Tongue-jaw Coordination in German Vowel Production

Philip Hoole[1,2] and Barbara Kühnert[1,3]

[1]Institut für Phonetik, Munich, Germany;
[2]Clinical Neuropsychology Research Group, Munich
[3]Department of Linguistics, Cambridge, England

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BACKGROUND

Tongue-jaw coordination for vowel oppositions
("Height" and "Tenseness")

1. Wood (1975) "*The weakness of the tongue-arching model of vowel articulation*"

		Tongue in Jaw	
		Higher	Lower
Jaw	Higher	i	ɪ
	Lower	e	ɛ

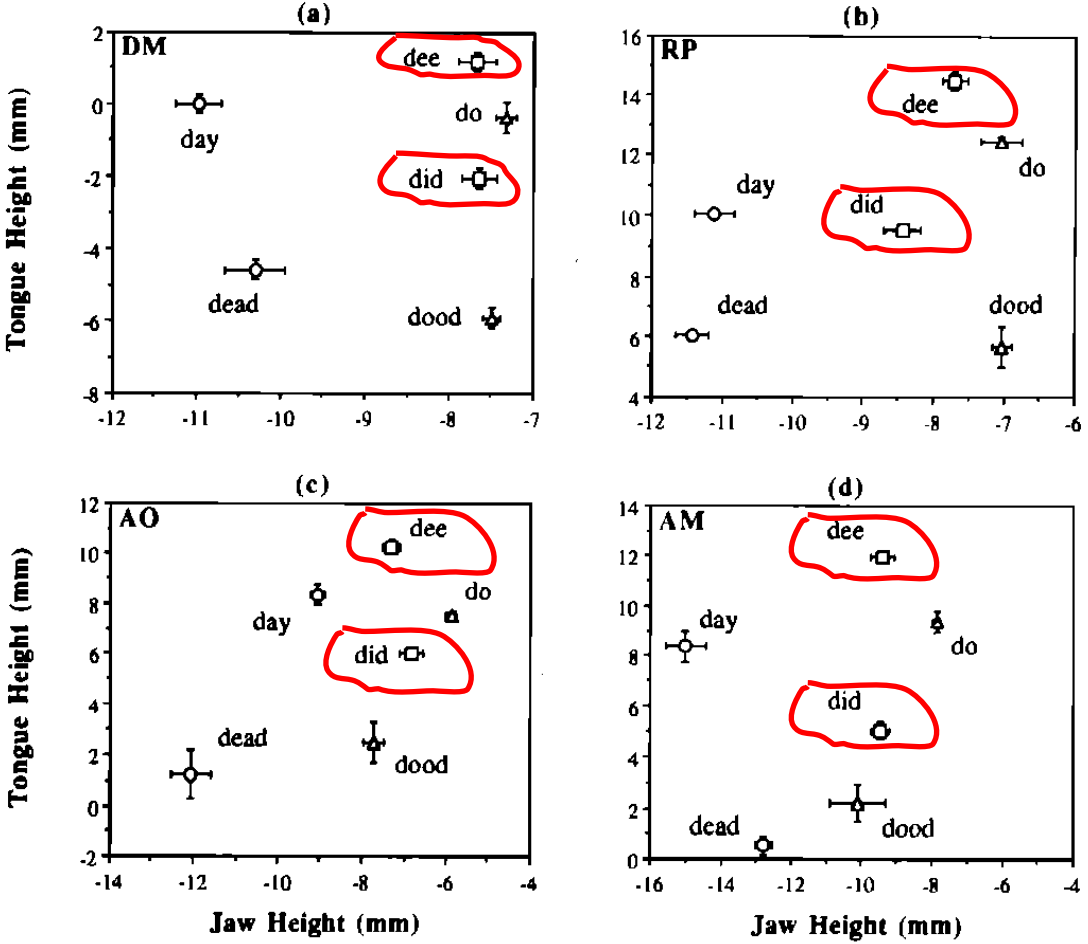
BACKGROUND (con't)

2. Ladefoged, P., De Clerk, J., Lindau, M. & Papçun, G. (1972) "*An auditory-motor theory of speech production*"

   Johnson K, Ladefoged, P. & Lindau, M. (1993) "*Individual differences in vowel production*"

