Modifications of tongue body kinematics as a focus marking strategy in German

Lena Pagel, Simon Roessig & Doris Mücke
IfL – Phonetik, University of Cologne

A growing body of research has shown that focus marking in German involves both intonational and articulatory modifications [1-3]. The latter can be subsumed under the term prosodic strengthening [4] which describes a spatio-temporal expansion of vocal tract gestures. This phenomenon can be achieved by two main strategies, namely *sonority expansion* [5] and *localised hyperarticulation* [6]. A greater opening of the vocal tract, as in the case of sonority expansion, allows for more acoustic energy to radiate from the mouth. A hyperarticulated vocalic target results in a more distinct vowel production. Both strategies can be employed to enhance prominence of a word or syllable. Crucially, there is evidence in the literature describing highlighting strategies not only from unaccented to accented entities (referred to as 'across-accentuation' in the present work) [7]. Rather, differences can also be observed between several focus types in which the respective entity is accented (referred to as 'within-accentuation'), suggesting that articulatory cues encode several focus conditions with varying degrees of prominence [8]. This study aims to contribute a comprehensive investigation of tongue body kinematics in German, analysing prosodic strengthening strategies in different vowel types both across- and within-accentuation.

We recorded 27 native speakers using Electromagnetic Articulography (AG501). Subjects were engaged in an interactive question-answer task in which they produced 20 target words containing the vowel /a/ or /o/ in carrier sentences. Four focus conditions were elicited by different types of questions: The target words could either be in the background (unaccented) or in broad, narrow, or contrastive focus (accented), which made it possible to compare the realisation of target words across-accentuation as well as within-accentuation. In our analysis, we investigated tongue body movements during the vowels /a/ and /o/ on the vertical and horizontal movement dimension. Since local turning points in the tongue trajectories were often difficult to identify for /o/ due to contextual variation, for a positional analysis, we calculated the mean tongue body position within the first 50% of the vowels /a/ and /o/. This portion is a correlate of the expression of prominence in the stressed syllable, as it captures the movement towards the vocalic target (cf. figure 1). The averaged position values were compared between vowels, movement dimensions and focus types. In addition, we labelled articulatory landmarks by hand for the vowel /a/ in order to analyse gesture duration and peak velocity.

The results are illustrated in figure 2. On the vertical dimension (cf. figure 2a), we can observe for both vowels that the mean tongue position is continuously lowered between all focus conditions, i.e. across-accentuation from background to broad as well as within-accentuation from broad to narrow and from narrow to contrastive focus. An investigation of the horizontal dimension (cf. figure 2b) exhibits no clear systematic variation for the central vowel /a/, but an incrementally retracted tongue body between all focus conditions for the back vowel /o/. Additionally, the analyses of gesture duration and peak velocity for /a/ reveal tendencies towards gradient modifications in the direction of longer and faster tongue movements between all focus types.

The present study has two main implications. First, the results provide further evidence for the two aforementioned strategies of prosodic strengthening. The tongue body is incrementally lowered in both vowels, allowing for a more open vocal tract and therefore for *sonority expansion*. Furthermore, the gradient lowering of the tongue in the low vowel /a/, as well as its retraction in the back vowel /o/ can be interpreted as cases of *localised hyperarticulation*. The second major finding is that the tongue position is not only varied across-accentuation, but also continuously within-accentuation, which is further supported by results on gesture duration and peak velocity. Hence, our study demonstrates that speakers of German use fine-grained modifications of supra-laryngeal articulation to enhance prosodic prominence in a gradient manner and beyond accentuation.

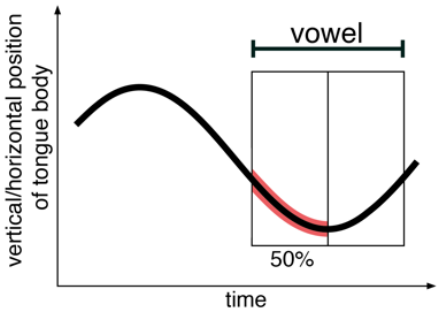

Figure 1: Schema of tongue body position measure within 50% vowel window

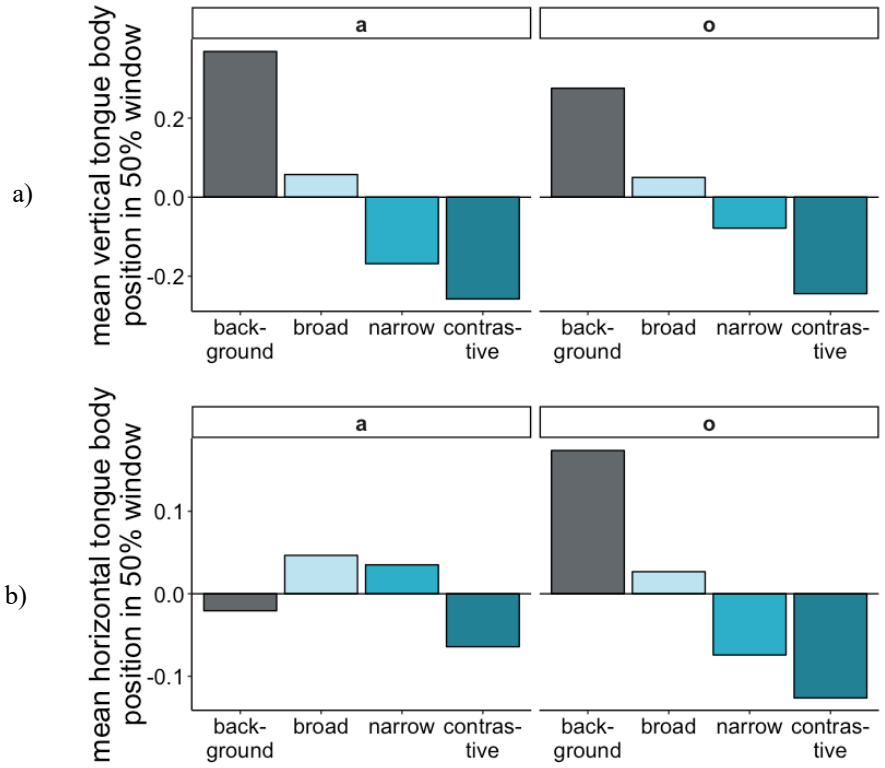

Figure 2: Results for mean tongue body positions (z-score) for vowels /a/ and /o/ in all focus conditions on a) the vertical and b) the horizontal movement dimension

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