Reductionism in Phonology: Clues from Complex Systems

Graduate Seminar
Instructor: Adamantios Gafos

There is a recurrent theme in phonology and phonetics in which some authors make a claim that some (/ all) qualitative aspects of phonological form can (/ should) be reduced to facts about the physics of speech. No doubt, certain phonological facts do seem to have a clear phonetic basis. Such arguments, assuming they are carried to their ultimate conclusion, would be attractive on the basis of theoretical parsimony: they promise to explain the facts of phonology in terms of a few basic principles of the physical sciences (this is what 'reduction' means), and hence we would end up with fewer irreducible principles than we thought we ought to have at first sight.

The theme of the present seminar is expressed by the following question: *can phonology be reduced to 'physical principles', and if not what is the proper way to capture the fact that much of phonology looks phonetically-driven?* This is a difficult question; no one knows the answer to it. But we can at least guess what may be the right ways to approach it: the fact that linguists revisit the problem periodically but address it inconclusively suggests that we need to look for clues elsewhere. And so we do in this seminar.

We begin with the assumption that language and phonology in particular is a *complex system*. Here, we are not alone. Biologists have worked hard to develop ways to talk about such complex systems of living action in terms of hierarchical levels. The higher levels are inextricably linked to the lower levels (a property called 'closure'), but crucially higher levels also exhibit 'emergent properties', that is properties that cannot be expressed in the language of the lower level (Pattee, 1973; Kauffman, 1995). In fact, the very reason why biologists developed theories of complex systems was precisely because of their dissatisfaction with the reductionistic attempts of molecular biology (Pattee, 1973). The research program of molecular biology had focused excessively at the microscopic details of the lower level of the cell. This research strategy was extremely productive (and no one doubts that those microscopic details need to be understood), but at the same time it neglected fundamental macroscopic concepts such as the concept of an organism and the concept of systems of organisms ('ecology'), with all their qualitative aspects of form and behavior (Goodwin, 1994).

More recently, cognitive scientists have also started to develop theories of cognition that begin with the assumption that what is to be explained is a complex system with both qualitative or higher-level aspects and quantitative, lower-level 'implementations' (Port and Van Gelder, 1995). These approaches suggest views and tools with which one may approach the similar problems we face in phonology; here too, we have a system expressed through phonetic substance (a few moving articulators) but which at the same time shows rather abstract qualitative properties.

The readings in this seminar consist of articles in, of course, linguistics, theoretical biology, the area of living action systems, cognition and mathematical modeling (a sample is provided in the next page). A typical meeting in this seminar would look like this. After one or two papers are presented, the class engages in a discussion of their content. The goal of the discussion is to make sense of the content of those papers, and then to harness any lessons that may be learned in the context of the overarching issues that are the concern of this seminar. The students are expected to read or better to enjoy reading material that is at once difficult and unfamiliar, and to think about what that material may teach us for the questions addressed in this seminar.

Requirements

(1) Leading of discussion

As part of this requirement, you lead the discussion of a particular topic. The discussion is based on a reading assignment (a paper) that the class has read. The purpose of your presentation is to bring out the substance of the relevant papers, to elucidate points that are unclear, to relate issues in the reading to other readings you have done, to criticize, to analyze, to think.

(2) A term paper

As part of this requirement, you will explore to greater depth a topic related to your interests and you will report your results by writing a paper and presenting it in class. This paper should run about 15-20 typed pages.

Representative Sample of Readings

Abraham, R. and Shaw, C. D. (1982). *Dynamics–The Geometry of Behavior.* Aerial Press, Santa Cruz, CA.

Browman, C. P. and Goldstein, L. (1995). Dynamics and Articulatory Phonology. In Van Gelder, T. and Port, R. F., editors, *Mind as Motion: Explorations in the Dynamics of Cognition*, pages 175–193. MIT Press, Cambridge, MA.

Churchland, P. S. and Sejnowski, T. J. (1992). *The Computational Brain.* The MIT press, Cambridge, MA.

De Saussure, F. (1949). *Cours de Linguistique Générale*, volume 4. Payot, Paris.

Goodwin, B. C. (1994). *How the Leopard Changed Its Spots: The Evolution of Complexity.* Simon & Schuster, New York.

Hayes, B. P. (1999). Phonetically Driven Phonology: The Role of Optimality Theory and Inductive Grounding. In *Functionalism and Formalism in Linguistics, Volume I: General Papers*, pages 243–285. John Benjamins, Amsterdam.

Hyman, L. M. (2001). The Limits of Phonetic Determinism in Phonology: ∗NC revisited. In Hume, E. and Johnson, K., editors, *The Role of Speech Perception in Phonology.* Academic Press, New York.