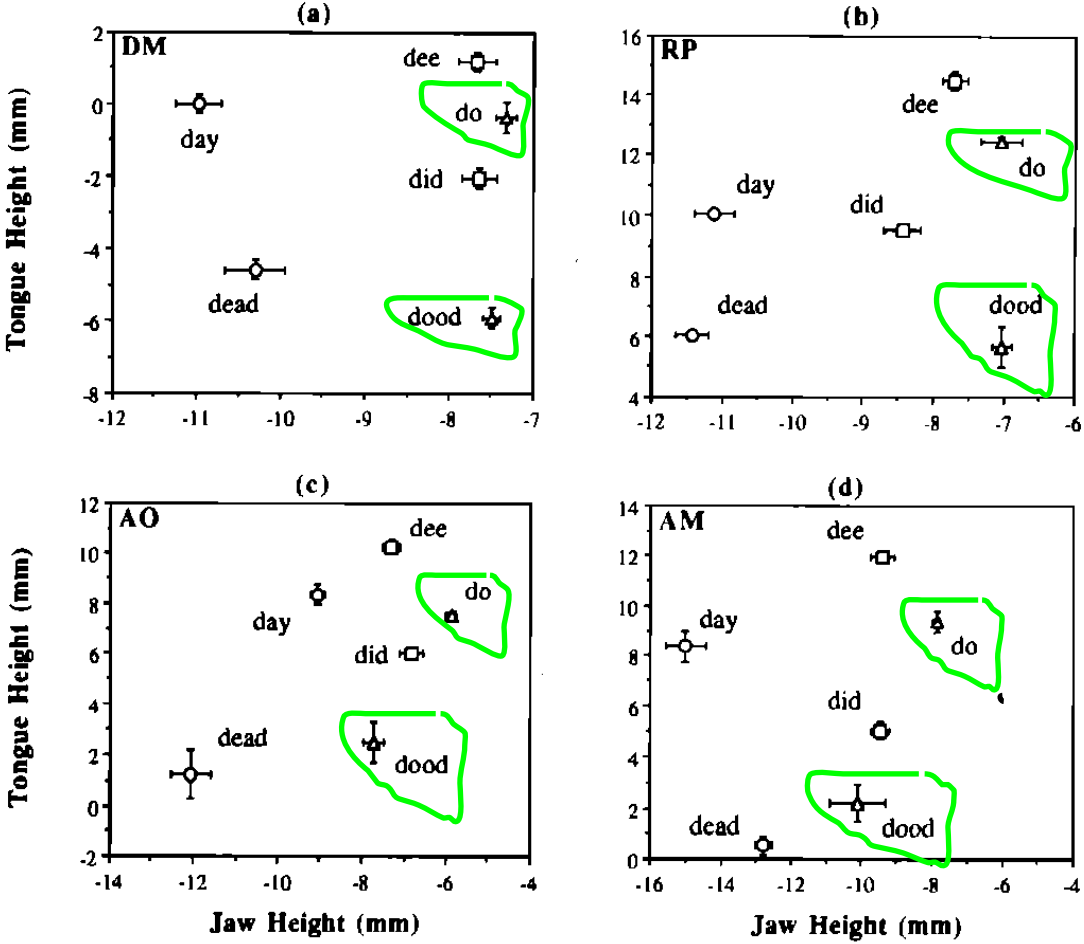
   Implication of individual differences: Phonetic goals specified in auditory terms.

   'The study of individual differences can help us identify the level at which the behaviors of different individuals are the "same".' Johnson et al. (1993)



Johnson et al., 1993

FIG. 4. The relationship of jaw height and tongue height in tense and lax vowels for four speakers in the /dVd/ environment. Error bars are standard deviation.



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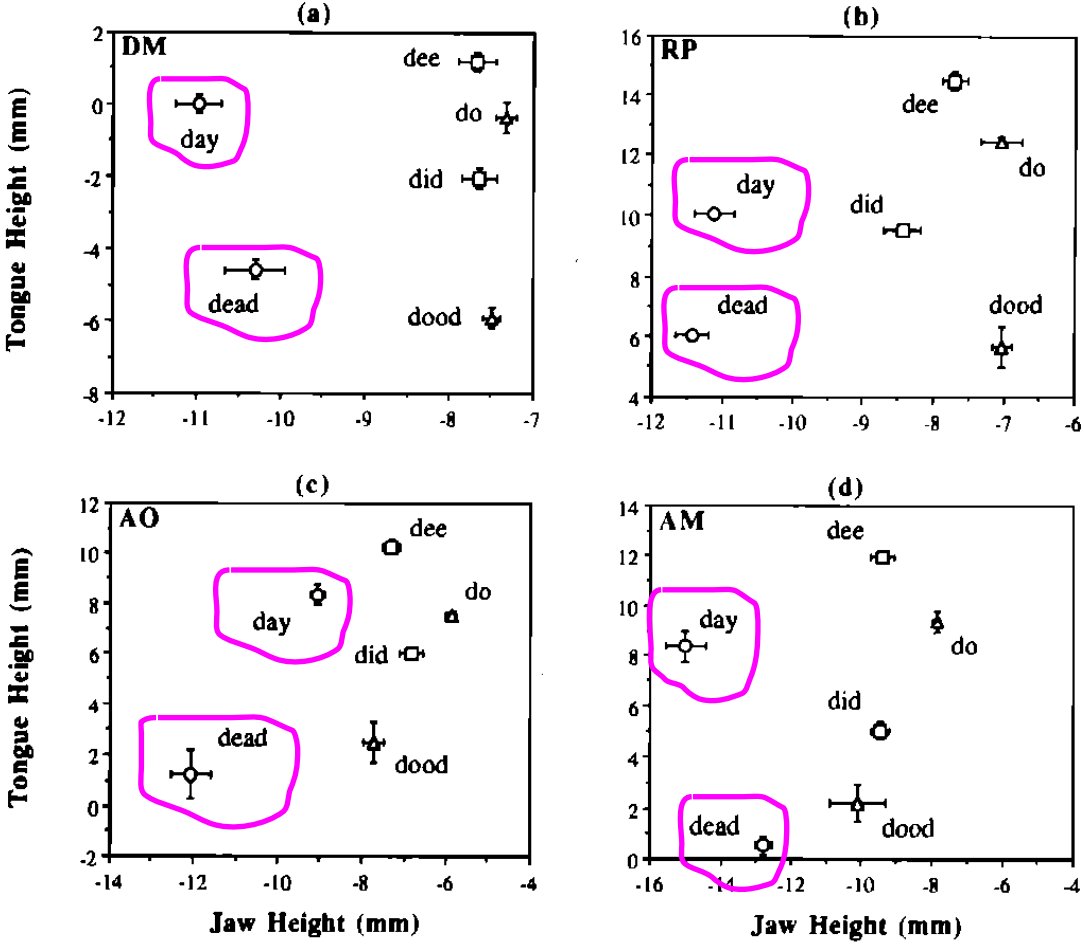


Johnson et al., 1993

FIG. 4. The relationship of jaw height and tongue height in tense and lax vowels for four speakers in the /dVd/ environment. Error bars are standard deviation.

