

# WORKSHOP

## PHONOLOGICAL SYSTEMS AND COMPLEX ADAPTIVE SYSTEMS

July, 4-6 2005

Dynamique Du Langage Lab  
Institut des Sciences de l'Homme  
LYON - FRANCE

### OPENING SESSION: INTRODUCTION

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# PROGRAM AT A GLANCE

		Monday, July 4th	Tuesday, July 5th	Wednesday, July 6th
	TOPIC	About Complexity	Phonology & cognitive processing	Phonetics & phonology I
	Chairman:	Björn Lindblom	René Carré	John Ohala
MORNING	9h-9h45	<b>Christophe Coupé, Egidio Marsico &amp; François Pellegrino</b> <i>Introduction to the workshop</i>	<b>Sharon Peperkamp</b> <i>Statistical inferences and linguistic knowledge in early phonological acquisition</i>	
	9h45-10h30	<b>Ian Maddieson</b> <i>Interrelationships between measures of phonological complexity</i>	<b>Noël Nguyen</b> <i>The dynamical approach to speech perception: from fine phonetic detail to abstract phonological categories</i>	<b>Gérard Philippon</b> <i>Some problems in defining and organizing phonological primes</i>
	10h30-11h15	<b>Christopher Kello</b> <i>Self-organization and fractal structure in phonological systems and dynamics</i>	<b>Nathalie Bedoin &amp; Sonia Krifi</b> <i>The hierarchy of phonetic features categories in printed syllables matching in adult skilled readers, normally developing young readers, and dyslexic children</i>	<b>Christophe Coupé, Egidio Marsico &amp; François Pellegrino</b> <i>Complexity of phonological inventories: features &amp; structures</i>
	11h15-11h30	Break	Break	Break
	11h30-12h15	<b>Didier Demolin</b> <i>Control and regulation in phonological systems</i>	<b>Willy Serniclaes &amp; Christian Geng</b> <i>Cross-linguistic trends in the perception of place of articulation in stop consonants: A comparison between Hungarian and French</i>	<b>Adamantios Gafos</b> <i>Dynamical systems and integrated phonetics-phonology</i>
LUNCH	12h30-14h	LUNCH at "Chez Sam"	LUNCH at "Le Vivaldi"	LUNCH at "Chez Sam"
AFTERNOON	TOPIC	Emergent properties	Acquisition	Phonetics & phonology II
	Chairman:	Didier Demolin	Michael Studdert-Kennedy	Ian Maddieson
	14h-14h45	<b>Björn Lindblom</b> <i>Deriving Language from non-Language</i>	<b>Nathalie Vallée</b> <i>Some favoured syllabic patterns in the world's languages explained by sensori-motor constraints</i>	<b>Abby Cohn</b> <i>Gradience and Categoriality in Sound Patterns</i>
	14h45-15h30	<b>René Carré</b> <i>Production and perception of vowels without acoustic static targets</i>	<b>Sophie Kern</b> <i>Universals and language specificities in canonical babbling</i>	<b>Ioana Chitoran</b> <i>Phonetic naturalness in phonology</i>
	15h30-16h15	<b>Louis Goldstein</b> <i>Emergence of syllable structure from a coupled oscillator model of intergestural timing</i>	<b>Yvan Rose</b> <i>Conceptual and empirical challenges to statistical approaches to child language production</i>	<b>John Ohala</b> <i>Languages' sound inventories: the devil in the details</i>
	16h15-16h30	Break	Break	Break
	16h30-17h30	<b>General Discussion</b>	<b>General Discussion</b>	<b>Closing Session</b>
<b>DINNER at "Les Terrasses de la Tour Rose"</b>				

# SOME PRACTICAL INFORMATION

## ➤ Hotels

- ✓ Directly paid by DDL (breakfast included)

## ➤ Lunches

- ✓ Restaurants in the neighborhood of the lab

## ➤ Dinner

- ✓ Workshop dinner on Tuesday 8:00 PM

*Les Terrasses de la Tour Rose*

- ☑ *Have to choose your main dish today*

## ➤ Web Connection

- ✓ Here (3 slots)

