Speech rate in cleft lip and palate speakers with compensatory articulation

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Introduction
According to an estimation by Stengelhofen (1989), 38% of all subjects born with a cleft lip and palate (CLP) will have persistent speech defects which will require long term speech therapy. Apart from hypernasal resonance disorders, compensatory articulatory patterns are the most frequent and salient feature of CLP speech. Trost (1981) distinguishes two types of sound errors in CLP articulation: while class I errors are inherently correct speech gestures which are resulting in distorted sounds because of structural anomalies, class II errors are active substitutions of sounds which a CLP speakers finds difficult or impossible to achieve. Especially backed articulation patterns with glottal, pharyngeal and nasal sound substitutions have been described (Wulff and Wulff, 1981). In an extension and elaboration of Trost’s (1981) system, Harding and Grunwell (1996, 1998) group CLP speech errors into passive undershooting gestures and active compensatory articulation patterns. Among the active substitutions described by Trost (1981) we find sounds such as the palatal fricative /ç/, the velar fricative /x/, and the glottal stop /ʔ/ all of which are illegal in the sound system of American English. However, /ç/ and /x/ are perfectly normal sounds of German while /ʔ/ is a frequent sound in varieties of British English. What has to be considered an illegal substitution in one language may, in a different context, be an acceptable sound of another language. The question arises, thus, if a compensatory articulatory gesture will also have an effect on quantitative aspects of speech such as speech rate. For instance, both a normal speaker of British English and a German CLP subject may substitute, in connected speech, glottal stops for voiceless alveolar plosives and what is a dialectal trademark of the former is an indication for a defective phonetic system in the latter. Will the CLP subject speak with the same ease and speed or will compensatory articulation slow him or her down?

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Methods

Subjects
During the course of a month, 146 subjects with CLP were examined. Median of age was 17.0 years (SD 7.33 years) with a range from 10 to 66 years for 98 male and 48 female subjects. 18 subjects had isolated cleft lip and alveolus, 92 subjects had complete unilateral CLP, 35 subjects had bilateral CLP, and one subject had a combination of a cleft lip and alveolus and a submucous cleft palate. All subjects had undergone alveolar bone graft and were presenting for a follow-up.

Materials and procedures
Perceptual evaluation was made from samples of spontaneous speech (approximately one minute in duration) which were recorded to DAT. During a semi-standardized interview the subjects summarized the last movie they had seen and verbalized a four-picture cartoon story. The speech samples were rated by the first author on two separate occasions using a rating form with 18 scales which is described in more detail in Bressmann (1999a) and Bressmann et al. (1999b). Articulation was rated on a four-point rating scale (ranging from normal to severe) which was similar to that described in Mühl (1983). Hypervasality was also rated on a four-point scale.

After the interview, all subjects were recorded with the two modules ‘rapid syllable repetition’ and ‘sentence repetition’ from the Modular Diagnostic System (MODIAS), developed by Merk and Ziegler (1999). In the module ‘rapid syllable repetition’, subjects were required to repeat six different sets of CV-syllables (/baba/, /dada/, /gaga/, /bada/, /nana/, /dana/), while in the module ‘sentence repetition’ subjects were required to say six sentences of the form ‘Ute kann die ____ bekommen’ (Ute can get the ____) with six different target words (Katze, Polster, Brettter, Pflanze, Kränze, Tulpe). The MODIAS automatically extracts amplitude models and identifies syllable centers and boundaries (figure 1). The segmentation can be corrected manually, if necessary. The mean syllable duration and the number of syllables per seconds are then calculated from the segmented signal.

Results
Median intra-rater reliability was 91.3% across all scales which was considered to indicate a sufficiently high reliability for the purposes of this study. Moderate to severe articulatory disorders were found in 30 patients (20.5%), mild disorders were found in 29 patients (19.9%), and 87 patients (59.6%) had normal articulation. Moderate to severe hypervasality was found in 30 subjects (32.2%), mild hypervasality in 52 subjects (35.6%) and normal nasal resonance in 47 subjects (32.2%).

Three subject groups were formed for analysis: group 1 patients were those with normal articulation, group 2 subjects were those with mild articulation disorders and group 3 patients were those with moderate to severe articulation disorders.

For the rapid syllable repetition task, the mean repetition rates were 6.17Hz (SD 0.6 Hz) for group 1, 6.16Hz (SD 0.62 Hz) for group 2 and 5.68Hz (SD 0.52 Hz) for group 3. The ANOVA showed a significant main effect ($F<0.001$) and subsequent t-tests yielded significant differences between groups 1 and 3 ($p<0.001$) and groups...
Figure 1. *Segmented MODIAS amplitude model of the sentence ‘Ute kann die Kränze bekommen’, spoken by a cleft palate subject with a severe articulation disorder as /u ə ðən ˈken-ə ʰə ʰæmən/.

2 and 3 ($p < 0.005$), but not between groups 1 and 2. When subjects were grouped by their hypernasality ratings, no significant main effects were found in the ANOVA.

For the sentence repetition task, mean sentence duration was 1669 ms (SD 259 ms) for group 1, 1691 ms (SD 172 ms) for group 2 and 1845 ms (SD 259 ms) for group 3. The ANOVA showed a significant main effect ($F < 0.001$) and subsequent $t$-tests yielded significant differences between groups 1 and 3 ($p < 0.005$) and groups 2 and 3 ($p < 0.02$), but not between groups 1 and 2. Similar patterns were obtained for the start times and syllable durations of the two syllables of the target word. A more detailed account of the results can be found in Bressmann (1999a) and Bressmann et al. (1999b).

**Discussion**

According to the results from this study, compensatory articulation does have a detrimental effect on the speed of articulation in rapid syllable repetition and sentence repetition. The same pattern holds across the tasks: group 3 subjects with moderate to severe articulation disorders differ significantly from the other two groups. When subjects are grouped according to the level of hypernasality for the syllable repetition task, no significant differences between the groups are obtained. This stresses the point made by other authors that resonance and articulation have to be regarded as separate subsystems in cleft palate speech (McWiliams et al. 1990). However, it should also be noted that while the differences in speech rate are significant they are not obvious from a perceptual point of view. None of the group 3 subjects would have to be considered severely dysfluent.
Conclusion

The results from the syllable and sentence repetition tasks demonstrate that compensatory articulation in cleft palate slows patients down even though we find some of the compensatory speech sounds in other languages of the world. A glottal stop does not quite seem to be a glottal stop when produced by a CLP speaker whose language does not allow this phoneme as a substitute for, say, a /t/ or a /k/ (such as German). It would be an interesting question for future research to examine if the acquisition of the correct sound through speech therapy would also have a positive effect on the speech rate.

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References


