

Does subglottal pressure increase under contrastive focus?

Indirect evidence using a new experimental set-up

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Theories of the control of breathing in speech production, and in particular of subglottal pressure, range from a general, very broad control to a more specific, local control. The former view is taken by Lieberman (1967) who assigned a major role to subglottal pressure in sentence declination. The latter view is taken by Ladefoged and Loeb (2009) who propose an involvement of subglottal pressure in the production of prominent (stressed) syllables. Both views may not be exclusive, since physiologically a slowly adapting mechanism and a fast voluntary control may be possible (Aleksandrova & Breslav, 2009).

There are several reasons why subglottal pressure has not been investigated intensively across many speakers. One is that quite invasive methods have traditionally been used to record subglottal pressure in human subjects (e.g. tracheal puncture; swallowing a balloon into the oesophagus). The method we applied is much more comfortable for the subject and allows a larger sample and longer recordings. It is based on the assumption that intraoral pressure quickly rises to subglottal pressure when the vocal tract is completely closed and the glottis is open (Löfqvist et al., 1982) as in voiceless aspirated stops. The pressure equalization usually corresponds to a plateau phase in the intraoral pressure profile. Based on this assumption we have established a new experimental design combining the recording of respiratory activity (as abdominal and thoracic volume changes using RespiTrace) and intraoral pressure (by means of a piezoresistive pressure sensor, see Fuchs & Koenig, 2009 for further details). Twelve German native speakers were recorded. Our speech material consisted of t#t sequences with contrastive focus on the left side (t#t), on the right side (t#t) and no focus (t#t, reference condition). In casual speech, speakers commonly realize t#t sequences as one alveolar stop with a relatively long closure period. We included 5 different targets in the three different focus conditions, for example (right focus condition): “Er malt Tanja, aber nicht Sonja“ (He paints Tanja, but not Sonja). Sentences were repeated 5 times (n=900, 5 targets* 3 focus conditions * 5 repetitions * 12 speakers). We hypothesized that if focus affects subglottal pressure, we would find traces of higher intraoral pressure in the focused location. Thus, we predict that if the focus is realized on the left, intraoral pressure should be higher on this side in comparison to the reference condition. If focus occurs on the right side of the word boundary, we expect an increase in pressure at this location. All acoustic data were labelled and segmental durations calculated. In the intraoral pressure data, we analyzed the velocity of the initial rise, the slope of the following plateau phase as well as the velocity of the pressure drop. Results for intraoral pressure in the left focus condition provide evidence that P_{io} rises more quickly than in any other focus condition, shows the shallowest slope and decreases slowly. Results for the right focus position show a slower initial pressure rise, a steep slope and a quick pressure drop. In a next step we will look at differences in breathing activity. Based on these findings we suggest that subglottal pressure is involved in production of contrastive focus.

References:

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