## ➤ Questions

- ✓ Ask people with a blue tag on their badge



# CONTEXT

## *Project: "Structure and Dynamics of Phonetic-Phonological Systems"*

- ✓ Project funded by French CNRS and Department of Research (Ministère de la Recherche) 2003-2004
- ✓ Funding dedicated to research on *Complex Systems within the field of Humanities and Social Sciences*
- ✓ Participants
  - *Laboratoire Dynamique Du Langage - UMR 5596 CNRS - Université Lumière Lyon 2*
  - *Laboratoire de Traitement et Communication de l'Information, UMR 5141 CNRS - ENST, Paris*
  - *Phonology Lab, Department of Linguistics, University of California, Berkeley, USA*
- **Focused on phonetic-phonological interface**
  - ✓ **Structural aspects**
    - *Phonological systems exploiting inventories (data-mining approach on UPSID)*
  - ✓ **Dynamical aspects**
    - *Speech production, speech perception, language acquisition, *diachrony**

# 1ST WORKSHOP IN FALL 2003

## ➤ Goals

- ✓ Propose approaches to complexity in phonology
- ✓ Question the relevance of the paradigm of Complex Adaptive Systems

## ➤ Participants

- ✓ René Carré
- ✓ Björn Lindblom
- ✓ Ian Maddieson
- ✓ Willy Serniclaes
- ✓ Liliane Sprenger-Charolles
- ✓ Michael Studdert-Kennedy
- ✓ DDLers

## ➤ Conclusion

- ✓ Necessity to assess the relevance of the possible phonological primitives (easier to say than to do)
- ✓ CAS: why not?

# WHAT IT IS ALL ABOUT...

## PHONETICS & PHONOLOGY

Production & Perception  
Acquisition  
Cognition  
Boundaries

Primitives  
Inventories  
Continuous  
*vs. discrete*  
*vs. categorical*

Dynamics

Syntagmatic  
*vs. paradigmatic*

Functional Load

Naturalness

Markedness

Hierarchy

COMPLEXITY

Frequency of occurrence  
*in the World's languages*  
*in a given language (?)*  
*in child-directed speech*

Reuse & combinatorial use

*from Algorithm and Computer Science*

Information Theory

Complex Adaptive System

*from Physics*

Self organization

*from Life Science & Physics*

Emergence & interactions

*from Life Science, Physics, ...*

Commands constraints

*from Engineering and System Control*



# COMPLEX, COMPLICATE AND DIFFICULT???

## ➤ Complex vs. Simple

- ✓ Complex System results of interactions between simpler elements
- ✓ Breakable into interacting simpler components (may be recursive!)

## ➤ Complicate vs. ... Well understood!

- ✓ IMHO, something is said to be complicate when one is unable to:
  - Identify the components
  - Understand their interactions
- ✓ Language (and phonology) will be seen as complicate until we manage to demonstrate why and how it is a complex adaptive system...

## ➤ Complex vs. Difficult

- ✓ What is the relation between complexity and processing difficulty??
- ✓ Distinction linked to the notion of Hierarchy?

# ABOUT COMPLEXITY AND INTERACTIONS

- Explain with a small set of primitives a wide range of phenomena (Occam's razor)
  - ✓ Control Commands (relation with primitives, knowledge and process)
  - ✓ Constraints & Degrees Of Freedom => Variation
  - ✓ Local Interactions, Self-Organization & Emergence
  - ✓ Global Constraints ?
- Difficulties
  - ✓ Identify the constituents (constraints, primitives, ...)
  - ✓ Understand the interactions
  - ✓ Decipher several intricate levels of interactions
    - Global systemic or local interactions
    - Perceptual, acoustic, motor components result in a *composite* complexity
    - Syntagmatic interactions
    - Interaction between speakers...



