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### Coarticulation: Theory, data and techniques

Edited by William J. Hardcastle and Nigel Hewlett

Cambridge: Cambridge University Press, 2000. Pp. 400. Hard cover \$75.00. ISBN 0-521-44027-0.

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This is a *dense* book. Seventy-five dollars is a not-at-all-unusual price for linguistics works these days; but in this case you will certainly at least get value for the money. Because this is a collection of papers by different authors, quality and style vary from chapter to chapter, but there are few wasted words, and hardly a sentence without a kernel idea worth taking the time to understand. On the other hand, it is a difficult and demanding book to read cover to cover, and most readers will probably prefer to focus on areas of particular personal interest rather than tackling the whole volume at one go.

In the Introduction, the editors introduce the notion of coarticulation by referring to how the sounds of language are highly context-sensitive and influenced by neighboring segments. This is followed by an overview of the chapters. Mention is also made of the book's origin as an EU-funded project of ACCOR ("Articulatory-acoustic correlations in coarticulation processes: a cross-linguistic investigation"), conducted 1992-95.

Part I, "Theories and models", attempts to provide general background and a foundation for the other chapters of the book. Chapter 1, entitled "The origin of coarticulation" (Barbara Kühnert and Francis Nolan), discusses what causes coarticulation, a history of the investigation of coarticulation, and how coarticulation develops in children's speech. The term "coarticulation" is said to date to the 1930s, while experimental techniques for studying coarticulation were developed by Bruecke and Bell in the mid-1800s. A series of coarticulatory models is reviewed, including Lindblom's "target undershoot" model of the 1960s (p. 16), Oehman's observation that two vowels interact with each other across intervening stops (p. 17), Wickelgren's idea that we store not phonemes in our brains but collections of context-sensitive allophones (p. 18), up to Keating's "window" model of the 1980s (p. 21), in which every feature of a segment is associated with a range of values rather than an absolute target. The chapter is inconclusive regarding child acquisition of coarticulation, and cites the need for further study. Chapter 2, "Coarticulation models in recent speech production theories" (Edda Farnetani and Daniel Recasens), expands on these and other theories of the past thirty years, including Lindblom's continuum of "hyper- to hypo-speech" (p. 34), Pauli & Sundberg's proposal that V-to-C coarticulation results from a low-cost production strategy (p. 37), Daniloff and Hammarberg's "feature-spreading" theory (p. 40), and a hybrid model (p. 59).

Part II is entitled "Research results: components of the motor system for speech". Each chapter features a key articulatory organ or organ complex: the velopharyngeal complex, the tongue, the larynx, the lips, and the lips and jaws. Chapter 3, "Velopharyngeal coarticulation"

(Michel Chafcouloff and Alain Marchal), discusses the direction (anticipatory/carryover) and extent of nasal coarticulation based on physiological, acoustic and perceptual evidence. In Chapter 4, “Lingual coarticulation”, Daniel Recasens addresses the variability of vowel height and frontness/backness, including for neutral vowels, and the influence of such factors as voicing, frication, and prosody. Chapter 5, “Laryngeal coarticulation”, has two parts: Part A, “Coarticulatory investigations of the devoicing gesture” by Philip Hoole, and Part B, “Voice source variation in the vowel as a function on consonantal context,” by Christer Gobl and Aibhe Ni Chasaide. This chapter discusses among other things whether the amplitude of the devoicing gesture is greater for fricatives than plosives. A blow-by-blow account is given of research procedures and ongoing results which might have been better presented in summary form; this chapter is, as a result, perhaps the least engaging in the book. Chapter 6, “Labial coarticulation” (Edda Farnetani), focuses on the feature of “rounding”, and the difference between “phonological rounding” as in French and Cantonese, and “redundant rounding” as in English. It looks into the question of blending and possible blocking of coarticulatory rounding, in cases of segments with contrasting labiality features (p. 162). In Chapter 7, “Lip and jaw coarticulation”, Janet Fletcher and Jonathan Harrington note how lip and jaw movements are easier to study since they can be clearly seen from the outside. They also point out that the jaw is relatively sluggish in its movements compared to the tongue, and that jaw movements will alter tongue position and sometimes tongue shape as well.

