Effects of syllable position on sound change: Aerodynamic and perceptual data on final fricative weakening
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Phonetic differences between syllable initial and syllable final consonants have been suggested to be at the origin of some sound changes. In particular, a decreased gesture syllable finally (i.e., less and shorter linguo-palatal contact syllable finally than syllable initially (Byrd 1996; Fougeron, 1999)) has been associated to weakening and/or loss of syllable final consonants (Hock 1986; Recasens 2001). However, the weakening (i.e., gliding, aspiration or loss) of syllable final fricatives in prepausal and preconsonantal position found in a variety of languages may not only be attributed to articulatory reduction, but more crucially to the aerodynamic and perceptual consequences of gestural reduction and of the temporal sequencing of articulatory events. This paper explores the differences in the aerodynamic characteristics for syllable onset and coda fricatives and their perceptual properties. Such differences may account for the weakening of fricatives (i) syllable finally, e.g., gliding (Latin *nos, vos* ‘we, you’ > Italian, Rumanian *noi, voi*; Latin *mense* ‘month’ > Occitan [mej]; English *sæh, bisig > saw, busy*), aspiration (present-day Spanish *desde, dos* [h] ‘since, two’), and elision (Latin *nos, vos > French *nous, vous* [s] > θ; English *yes > yeah; of, have* [v] > θ), and (ii) when followed by a nasal consonant (Latin *mesnata* ‘kids’ > Catalan *mainada*; Old French *ae(s)mer*, Standard Catalan *esma > Balearic dialects ejma*, English *aim*; Old French *ble(s)mir*, Provençal *blesmar > English blemish*; English *isn’t, doesn’t, something* pronounced [ɪnt], [ɪnt], [dænt] [sæmɪ] (Gimson 1962)).

It is known that fricatives have tight positional, aerodynamic, and time constraints, vis-à-vis stops, and they allow lesser articulatory and aerodynamic variation than other segment types (Recasens et al. 1997, Solé 2002). If the aerodynamic conditions for generating audible turbulence in coda fricatives are not met, due to a decreased gesture, and/or a reduced oral pressure build up (due to time constraints or a lower rate of flow), fricatives are likely to decay and the resulting sound may be interpreted as a glide or may be perceptually missed. Similarly, in fricative+nasal sequences, the anticipatory velopharyngeal opening for the coarticulated nasal may bleed the oropharyngeal pressure required to produce turbulence for the fricative.

In a first experiment, simultaneous oropharyngeal pressure (Po), airflow and audio-signal were obtained for two American English speakers reading sequences containing symmetrical CVC nonsense syllables, where C=voiced and voiceless fricatives, before a consonant (CVC#C) and phrase-finally (CVC##). The data allow us to observe the timing of aerodynamic and acoustic events, and relate them to inferred articulatory gestures. Aerodynamic and acoustic analyses showed that coda fricatives, vis-à-vis onset fricatives, exhibit (i) a slower oral pressure build-up, (ii) a lower pressure peak, (iii) a delayed onset of audible frication, (iv) a shorter duration (when the syllable is not phrase-final) and (v) a lower intensity of frication (rate of flow being proportional to intensity), compatible with a reduced lingual gesture for coda as opposed to onset fricatives.

The results suggest that a reduced gesture syllable-finally may delay the onset of frication (and thus make it more likely to be affected by overlapping gestures) and may endanger the aerodynamic conditions -- rate and duration of airflow-- for generating audible turbulence,
making the fricative more difficult to detect. A second experiment was carried out in order to test the hypothesis that diminished intensity and reduced duration of turbulence in coda fricatives may lead to the identification of a glide or may be perceptually missed. The CVC stimuli produced by one of the talkers in the first experiment were (i) attenuated by 6 dB step changes, beginning at vowel offset (approximating phrase-final position), and (ii) truncated in 20ms steps beginning at vowel offset (approximating consonant overlap). Subjects were instructed to identify the syllable as CVC, CVj, CVh, CV or to write down whatever they heard, if they heard something else, in normal orthography on the answer sheet.

The results of the perceptual experiment are currently being analyzed and suggest that coda fricatives with diminished intensity of turbulence and/or truncated duration may be reinterpreted as an aspirated [h] -- reflecting the large and slightly turbulent airflow escaping through the open glottis before the fricative constriction has been formed--, an offglide of the vowel, or may be perceptually missed, replicating the historical and synchronic processes.

Finally, the loss and weakening of fricatives followed by a nasal consonant may be attributed to the anticipatory velopharyngeal opening required for the nasal impeding the build-up of the oral pressure necessary for frication. Work by Ohala and Solé (1998) shows that when oropharyngeal pressure during the production of fricatives is vented with catheters simulating the effect of velopharyngeal leakage, fricatives lose much of their high-frequency aperiodic energy, making them frictionless continuants. Our findings suggest that gestural and associated aerodynamic effects may account for the historical and present-day tendency for syllable final fricatives, and for fricatives followed by nasals, to weaken or disappear.

References