Vowel identification at high fundamental frequencies in the context of minimal pairs

Daniel Friedrichs[a]*, Dieter Maurer[b], Heidy Suter[b], Volker Dellwo[a],

*Corresponding author: daniel.friedrichs@uzh.ch, Tel: +41 44 63 40234
[a] Phonetics Laboratory, University of Zurich, Plattenstrasse 54, 8032 Zurich, Switzerland; daniel.friedrichs@uzh.ch, volker.dellwo@uzh.ch
[b] Institute for the Performing Arts and Film, Zurich University of the Arts, Gessnerallee 11, 8001 Zurich, Switzerland;
heidy.suter@zhdk.ch, dieter.maurer@zhdk.ch

Abstract
Is vowel perception inevitably compromised once F_0 of a sound exceeds F_1 of the intended vowel as given in formant statistics for 'normal speech'? Hitherto, no general consensus could be established with regard to the intelligibility of high-pitched vowel sounds, but three positions can be identified: (1) For a given vowel, sounds on F_0 above F_1 as given in formant statistics for normal speech lose their vowel intelligibility (see e.g., Joliveau et al., 2004). (2) A correct vowel identification of 80% can be maintained up to c. 525Hz and quickly drops to 15% at c. 700Hz, with the exception of sounds of /a/ which may exhibit correspondingly higher identification rates (Sundberg, 2012). (3) Vowel intelligibility can be maintained up to c. 880Hz if the sounds are produced with a raised larynx position or in a CVC context; this holds true up to F_0 = c. 1050Hz for both conditions combined (Smith and Scott, 1980).
The present study investigated the intelligibility of the long German vowels /i, y, e, ø, ɛ, a, o, u/ in the context of minimal pairs at various F_0. A professional female singer produced 18 minimal pairs at nine F_0 levels from 220 to 880Hz. Vowel perception was tested in a binary forced listening experiment including 18 subjects (10 women, 8 men; age 20-54). The results reveal that, under laboratory conditions of speech production, vowel identification in the context of minimal pairs can be maintained with a rate of > 65% for all F_0 and all vowels investigated. Moreover, the corner vowels /u, a, i/ proved to be intelligible with a rate > 90% up to F_0 of 880Hz. Thus, in line with the third position mentioned, possible vowel discrimination is found for F_0 of sounds covering the entire frequency range of statistical F_1 of all vowels.