# ABOUT REUSE & COMBINATORIAL USE

## ➤ Holistic vs. Parsed Processing

- ✓ Segmentation/Parsing from continuous to discrete?
- ✓ Nature of the discrete elements?
  - Gestures, Trajectories, Targets (cf. this afternoon)

## ➤ Comparison to Speech Recognition Technology

- ✓ DTW (Dynamic Time Warping) vs. HMM (Hidden Markov Models)
  - DTW: Holistic spectral distance
  - HMM: Statistical combinatorial "distance"
- ✓ Shift between DTW to HMM due to increase of complexity in the speech to recognize (more numerous words, coarticulated speech, ...)
- ✓ Consequences:
  - Increase accuracy and robustness
  - Decrease the amount of memory needed to store acoustic forms of words
  - Need for a correct segmentation/combinatorial processing

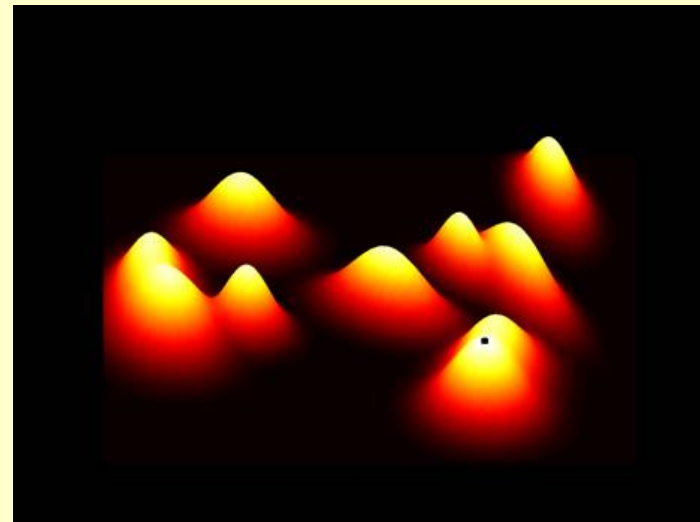
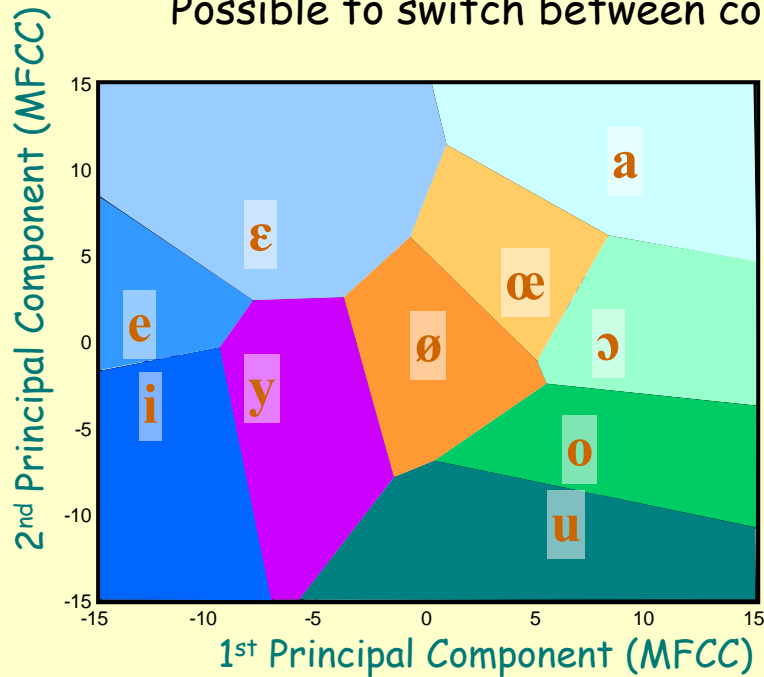
# DISCRETE vs. CONTINUOUS

- One of THE big points!
  - ✓ Several talks in this workshop...
- Two dichotomies?
  - ✓ Stimulus-oriented distinction between discrete and continuous stimuli (e.g. Male/Female categories vs. Colors)
  - ✓ Process-oriented distinction between discrete and continuous tasks (e.g. phone recognition vs.  $F_0$  height ranking of phones)
- Does human speech recognition need to be discrete at the phonological level?
- Notions
  - ✓ Discrimination between stimuli
  - ✓ Identification
  - ✓ Cognitive representation
  - ✓ Linear/non linear distances
  - ✓ Dissimilarities
  - ✓ ...