SPECIFIC AIMS

1. How is tongue-jaw coordination in vowel production influenced by consonant context?

2. How does the rounded-unrounded opposition fit into the scheme of things?

3. Are similar "individual differences" found in German to those described for American English?

Material

8 German front vowels:

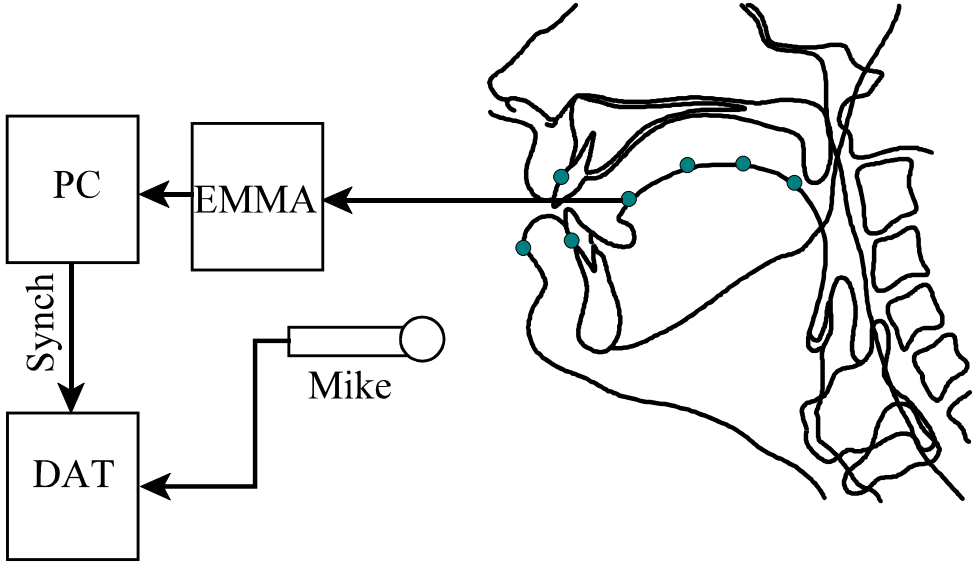
/ **iː ɪ yː ʏ eː ɛ øː œ** /

These form 4 pairs contrasting with respect to “Height”, “Tenseness” and “Rounding”.

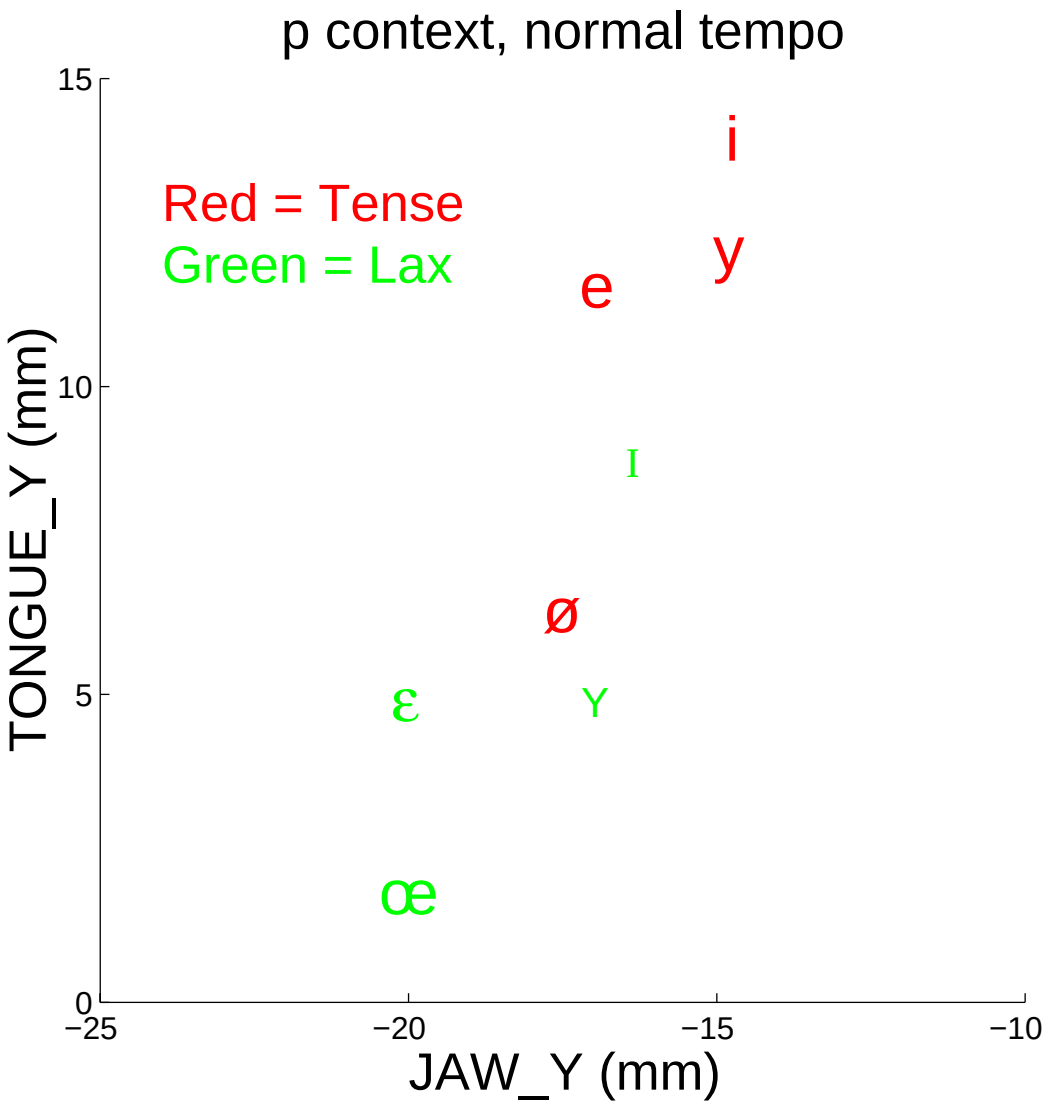
(/ ɛː ɑː a oː ɔ uː ʊ / were also recorded but are not analyzed here)

3 consonant contexts (pVp, tVt, kVk)
7 speakers
2 speech rates (separate recording sessions)
6 movement sensors (x/y coordinates): 4 on tongue, 1 on jaw, 1 on lower lip

Analyses presented here are based on the vertical positions of the jaw and the second tongue sensor from the front.



Typical setup for electromagnetic midsagittal articulography (EMMA)


p context, normal tempo
Red = Tense
Green = Lax
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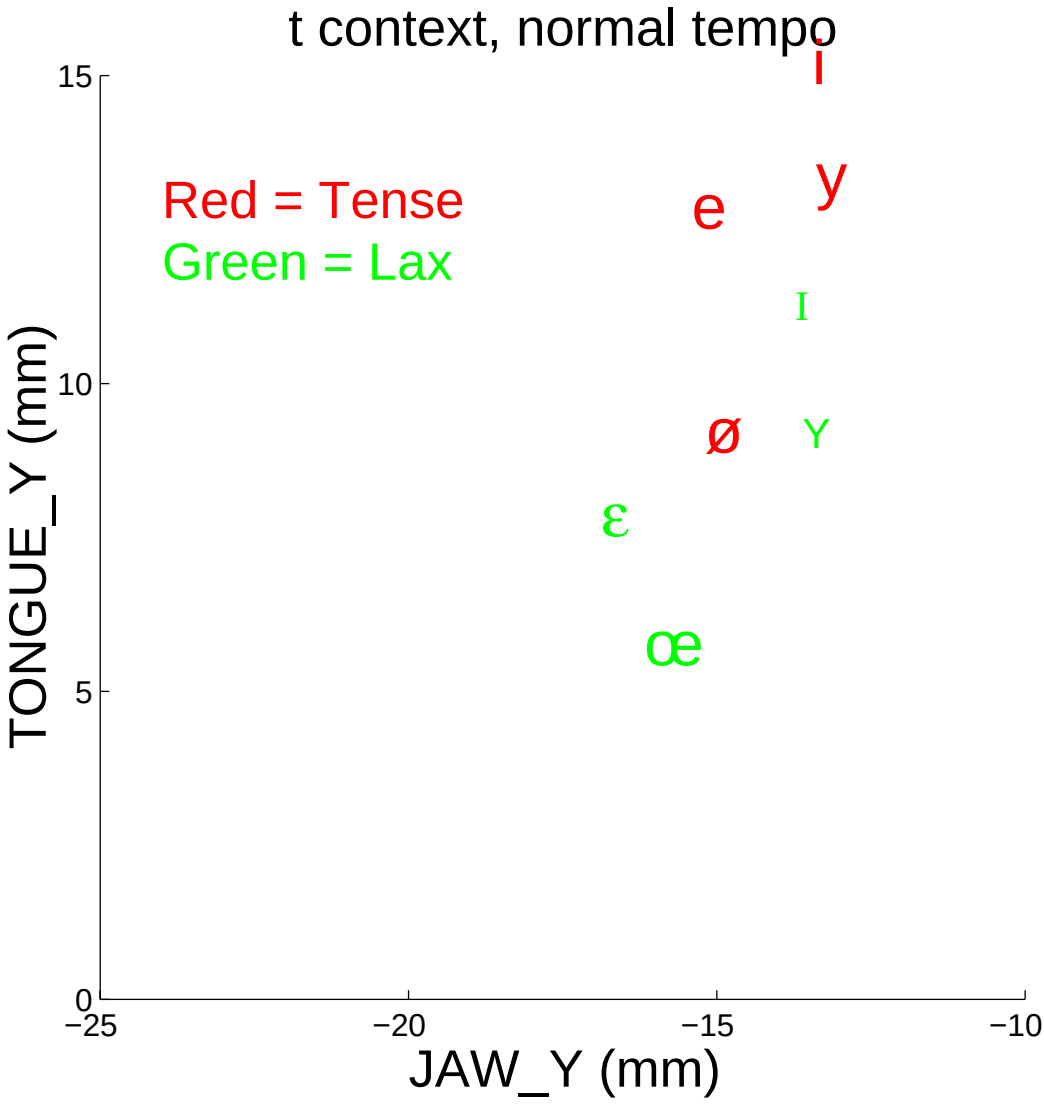
TONGUE_Y (mm)
JAW_Y (mm)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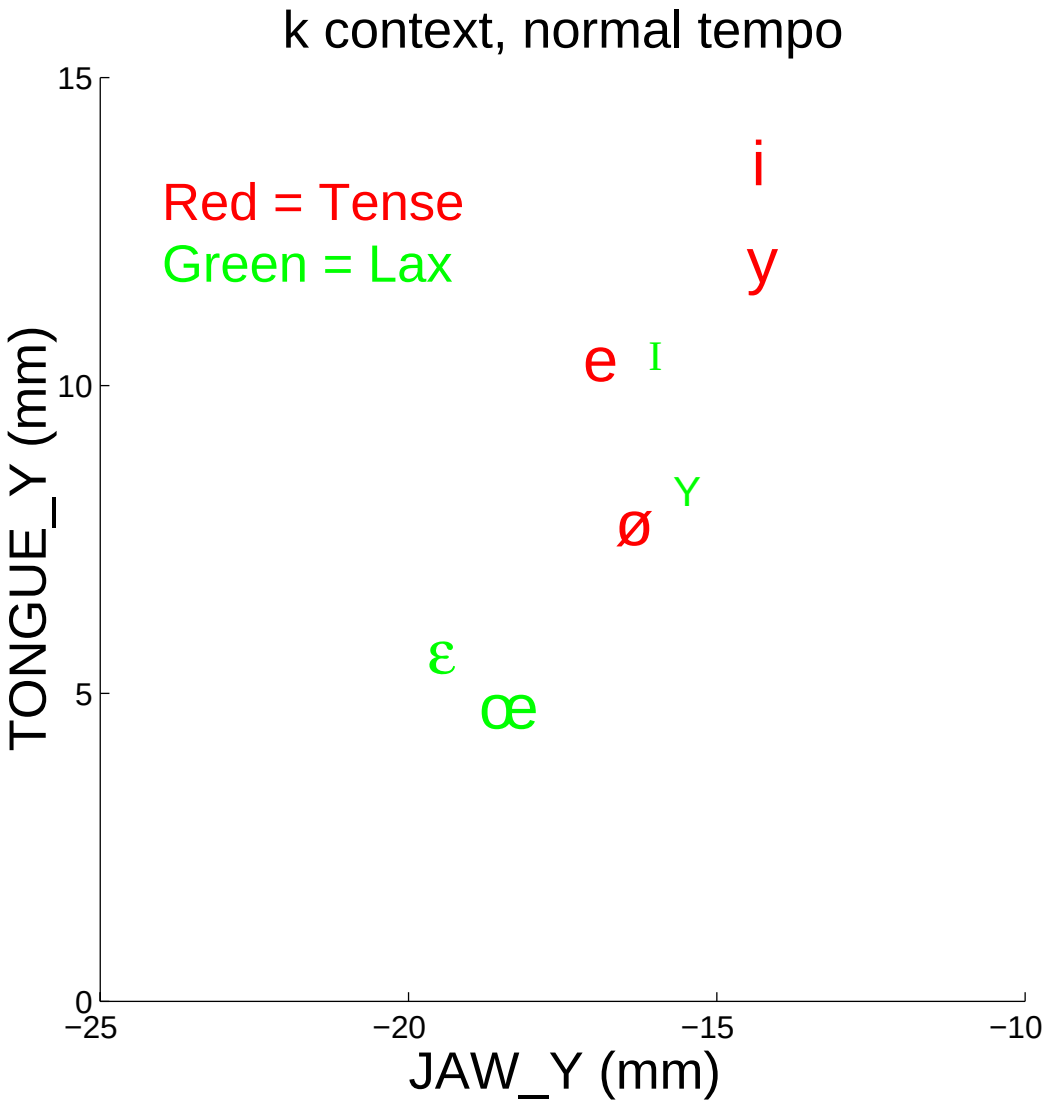
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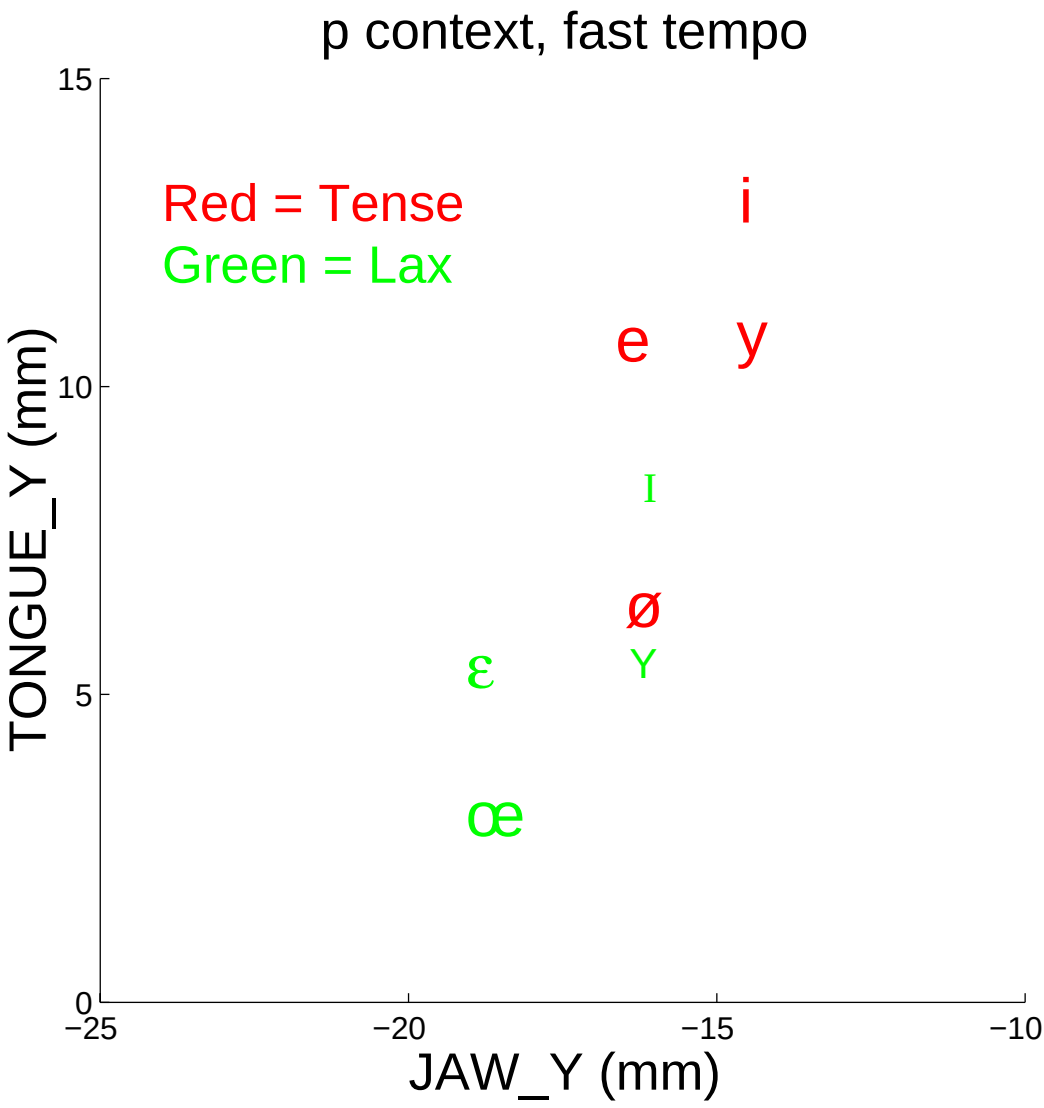
TONGUE_Y (mm)
JAW_Y (mm)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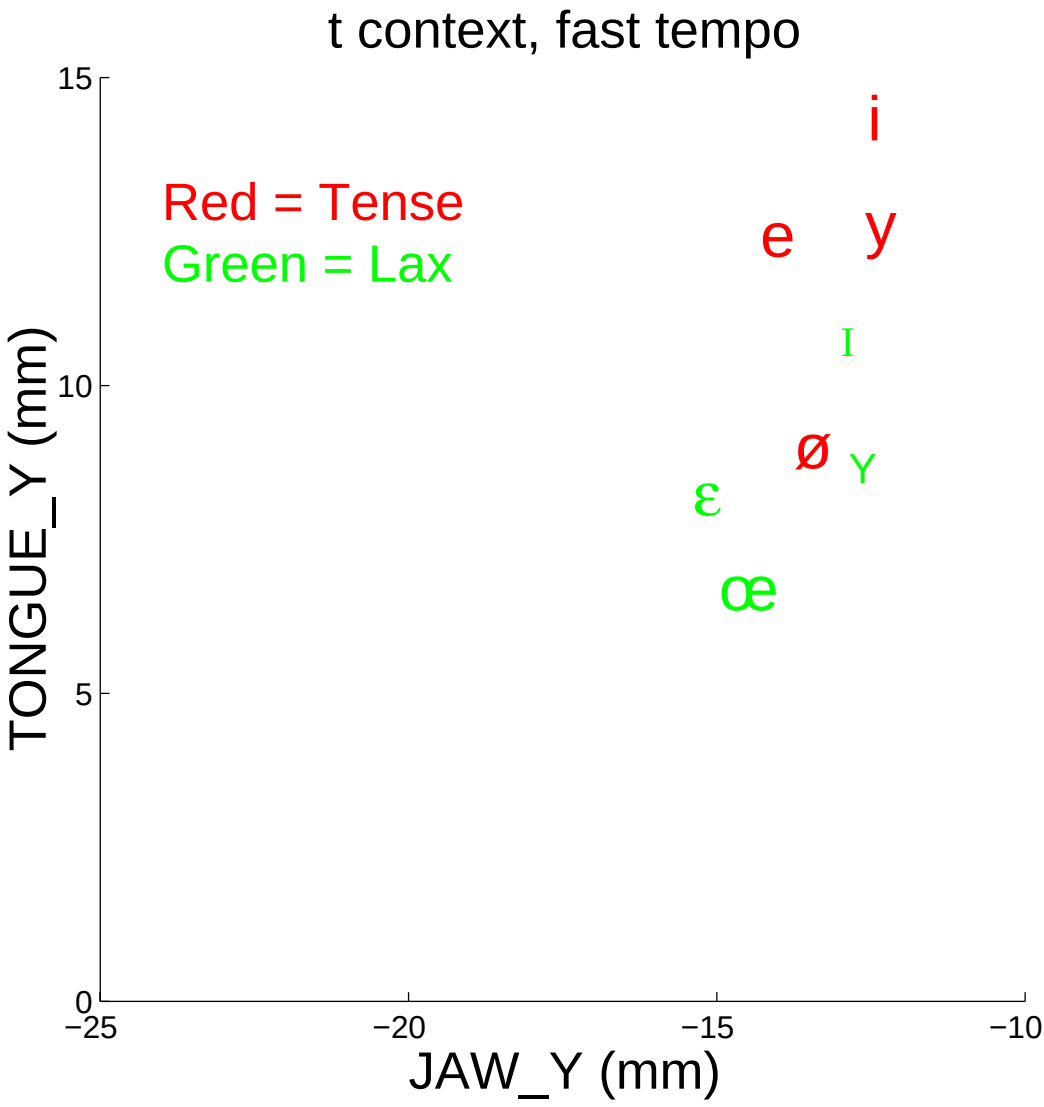
TONGUE_Y (mm)
JAW_Y (mm)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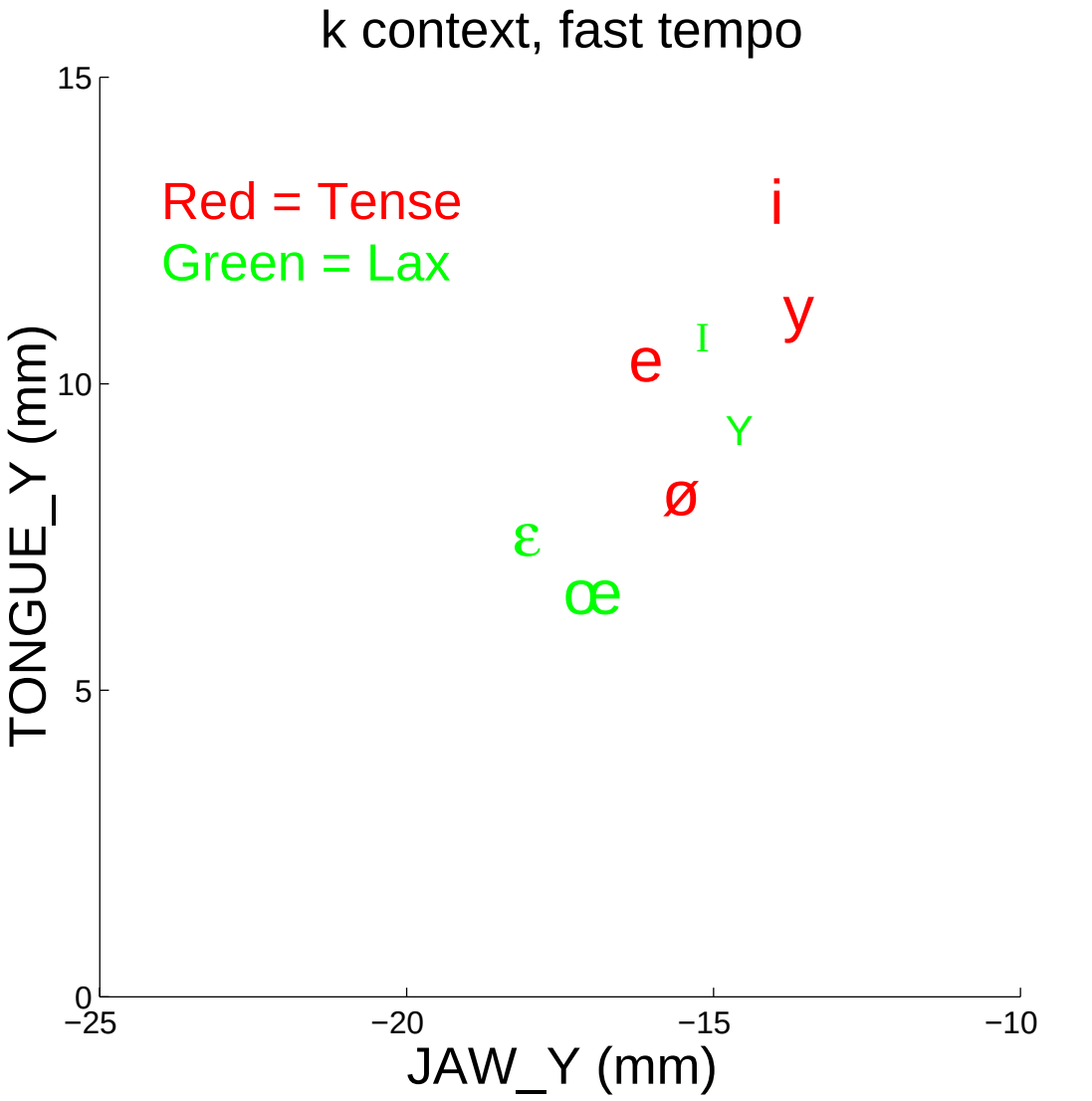
TONGUE_Y (mm)
JAW_Y (mm)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Red = Tense
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TONGUE_Y (mm)
JAW_Y (mm)

TONGUE-JAW SLOPE

Slope = Jaw difference/Tongue difference

Examples for the three oppositions:

1. Height

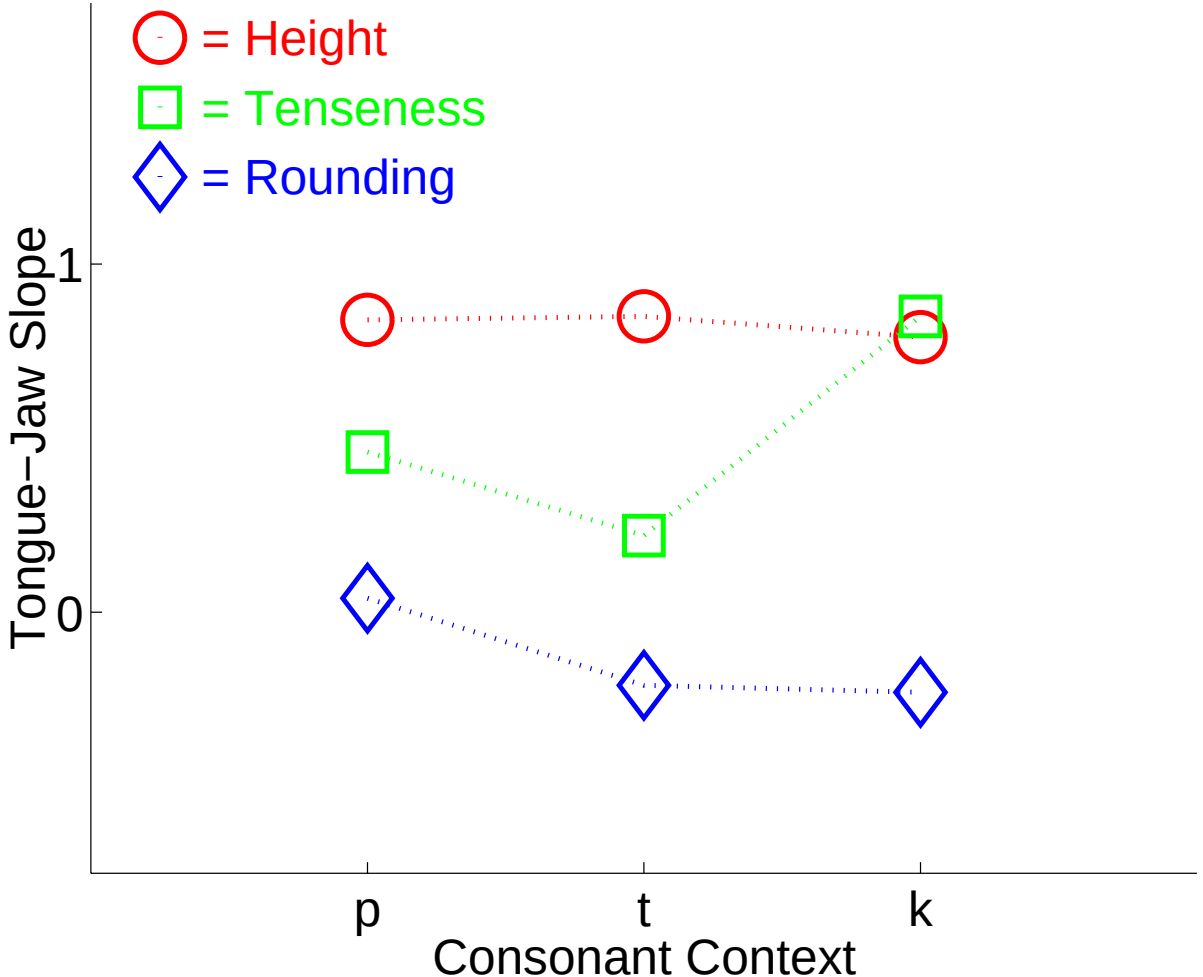
$$\textbf{Slope} = (i_{jaw} - e_{jaw}) / (i_{tongue} - e_{tongue})$$

2. Tenseness

$$\textbf{Slope} = (i_{jaw} - \mathrm{I}_{jaw}) / (i_{tongue} - \mathrm{I}_{tongue})$$

3. Rounding

$$\textbf{Slope} = (i_{jaw} - y_{jaw}) / (i_{tongue} - y_{tongue})$$


= Height
= Tenseness
= Rounding
Tongue–Jaw Slope
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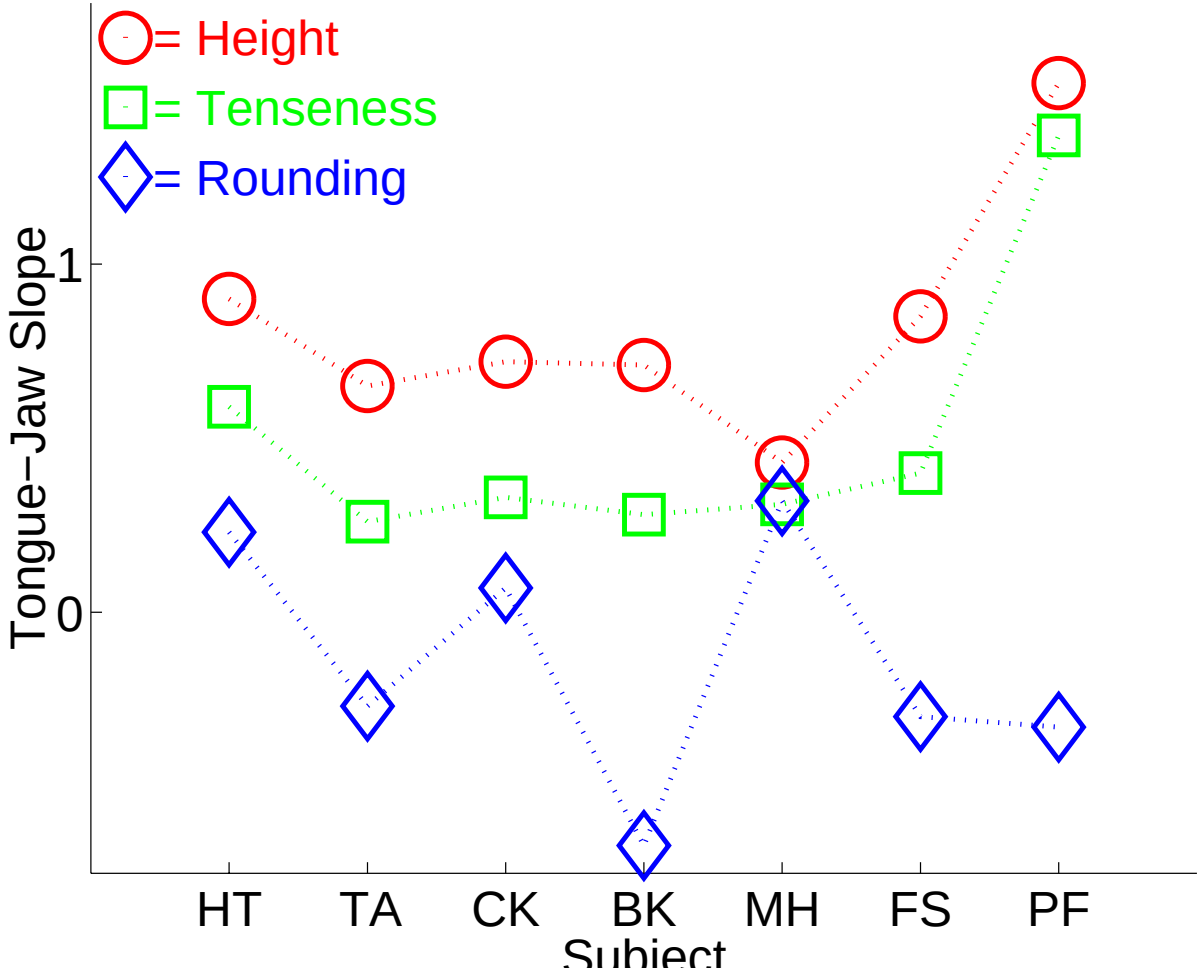
Consonant Context


= Height
= Tenseness
= Rounding
Tongue–Jaw Slope
1
0
HT
TA
CK
BK
MH
FS
PF
Subject

CONCLUSIONS

1. The oppositions “Height”, “Tenseness” and “Rounding”

    Relative amount of jaw involvment varies over a continuum from the rounding opposition (least) to the height opposition (most).
    The tenseness opposition lies between these two and is more strongly affected by consonantal context.

2. Speaker-specific patterns

    All speakers make the same *relative* use of the continuum.

    Does the fact that they may prefer different regions or different ranges of the continuum need to mean that they are employing different articulatory strategies?

What is the right articulatory level to examine for evidence of consistency?

Until we know the answer to this question it may be premature to abandon an articulatory formulation of phonetic goals in favour of an auditory one
(even if the latter may well turn out to be correct in the long run)

Final Remark

Why does German show more stable patterns of tongue-jaw coordination for the tense-lax opposition than English?

- Diphthongization much more important in English

- Articulatory system more constrained in German because of the additional rounding contrast