The syllable as emerging unit of information, processing, production

September 27-29, 2012
Dartmouth College, Hanover NH
Neukom Institute for Computational Science; Linguistics and Cognitive Science Program

Location: Haldeman 125
Contact: Ioana Chitoran (ioana.chitoran@dartmouth.edu)

DAY 1 THU, September 27

8:00 Breakfast (catered by Lou’s)
8:30 Work session

Introductory remarks (Ioana Chitoran and Rick Granger)

8:45 Short presentations – 10 min + 7 min questions
   • What is the problem I am trying to solve?
   • What is hard and what is easy about it?

In order to ensure communication across our fields, we would like to ask you to be particularly explicit about potentially ambiguous terms, that may have different assumptions behind them. Anyone should feel free to interrupt the speaker whenever such a term is encountered.

10:45 Coffee break
11 Work session

Presentations by topic
Building on the previous short presentation (“What is the question?”), please tell us “Where you are now”. 45 min slots per topic, including the presentation and the discussion around it.

Suggested topics and groupings:

1. O. Ghitza, W. Idsardi, R. Granger (D. Poeppel, in absentia) – neuronal cortical oscillations in speech and language processing; brain representation of syllables; statistical analyses of fundamental feature content of very large speech corpus – 40 min including questions
2. F. Pellegrino – the syllable as processing window. The relevance of cross-linguistic comparison of (i) syllable and information rate; (ii) experimental paradigms of reversed speech and cocktail party speech – 30 min including questions

12:30p Lunch (catered)
1:30p Work session

3. J. Bohland – Dynamical models of speech production/perception: The DIVA/GODIVA model of the syllable; competitive queuing theory; neural bases for phonological representations – 30 min including questions

4. L. Goldstein, H. Nam, E. Saltzman, J. Krivokapic – Dynamical models of speech production/perception: the coupled oscillator model; predictions for acquisition; relevance for sound change – 45 min including questions

5. S. Tilsen – Dynamical models of speech production/perception: a hybrid model of speech planning/production; competitive queuing and coupled oscillators – 30 min including questions

3:15p Coffee break
3:30p Work session

6. M. Tiede, I. Chitoran (T. Mooshammer, in absentia) – reorganization of articulatory gestures in speech. Implications for a dynamical systems approach to language. Articulatory gestures reorganize in accelerated speech. Do the resulting articulatory patterns reflect: (i) only general physical and biological constraints imposed by the articulatory and auditory system? (ii) also constraints imposed by articulatory routines developed and learned on a language-specific basis? Can we observe the emergence of syllable organization, with language-specific differences, by observing the effects of speech rate on the synergy among articulators in syllable production? – 30 min including questions

General discussion:
- emerging questions and conclusions
- topics for tomorrow’s discussion groups
- selecting tomorrow’s groups

5:30p end
7:00p Dinner at the Salt Hill Pub
Today’s discussions will proceed according to the groups established yesterday. We will discuss the emerging questions agreed on, and attempt to formulate hypotheses.

**Preliminary list of questions:**

1. How ‘real’ is the syllable as a unit of action and perception?

2. The connection between syllables and oscillation seems to be more compelling on the perception side. But regarding a syllable-related oscillation in motor planning/execution: what evidence (neural or linguistic) exists for planning oscillations associated with syllables? Presumably such oscillations would coordinate motor activity. Generally we might contrast two hypotheses:

   (a) **syllables are motor planning systems:** they have inherently oscillatory dynamics and are (at least partly) independent of gestures (semi-autonomous); articulatory gesture planning systems are coupled to them.

   (b) **syllables are merely perceptual phenomena:** the perception of syllables emerges from the occurrence of sequences of competitively selected sets of gestures (perhaps organized around a high-sonority nuclear vocalic gesture). Phonotactic generalizations can be re-expressed vis-à-vis gestural coupling, without need for syllables.

      -- here we might consider:
      i. the absence of lexical syllabification contrasts
      ii. the ambiguity of evidence for syllables as processing units (Côté 2012)
      iii. ambiguity in syllabification judgments
      iv. non-obligatoriness of prosodic structure building

3. Do planning oscillators relate to oscillations in firing patterns in the brain?

   - Discuss how oscillations corresponding to the syllable relate to those corresponding to larger phrases (theta and delta), and how oscillations corresponding to the syllable relate to those corresponding to smaller units (theta and gamma).
   - Discuss the large variability observable at the phrasal level both within a speaker (different phrases are of different length within one speaker’s productions) and across speakers (there are some differences in phrasing between speakers). How do we relate these differences – and do we want to do so – with the neural level. I expect that the two are, in the end, unrelated, that variability is at the linguistics and planning level, but I would like to think more about this.
   - Discuss the consequences of the brain oscillations on perception. We seem to be able to entrain to rhythmic productions which then allows us to predict rhythmic patterns in perception, but is there evidence that we perceive by default in some rhythmic manner (e.g., that we perceive best stimuli which are presented at a certain frequency)? This is relevant for the understanding of rhythm, and what the function of rhythm is from a biological perspective.
4. Starting from Greg Hickok's recent posts on the Talking Brains blog, we should discuss whether having syllable and feature/gesture representations obviates the need for segments. 
http://www.talkingbrains.org/
Related questions:
- How are syllables and gestures stored and retrieved?
- What is the nature of representation of consonant clusters - how are they bound together as a moveable unit, but still separable as individual speech sounds?

