Age-related effects of prosodic prominence in vowel articulation

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Motivation: Our physical system is in a continuous status of fine-tuned adaptions to the communicative needs during speech. Prosody plays an essential role for conveying the meaning of an utterance, i.e. speakers use a series of modulations of their speech motor system to highlight information in the prosodic system [1,2]. Yet, physiological changes, e.g. due to age, can have an effect on the ability of balancing between the different adjustments within the speech motor system. Age-induced changes, such as loss of flexibility and muscular strength, can inter alia result in smaller and slowed down movements [3,4]. In this study, we investigate how older and younger speakers convey prosodic prominence in varying focus conditions by looking at the articulatory domain in the most sonorous proportion of accented and unaccented syllables.

Method: We carried out recordings from 20 older (10 f, 10 m; 65-80 years) and 20 younger (10 f, 10 m; 20-30 years) German speakers with an Electromagnetic Articulograph (AG 501). To control for segmental context, we alternated vowel height in the stressed syllable and the syllables immediately preceding and following the stressed syllable (e.g. $CV_0\#CV_1CV_2$ = /i-a-i). The target words were girl names (e.g. Mali, Mila), where *set A* contained /a:/or /o:/ in the stressed syllable, and *set B* /i:/, /e:/ or /u:/. Participants produced these words in three different focus conditions: background, broad focus and contrastive focus. Animated scenes with questions were used to elicit answers (adapted from [5]) with the target words in the different focus conditions, such as 'Der Opa hat der MILA gewunken' ('*The grandpa had waved to MILA'*). Articulatory data was annotated using the EMU-webAPP [6]. As articulatory variables for the vocalic tongue movement (see Figure 1), we computed the gestural activation interval (GAI), displacement, peak velocity and symmetry ratio (deceleration/acceleration). Furthermore, we computed the segmental duration and the vowel space area including the first two formants for every target vowel. We report preliminary results for 4 speakers per age group.

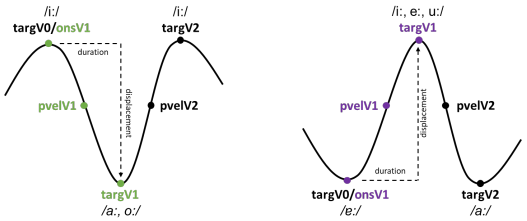

Figure 1: Landmarks for vocalic gesture 'set A' (left) and 'set B' (right).

Results: Figure 2 shows the results for the temporal and spatial articulatory variables, separately for all vowels (i, e, a, o, u), focus structures (background, broad focus, contrastive focus) and speaker groups (young, old). Both speaker groups increase the *GAI* for the vocalic movement to signal prominence. Interestingly, older speakers show longer durations for the GAI than younger ones. This pattern can also be observed in acoustic vowel durations. However, the movement durations are not modified in a symmetrical way. Especially in the production of high vowels, the deceleration phase (interval from pvel to targ) – and not the acceleration phase (interval from onset to pvel) – increases under prominence leading to higher values in the *symmetry ratio* [7]. However, *peak velocities* are not affected by aging. The strategies in the spatial dimension are more difficult to grasp. Both groups increase the displacement for the vowel /a:/ to signal prominence. However, the back vowel /o:/ is hyperarticulated in the older group. This behavior is better understood when comparing the values with the acoustic vowel space; the latter one reveals a smaller and more retracted vowel space for the older speakers.

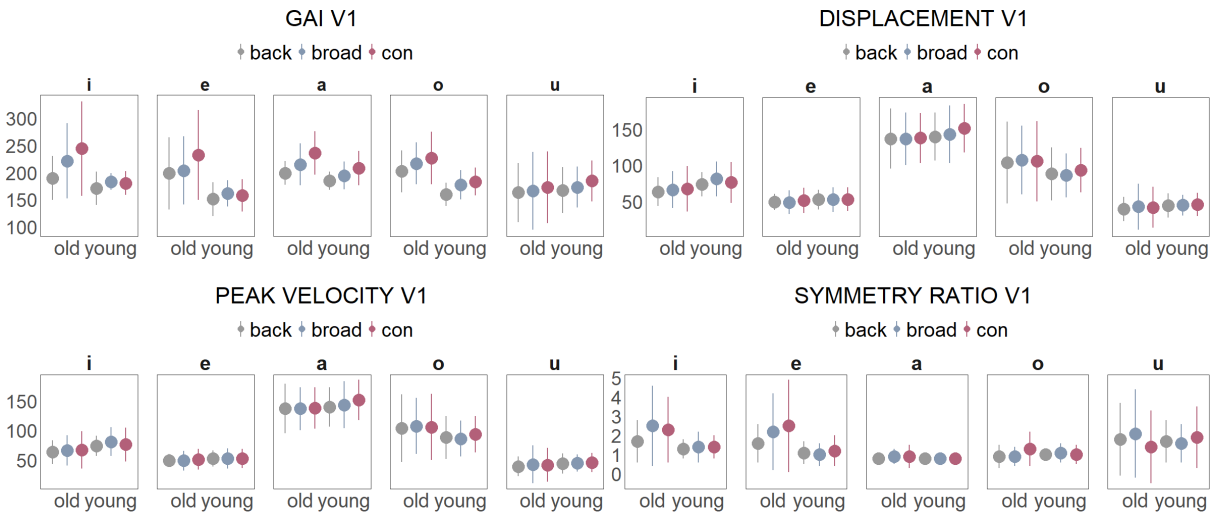

Figure 2: Articulatory variables for the vocalic movement of the tongue body.

Conclusion: Both speaker groups maintain prominence relations by adjustments of the supra-laryngeal system. This is the case across accentuation (accented vs. unaccented syllables) as well as within accentuation (syllables in broad vs. contrastive focus). However, the groups differ in the way they use highlighting strategies, i.e. older speakers show stronger modifications in the temporal domain than younger speakers, leading to an increase of sonority in the perceptual domain [8]. Analogously to effects of aging on gross motor control (limb coordination) reported in the literature [9], our data reveal longer and asymmetrical movement patterns across all focus conditions. However, an overall slowing down of the maximum velocities of the tongue body movement cannot be confirmed in our data.

References:

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