# DISCRETE vs. CONTINUOUS (CONT'D)

## ✓ Example of VQ vs. GMM

- Pattern Recognition Approaches
- VQ: Vector Quantizing  
Nearest Neighbor Decision => Hard Boundaries
- GMM: Gaussian Mixture Model  
Maximum Likelihood Decision => "Fuzzy" Statistical Boundaries  
Possible to switch between continuous and discrete point of view



- ✓ Variation of experimental task => ( $\pm$  categorical) behavior

# ABOUT CONSTRAINTS & "HISTORICAL" OT

## ➤ Constraints are useful!

- ✓ Very common in natural systems
- ✓ Various nature
- ✓ May interfere in an antagonist way => diversity
- ✓ Interact and result in complex multidimensional "constraint landscape"
- ✓ Modeling based on Numeric Methods rather than Formal Methods

## ➤ So... Why reduce high multifactor to 1-dim ranking?

- ✓ 1-dim projection => loss of information  
=> complicate and *ad hoc* description

## ➤ Constraints and degrees of freedom

- ✓ A language has to be:
  - Embodied
  - Learnable *enough* (not necessarily *optimal*)
  - Functional *enough* (not necessarily *optimal*)

# ABOUT MARKEDNESS...

- Notions that may be measured
  - ✓ Frequency of occurrence in World's Languages
  - ✓ Frequency of occurrence in a given language (lexicon)
  - ✓ Frequency of occurrence in a given corpus
- Notions than may be estimated or modeled
  - ✓ Quantity of information
  - ✓ Functional load
  - ✓ Not easy:
    - Frequency in fluent speech (different from lexicon)
    - Influence of speech rate (significant variations among languages and speakers)
    - Interaction with morphology and syntax
- Notion than puzzles me... *Markedness*
  - ✓ IMHO, instance of something that may be emergent, descriptive but lacking actual explanatory power

# 3 REASONS TO RECONSIDER INFORMATION THEORY IN THE PHONOLOGY OF THE 21<sup>ST</sup> CENTURY

- ① Language-dependent patterns and quantity of information
  - ✓ Choice of Epenthetic Vowels (Hume & Bromberg, 2005)
  - ✓ Choice of the support vowel for hesitation and filled pauses in 8 languages (?) (Vasilescu, Candea & Adda-Decker, 2004)
  
- ② Compensations between phonetics, phonology, morphology and syntax
  - ✓ Relation between the phone duration, the syllabic structure and the morpho-syntactic types of languages (Mehler & Dupoux, 2004)
  - ✓ Are languages with small phonemic inventories spoken faster?
  
- ③ Existence of LARGE corpora to assess phonological hypotheses
  - ✓ Take phonetic details into account
  - ✓ Take individual variation into account
  - ✓ Develop an information-driven integrated approach

# MORAL OF THE STORY

Tentative to put together parts of the puzzle and to answer questions relative to complexity of articulation, distinctiveness, acquisition, phonological processes, cognitive processes, dynamics, categories, hierarchy, syllable structures, naturalness, features, gestures, trajectories, commands, targets, ...  
but don't forget:

*"Everything should be made as simple as possible,  
but not simpler"*

Albert Einstein

# SESSIONS OVERVIEW

## *Session*

## *Topic*

## *Chairman*

- Monday AM: About complexity (Björn Lindblom)
- Monday PM: Emergent properties (Didier Demolin)
  
- Tuesday AM: Phonology & Cognitive Processing (René Carré)
- Tuesday PM: Acquisition (Michael Studdert-Kennedy)
  
- Tuesday Evening: Dinner ("chef" of the "Terrasses...")
  
- Wednesday AM: Phonetics & Phonology I (John Ohala)
- Wednesday PM: Phonetics & Phonology II (Ian Maddieson)
  
- **AFTER?**
  - ✓ BOOK?
  - ✓ SPECIAL ISSUE OF A JOURNAL?



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