5. What role does the motor system play in perception? (also based on Greg Hickok’s blog)

6. Can we relate the frequency of brain oscillators and planning oscillators for articulatory gestures? Are there frequency constraints on gesture production?
Related questions about syllable production:
- In production, how can we best account for modulations of intra-syllable gesture durations and amplitudes as functions of location in the syllable?
- Relatedly, how are a syllable's gestures affected by: lexical stress, prosody, information content, the number of syllables in 'higher order' units, the state of the prosodic hierarchy during the time that a syllable is produced, and by temporally/sequentially 'remote' syllables/gestures?
- How are onset and coda gestures phased to the syllable at fast and slow rates; in particular, the observed stiffness of consonantal gestures does not scale with vowel length -- is this language-specific, or a general property of production, and what are its implications for syllable planning?

7. Can we / how can we reconcile dynamical systems / gestural approaches in phonology / speech motor control with neural network, competitive queuing, and psycholinguistic approaches like in DIVA/GODIVA (and other models). Where are the points of connection, and where do the models fundamentally diverge?

8. How can phonotactic probabilities be encoded in learned representations (auditory, motor, or abstract/symbolic) of syllables, words, non-words?

10:30 Coffee break
10:45 Work session

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:30p</td>
<td>Lunch (catered)</td>
</tr>
<tr>
<td>1:30p</td>
<td>Work session</td>
</tr>
</tbody>
</table>
3:00p  Coffee break
3:15p  Work session

General discussion:
What are the most important questions to address next?

5:30p  end

7:30p  Drinks at the Canoe Club
7:45p  Dinner at the Canoe Club

DAY 3    SAT, September 29

8:00    Breakfast (catered by Lou’s)
8:30    Work session

Based on yesterday’s discussions, finalize the main questions to be addressed in the future, near-term and long-term.

10:30   Coffee break
10:45   Work session

Discuss the possibility of putting together an edited volume based on this working group. Determine what it should contain, in order to achieve the main goals of our meeting:
- give a coherent direction to the field
- address all represented sub-fields

12:30p   Lunch at Market Table (reservation is for 1 pm)

2:30 to 5 pm  Optional work session, if needed
List of participants:

Jason Bohland (Boston University, Health Sciences Department, Sargent College of Health and Rehabilitation Sciences)
jbohland@bu.edu
Ioana Chitoran (Dartmouth College, Linguistics and Cognitive Science Program)
ioana.chitoran@dartmouth.edu
Oded Ghitza (Boston University, Biomedical Engineering, Hearing Research Center)
oghitza@bu.edu
Louis Goldstein (USC, Department of Linguistics, and Haskins Laboratories)
louisgol@usc.edu
Richard Granger (Dartmouth College, Psychological and Brains Sciences and Computer Science)
richard.granger@dartmouth.edu
Bill Idsardi (University of Maryland, Department of Linguistics)
idsardi@umd.edu
Jelena Krivokapic (Yale University, Department of Linguistics)
jelena.krivokapic@yale.edu
Tine Mooshammer (USC and Haskins Laboratories, New Haven, CT)
tine@haskins.yale.edu
Hosung Nam (Haskins Laboratories, New Haven, CT)
nam@haskins.yale.edu
François Pellegrino (CNRS Lab “Dynamique du Langage”, University of Lyon, France)
Francois.Pellegrino@univ-lyon2.fr
David Poeppel (NYU, Department of Psychology)
david.poeppel@nyu.edu
Sravana Reddy (Dartmouth College, Neukom Institute Fellow, Linguistics and Cognitive Science Program and Department of Computer Science)
sravana.reddy@dartmouth.edu
Elliot Saltzman (Boston University, Health Sciences Department, Sargent College of Health and Rehabilitation Sciences, and Haskins Laboratories)
esaltz@bu.edu
James Stanford (Dartmouth College, Linguistics and Cognitive Science Program)
james.stanford@dartmouth.edu
Mark Tiede (Haskins Laboratories, New Haven, CT)
tiede@haskins.yale.edu
Sam Tilsen (Cornell University, Department of Linguistics)
tilsen@cornell.edu