DYNAMICS AND KINEMATICS OF REPETITIVE SPEECH MOVEMENTS

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A standard model of isolated speech movements is thought to be a linear second order system (Saltzman and Munhall, 1989). Several variations to this model have been proposed which claim to render isolated as well as sequences of speech movements more accurately. There are also proposals from other areas of motor control which aim to render both non-repetitive and repetitive sequences of not specifically speech movements. We used the Harvard/Haskins database of regularly-timed speech (Patel et al., 1999) to extract kinematic relations of jaw and lower lip movements in opening and closing /b, m/ gestures. These relations are then compared with the via-simulation predicted relations from linear and nonlinear models of the speech gesture as well as autonomous and nonautonomous two-dimensional proposed models. In simulations, topological differences with regard to the kind and the number of the model-specific attractors (fixed points, limit cycles) are considered. It is shown that, for the experimental data in this work, none of these models are able to completely account for the data. Relative time to peak velocity (RTTP) values of closing movements tend to be higher than values predicted by any fixed point model. Those models which simulation results indicate are able to generate higher values of RTTP exhibit other incompatible kinematic relations (e.g., strongly nonlinear peak velocity vs. movement amplitude relation). We conclude with a discussion of the extent to which the task at hand uniquely determines the dynamical regime (repeated isolated gestures vs. limit cycle) underlying the observed performance. If time permits, we will review results from our own work with acquiring similar data, under more controlled conditions (specifically speech rate controlled), in an attempt to address the nature of the dynamical regime underlying the movements.

References

- Saltzman, Elliot L. and Kevin G. Munhall (1989). "A dynamical approach to gestural patterning in speech production". In: *Ecological psychology* 1 (4), pp. 333–382. DOI: 10.1207/s15326969eco0104_2.
- Patel, Aniruddh D., Anders Löfqvist, and Walter Naito (1999). "The acoustics and kinematics of regularly timed speech: a database and method for the study of the P-center problem". In: *Proceedings of the 14th International Congress of Phonetic Sciences*. (San Francisco). Vol. 1, pp. 405–408.