Part III provides a home, under the catch-all classification of “Wider perspectives”, for two chapters that did not quite fit elsewhere. Chapter 8, “Relating language-particular coarticulation patterns to other language-particular facts” (Sharon Manuel), tests the notion that there will be more leeway for coarticulatory variation in a language with fewer vowels. The results are inconclusive, but a tendency is noted for coarticulation to be constrained so as to maintain contrasts in a language with a larger number of vowels (p. 196). The chapter also notes that prosody and temporal coordination of articulatory gestures are strongly linked. Chapter 9, “Implications for phonological theory” (Mary Beckman), proposes that under an alphabetic model of articulation (visualized as discrete phonemes strung together), “coarticulation constitutes a mismatch between the sound pattern of an actual utterance of a word and its stored representation in the mental lexicon” (p. 216). This, the author concludes, urges consideration of a “non-linear” model of coarticulation, and approaches such as phonological “underspecification” of segments. Interesting examples are cited from languages such as Russian, Japanese, and Arabic. This chapter stands out in this work both for its phonological rather than phonetic orientation, and also for its very heavy-handed academic tone, which tended, in this reviewer’s opinion, towards stylistic overkill. A lighter touch would have made the material easier to work through.

The seven chapters of an appendix on “Instrumental Techniques”, report on the state of the art of various specialized methods and instruments for performing articulatory and acoustic measurements. The methods presented are:

1. “Palatography” (Fiona Biggon and Katerina Nicolaidis);
2. “Imaging techniques” (Maureen Stone), including X-ray, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound;
3. “Electromagnetic articulography,” or EMMA (Philip Hoole and Noel Nguyen);
4. “Electromyography” (William Hardcastle)
5. “Transducers for investigating velopharyngeal function” (Michel Chafcouloff), including aerometry, electromyography, various acoustic methods, radiography, endoscopy, photodetection, various mechanical devices, ultrasound, MRI, and EMMA;
6. “Techniques for investigating laryngeal articulation” (Philip Hoole, Aibhe Ni Chasaide)

and Christer Gobl), including fiberoptic endoscopy, transillumination, electromyography, pulse-echo ultrasound, acoustic analysis with inverse filtering, glottography, and the Sondhi tube. (Like Hoole, Ni Chasaide and Gobl's other contributions to this volume, this chapter is divided into two parts: Part A, "Investigation of the devoicing gesture" by Hoole, and Part B, "Techniques for analyzing the voice source" by Gobl and Ni Chasaide.)

7. "Acoustic analysis (Daniel Recasens).

Chapters 1-6 of the appendix contain detailed information on material presented more briefly in Stone 1997, as well as in the Measuring Speech Production series of videos produced by the Acoustical Society of America. The instruments described are all used for performing general phonetic measurements and are not specifically designed for studying coarticulation phenomena per se; but this material may perhaps be useful as a list of options for those previously unfamiliar with the methods introduced. Nevertheless, with their intrusiveness, high cost, and difficulty of access, not to mention other drawbacks, one wonders how many researchers will turn to these methods to study coarticulation. Chapter 7 addresses use of the spectrograph and other acoustic tools in studying coarticulatory phenomena. It is likely that most "ordinary" researchers will probably, in addition to their own introspection and observations, stick with more readily available and less intrusive acoustic tools such as the spectrograph and other speech analysis software now conveniently available for free download from many sources over the Internet. This chapter gives examples of how to do acoustic analysis of formant transitions, the stable portion of a vowel, stop release, fricative noise, nasals, liquids and glides, voicing and tone, and duration and intensity. This is a laudable beginning, but there is room for much more to be done in this area.

While this book is overall very tight in structure and rich in content, it is not by any means the do-all, end-all work on coarticulation. There are a number of areas not covered in this book that this reviewer would like to have seen and hopes to see in future works. One such area is: what really happens between words in running discourse? An attentive ESL teacher, for example, will find that most textbook explanations are inadequate for teaching English word *linking* to students. For example, is *to a* pronounced with a [w] glide between the vowels? Or a glottal stop? Or does the schwa have a zero initial? Or what factors are correlated with each of the possible variants? This line of inquiry overlaps with phonology, sociolinguistics, discourse analysis, and ESL pedagogy, but linking across word boundaries and syllables is certainly a core issue of coarticulation. The relation between prosodic style and coarticulation is another area ripe for further study. A good theory must be backed up by real-life practice, and phenomena encountered in actual practice, such as faulty pronunciation by foreign learners of a language, certainly suggest areas for additional and deeper theoretical work.

This book is a good beginning of more serious and concentrated work on coarticulatory phenomena than has previously been seen. Hopefully many more such studies will follow.

Readers are referred to two previous reviews of this book posted over the LINGUIST list, archived at:

<http://linguistlist.org/issues/12/12-490.html> and  
<http://linguistlist.org/issues/12/12-1877.html#1>.

## References

Stone, Maureen. 1999. Laboratory Techniques for Investigating Speech Articulation. *The*

*Handbook of Phonetic Sciences*. (William J. Hardcastle, and John Laver, eds.), 11-32. Oxford: Blackwell.

Stone, Maureen. 1993. *Measuring Speech Production*. Sewickley, PA: Acoustical Society of America. Instructional video set with accompanying text booklet.  
(see <http://asa.aip.org/videos.html>).