approach to speech. It models the planning and execution stages—from gestures and their overlap to articulatory motions and acoustics. Using the model, it is possible to implement hypotheses about cross-linguistic differences in contrasts, amount of gestural overlap, or gestural parameters, and to run simulations using TADA (Task Dynamic Application). These simulations generate articulatory and acoustic trajectories that can be compared to data. This use of the model allows for deeper interpretation of experiments that look at the relation between phonology and phonetics. Also, TADA, together with its articulatory synthesizer CASY (Configurable Articulatory Synthesis), can be used to simultaneously model three major sources of variability in speech production and acoustics: prosody, coarticulation, and speaker differences. System-level manipulation of the high-level parameters and of speaker-based parameters (e.g. ratio of oral to pharyngeal cavity length) therefore allows for the study of the effect of these sources of variation on signal-level parameters (both articulatory and acoustic) that could then be checked against data. This use of the model promises to be important for applications in speech recognition and synthesis systems, where it is useful to have explicit models of signal-variability due to these factors.

Lecture 1. Articulators and Gestures: Theories of Speech Production

MacNeilage, P. (1970). Motor control of serial ordering of speech.

Psychological Review, 77, 182-196.

Fowler, C. A. & Saltzman, E. (1980). Coordination and coarticulation in speech production. *Journal of Phonetics*, 36, 171-195.

Hawkins, S. (1992). An introduction to task dynamics. In J. Docherty and D.R. Ladd (Eds.) *Papers in Laboratory Phonology II: Gesture, Segment, Prosody*. Cambridge University Press.

Guenther, F. H., Hampson, M., and Johnson, D. (1998). A Theoretical Investigation of Reference Frames for the Planning of Speech Movements. *Psychological Review*. 105, 611-633.

Lecture 2. What is Dynamics?

Iskarous Intuitive Notes on Kinematics and Dynamics

Browman, C. and Goldstein, L. (1985). Dynamic Modeling of Phonetic Structure. In Fromkin, V. (Ed.). *Phonetic Linguistics*. Academic Press.

Lecture 3. Vocal Tract Dependencies: Task-Articulator Jacobian

Mermelstein, P. (1973). Articulatory model for the study of speech production. *Journal of the Acoustical Society of America*, 53, 1070-1082.

Saltzman E. and Munhall, K. (1989). A dynamical approach to gestural patterning in speech production. *Ecological Psychology*. 1, 333-382.

Lecture 4. Using TADA to study phonological patterns I (Lab Session)

TADA (Task Dynamics Application) Manual

http://www.haskins.yale.edu:16080/tada_download/doc/TADA_manual_v09.pdf

Iskarous, K., Mcdonough, J. and D. H. Whalen, (manuscript). A gestural account of velar contrast in a coronal heavy inventory: the back fricatives in Navajo.

Lecture 5. Using TADA to study phonological patterns II & New Developments

E. Saltzman, H. Nam, L. Goldstein, and D. Byrd. (2006) The distinctions between state, parameter and graph dynamics in sensorimotor control and coordination. In M. L. Latash and F. Lestienne, (Eds.). *Motor Control and Learning*. New York: Springer pp. 63-73.

Nam, H., Goldstein, L., & Saltzman, E. (in press). Self-organization of syllable structure: a coupled oscillator model. In F. Pellegrino, E. Marisco, & I. Chitoran, (Eds.). *Approaches to phonological complexity*. Berlin/New York: Mouton de Gruyter.