James, W. (1892). *Psychology: The Briefer Course.* University of Notre Dame, Notre Dame, Indiana. 1985 edition.

Kauffman, S. (1995). *At home in the universe: The search for the laws of self-organization and complexity.* Oxford University Press.

Kelso, S. J. A., Tuller, B., and Harris, K. S. (1983). A "Dynamic Pattern" Perspective on the Control and Coordination of Movement. In MacNeilage, P. F., editor, *The Production of Speech*, pages 137–173. Springer-Verlag, New York.

Lindblom, B. (1983). Economy of Speech Gestures. In MacNeilage, P. F., editor, *The Production of Speech*, pages 217–245. Springer-Verlag, New York.

Pattee, H. H. (1973). The Physical Basis and Origin of Hierarchical Control. In Pattee, H. H., editor, *Hierarchy Theory: The Challenge from Complex Systems*, pages 71–108. Braziller, New York.

Port, R. F. and Van Gelder, T. (1995). *Mind as Motion: Explorations in the Dynamics of Cognition.* MIT press, Cambridge, MA.

Steriade, D. (1997). *Phonetics in Phonology: The Case of Laryngeal Neutralization.* Ms. UCLA, CA.

Thelen, E. (1995). Time-Scale Dynamics and the Development of an Embodied Cognition. pages 69–100.

Turvey, M. T. (1990). Coordination. *American psychologist*, 45(8):938–953.

PRIMARY MATERIALS

Theory of complex systems: Simon and Pattee articles in 'Hierarchy Theory: The Challenge of Complex Systems'; 1 week

Clues from Biology: Goodwin book chaps. 1, 4, 7, Pattee article in 'Towards a theor. biology' vol.; 2 weeks

Clues from Philosophy: O'Connor (see papers on physicalism and identity theory); 1 week

Dynamic approach to Cognition: Port & Gelder 95, Chapters 3 (by Thelen) and 12 (by Port et al.); 2 weeks

Dynamics and Gestures: Browman & Goldstein, Saltzman; 1 or 2 weeks

Phonology of Time (3 weeks):

Inter-segmental timing: Gafos 00 (ms.), Chitoran et al 00 (ms.); 2

Intra-segmental timing: Gick 99 (th), Silverman 97 (th), Kingston 85 (th), Steriade 94 (talk);

Morphology of Time: Gafos handouts of ongoing work; 1 week

Functional approaches to phonology:

Steriade's 'phonetics in phonology: the case of laryngeal neutralization', segmenthood talk and paradigm uniformity paper, Hayes 'phonetically-driven phonology', selected chapters from Boersma's 'Functional Phonology'. Also, some leftovers I can't classify: Turvey's ecological theory of action, and (from within the field of linguistics) Hyman, Lindblom, Ohala.

Resources on the web: Haskins Laboratories, http://haskins.yale.edu, under Tools, see Linguistic Gestural Model, and also Computational Model. New England Complex Systems Institute web site at http://necsi.org/guide/

Computational resources: GEST, installed on the departmental MacG3 computer. This is an experimental version of the Linguistic Gestural Model system (see note above). You may use the system to test your hypotheses about gestural timing relations and their acoustic consequences.

STUDENT PROJECTS

Extensions of leading ideas presented in the class will be pursued through individual, research papers. The deadline for your paper's abstract is October 26. Some suggestions, going either by concept or by language. By concepts, we have complex segments and timing, morphology of time (templates), and phonology of time (vowel syncope and reduction processes). Languages with relevant problems: Afar, Berber and releases, English schwa epenthesis, Moroccan Arabic (syncope, reduction), Syrian Arabic (syncope, releases), Piro releases, notion of segment in Chinese dialects.

MEETINGS SCHEDULE

09/07: Introduction: the physical, the mental, some perspectives, and a concept map

Case studies (*is phonological form just spatial or spatio-temporal?*)
09/14: Case study 1: Gafos on phonology of Moroccan
09/21: Nikki on Browman & Goldstein (a,b), ? On Saltzman (a,b),
09/28: ? on Fujimura, Case study 2: Ioana on Georgian clusters

Theory
10/05: theory of complex systems (Pattee, Simon), clues from biology (Goodwin book)
10/12: cont'd (Goodwin book on organisms vs. molecules, Pattee on biological hierarchies)

Case studies
10/19: Case study 3: Gick diss. on inter-segmental timing of glides and liquids
10/26: Case study 4: Silverman diss. on inter-segmental timing

More case studies
10/26: Kingston diss, Steriade long ms.
11/02: cont'd
11/09: Hayes, Hyman (*are phonological constraints universal?*)
11/16: Boersma (*functionalism: general principles of what?*)

TBA
11/23:
11/30:
12/07:
12/13: