Age-related effects of prosodic prominence in vowel articulation

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BACKGROUND

PROMINENCE MARKING requires changes in intonation & articulation in intonational languages [1, 2]

- ***Highlighting strategies*** (hyperarticulation, sonority expansion, feature enhancement) within target syllables
- Adjustments are ***gradient*** & require a high amount of physical control

AGING can lead to deficits in

- ***Gross motor control*** (prolonged and smaller limb movements, reduction of maximum velocities, asymmetrical movement pattern [3, 4])
- ***Speech motor control*** (slower acoustic speech rate, slower tongue body movements, prolonged deceleration phases [5, 6])

AIM OF THE STUDY

How does aging affect prominence marking in the acoustic and articulatory dimension? We focus on vowel production.

METHOD

Participants: 4 older (65-68 years) and 4 younger speakers (20-30 years)

Recordings

- Electromagnetic Articulography (AG501)
- Girl names (e.g. Mali, Mila) in carrier sentence (V1 = /a, e, i, o, u/), stress on first syllable
- Animated game scenario to elicit prominence:
  - Unaccented (background)
  - Accented (broad focus, contrastive focus)

Acoustics: V1 duration, Vowel Articulation Index (VAI with formants F1 & F2 [7])

Articulation of vertical tongue body movement: gestural activation interval (GAI), maximum velocity (pVel), displacement, symmetry ratio (deceleration phase / acceleration phase)

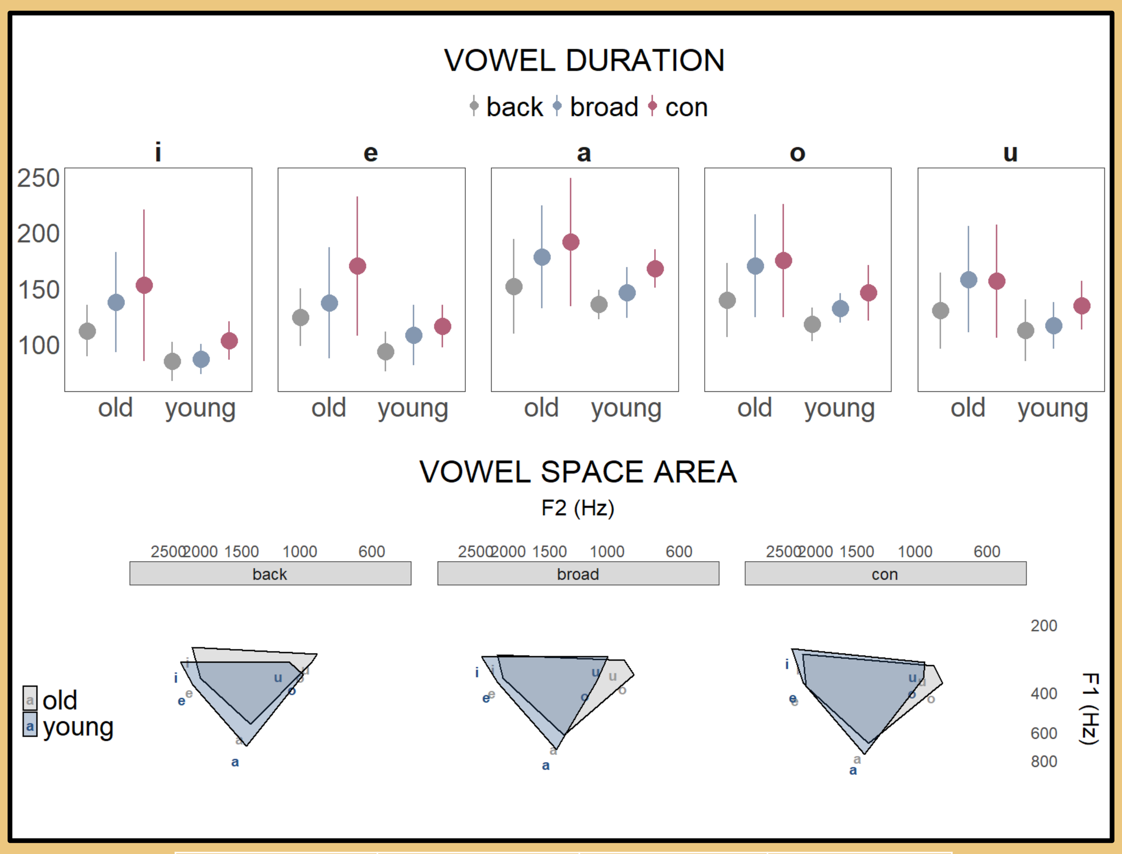
ACOUSTIC RESULTS

V1 duration increases in both groups: background<broad<contrastive

- Prominence modifications stronger for older group
- V1 durations (μ = 31ms) longer for older speakers

Spatial Vowel Index increases in both groups: background<broad<contrastive

- Prominence modifications stronger for younger group
- Vowel space more retracted in older speakers



Parameter	Focus	young	old
V1 duration (ms)	background	109 (26)	132 (35)
	broad	119 (28)	156 (49)
	contrastive	137 (30)	170 (58)
VAI	background	0.96 (0.11)	0.95 (0.08)
	broad	1.05 (0.11)	0.99 (0.08)
	contrastive	1.07 (0.08)	1.01 (0.06)

ARTICULATORY RESULTS

Gestural activation interval for vowel increases in both groups to signal prominence

- GAI (μ = 33ms) longer for older speakers

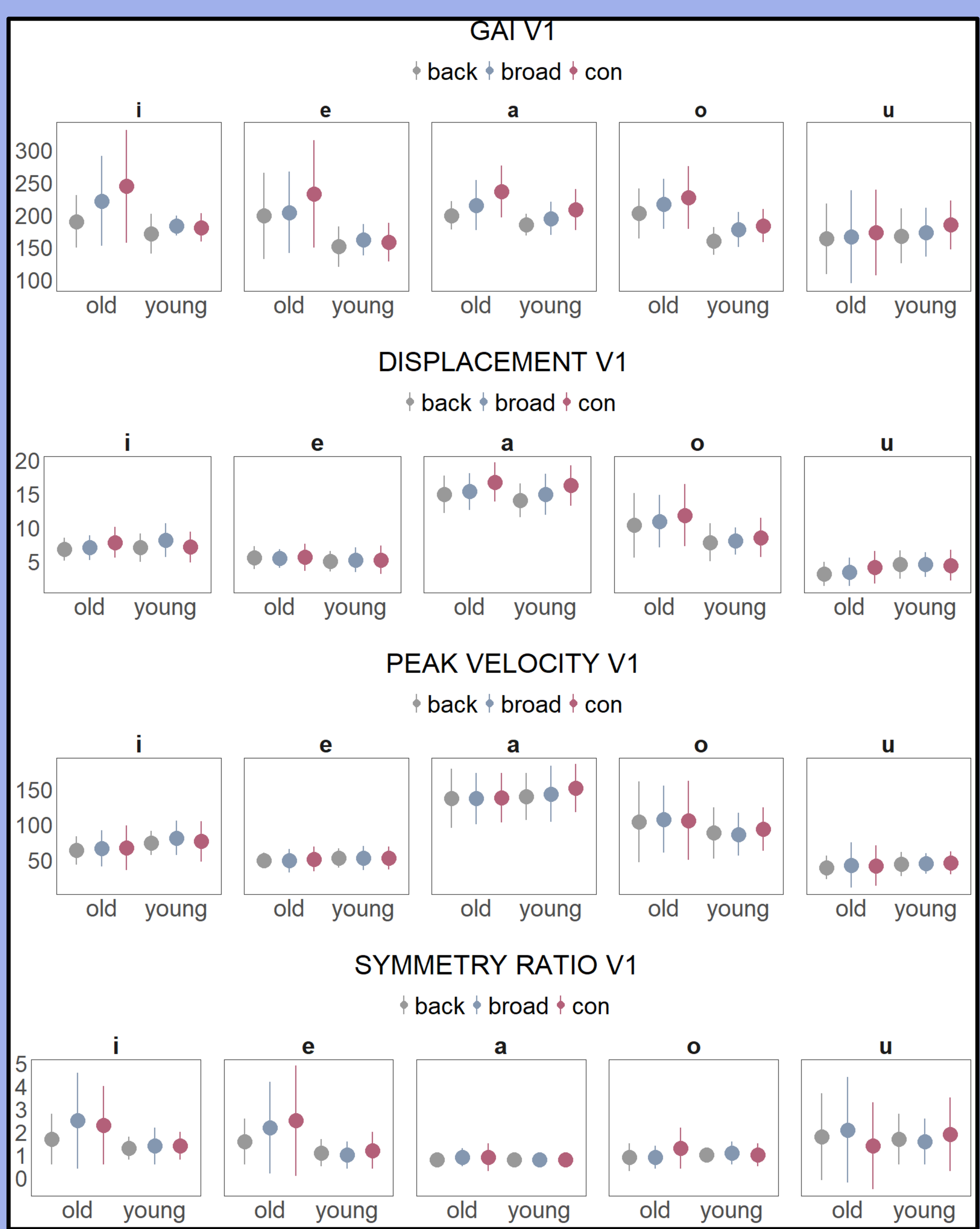
Symmetry ratio: No symmetrical increase in duration

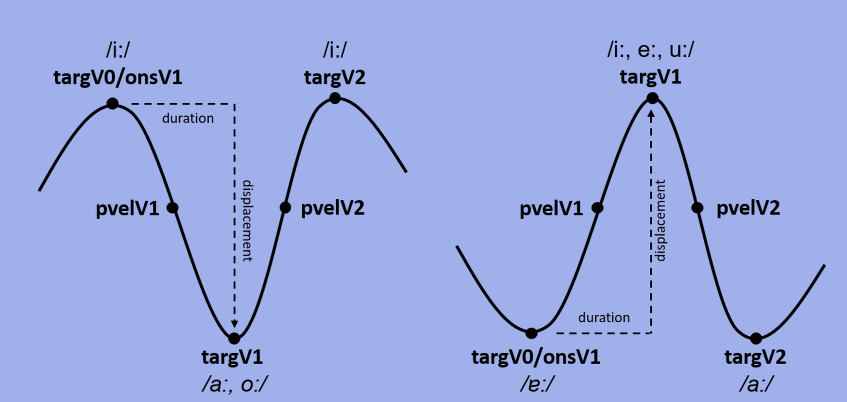
- Deceleration phase (interval from pvel to targ) increases under prominence in the older group, especially in high low vowels

Displacement more difficult to grasp:

- Increases in both groups for the low vowel /a/ (low degree of coarticulatory resistance)
- Increase for /o/ in older group (see acoustics results) revealing a more retracted vowel space

Maximum velocities are not affected in a systematic way.





Parameter	Focus	young	old
GAI (ms)	background	167 (31)	190 (48)
	broad	177 (29)	204 (60)
	contrastive	183 (33)	223 (70)
PVEL (mm/s)	background	80 (42)	79 (50)
	broad	80 (44)	80 (49)
	contrastive	84 (46)	83 (51)
DISPL (mm)	background	7.7 (4.1)	8.2 (5.1)
	broad	8.0 (4.3)	8.4 (4.9)
	contrastive	8.3 (4.9)	9.4 (5.5)
Symmetry (DEC/ACC)	background	1.2 (0.7)	1.4 (1.2)
	broad	1.2 (0.7)	1.7 (1.8)
	contrastive	1.2 (1.0)	1.7 (1.7)

DISCUSSION

Prominence relations are maintained in both groups

- Across accentuation (accented vs. unaccented)
- Within accentuation (broad vs. contrastive focus)

Groups differ in the way they use highlighting strategies

- Stronger temporal modifications for older speakers
- Achieved by prolongation of the deceleration phase

→ sonority expansion [8]

- Compensatory strategy for smaller vowel space?

Speech motor control reflects gross motor control

- Longer, smaller and asymmetrical movement patterns
- But not slower velocities

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