Laryngeal–oral coordination in mixed-voicing clusters

Philip Hoole, Lasse Bombien*

Institute of Phonetics and Speech Processing, Schellingstraße 3, D-80799 Munich, Germany

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Laryngeal–oral coordination was studied in German clusters of voiceless fricative or plosive plus /l/ or /r/ by means of videofiberendoscopy and transillumination. In all cases voice onset time (i.e. the time from release of C1 to onset of voicing) was longer in the clusters compared to the single fricative or plosive controls. However, the coordination patterns leading to this consistent acoustic effect were quite varied, ranging from a passive effect of aerodynamic conditions at release of C1, via shortening of C1 with constant glottal gesture, to enhancement of the glottal gesture. Active reorganization was particularly clear in the rhotic clusters. For the single consonants the duration of the glottal gesture was quite constant over place of articulation but occlusion duration varied systematically. Accordingly, for both clusters and singletons peak glottal opening did not keep a constant timing relationship to landmarks in the oral occlusion of C1. The above findings were robustly present over a range of prosodic conditions. Prosodic strengthening itself had a particularly clear influence on the magnitude of the devoicing gesture.

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1. Introduction

This paper will be concerned with laryngeal–oral coordination in syllable-initial clusters of German consisting of a voiceless element (plosive or fricative), followed by a sonorant (/l/ or /r/). Our basic contention is that such sound sequences can be potentially very useful for highlighting the gaps in our knowledge about the principles underlying interarticulatory coordination (just as much as the more frequently investigated purely voiceless clusters; e.g. Löfqvist & Yoshioka, 1980; Ridouane, Fuchs, & Hoole, 2006; Yoshioka, Löfqvist, & Hirose, 1981). Let us assume as the most basic hypothesis that in both a singleton onset such as /p/ as well as in a cluster onset such as /pl/ the devoicing gesture is organized with respect to the underlyingly voiceless segment /p/. The addition of /l/ to the onset should not then have any effect on the timing of landmarks in the glottal gesture relative to those in the oral gesture of the /p/. Such a scenario would account perfectly well for the well-known substantial devoicing of, for example, /l/ in /pl/ and /r/ in /pr/ in languages such as English and German as a simple coarticulatory process, given that the laryngeal–oral timing pattern for syllable-initial /p/ involves peak glottal opening located close to the release of the oral occlusion.1 As we will see below, this basic scenario is actually not well supported by currently available findings. There is even some support for radically different patterns, for example that addition of an underlyingly voiced sonorant to an otherwise voiceless syllable onset can lead to an increase in the magnitude of the glottal gesture. Thus, the fundamental motivation for our own investigation is that we are currently ignorant about how the laryngeal–oral coordination relations should be formulated, and that mixed-voicing syllable onsets have interesting implications for the level of the syllabic hierarchy at which the devoicing gesture is organized.

In the following paragraphs we will review earlier work, aiming to identify potential patterns of laryngeal–oral coordination, summarizing them schematically in Fig. 1 to provide a framework for further discussion.

A convenient point of departure for consideration of previous findings is Docherty’s (1992) acoustic investigation of English. Based on his own results, and other relevant results available at that time, two fairly pervasive generalizations can be identified:

1. VOT (i.e. the period of voicelessness following release of the stop or fricative) is longer in /Cl/ and /Cr/ sequences than in simple CV sequences.
2. It is well documented that stops and fricatives generally have a shorter occlusion duration when they occur in clusters (e.g. Haggard, 1973; Hawkins, 1979; Klatt, 1975, 1973), though in fact we will also be encountering some cases where this effect is quite weak.

* Corresponding author. Tel.: +49 89 2180 3149; fax: +49 89 2180 5790.
E-mail addresses: hoole@phonetik.uni-muenchen.de (P. Hoole), lasse@phonetik.uni-muenchen.de (L. Bombien).

1 We will be using the phonemic symbol /r/ to refer to the rhotic that in our German speakers was a dorsal articulation in the velar/uvular region. Depending on context, it can range from voiced approximant to voiceless fricative.