THE PRODUCTION OF CORONALS IN HYPER AND HYPO SPEECH

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ABSTRACT

The coronals [stdtn] have place-neutral articulatory gestures: The front tongue creates a constriction against the structure(s) anatomically opposite to it. On the contrary, [N\^\r] have displaced gestures.

When changing from hyper to hypo style, Swedish post-alveolar /s/ and [ʃ] move substantially forwards and /s/ somewhat backwards in EPG registrations; the [ʃ] change is great-est, reflecting its more posterior hyper gesture. Thus, constric-tion is the active articulator creates a constriction against the structure(s) lying anatomically directly opposite to it [6]. Thus, a smaller number of consonants have displaced articulations, where the active articulator is displaced from its neutral gesture position. Among coronals, the apicodentals and laminoalveolars have neutral gestures, whereas postalveolar and retroflex sounds are displaced.

1. INTRODUCTION

1.1 The hyper-hypo scale

The hyper-hypo scale of speech production is a fundamental dimension of phonetic variability [14]. Obviously, the range of this dimension is considerable. There is however no con-census about the nature of the control of the variation. Where-as some propose that the variation is quantitative, i. e. the same motor commands are given but with varying strength [1], others assert that there is a qualitative difference between com-mands for hyper and hypo style realisation of a certain articu-latory gesture, i. e. that the commands differ in other respects [17]. Supposedly, both positions may be right. To make it possible to settle this dispute adequately, much more empiric data are needed.

The variation along the hyper-hypo dimension can be systematically studied in data bases containing the same phrasal material produced by the same subjects in various styles. However, the hyper-hypo style variability in produc-ing individual gestures can also be analysed in materials consisting of sounds produced in isolation in contrast to those in phrases. The isolated case is typically of an extreme hyper type, whereas phrases are normally more or less hypo. Also stress level influences the hyper-hypo position. Thus, there is a wide variation within every ordinarily pronounced sentence, where stressed syllables have sounds with more elaborately produced gestures, whereas unstressed syllables are typically nearer to the hypo end of the scale.

1.2. Place-neutral and displaced articulatory gestures

Most consonants are produced with a place-neutral gesture, that is the active articulator creates a constriction against the structure(s) lying anatomically directly opposite to it [6]. Thus, a smaller number of consonants have displaced articulation, where the active articulator is displaced from its neutral gesture position. Among coronals, the apicodentals and laminoalveolars have neutral gestures, whereas postalveolar and retroflex sounds are displaced.

1.3. Hypotheses

In hyper speech, the articulatory targets for phonemes are generally attained much more closely than in hypo speech. We hypothesise that displaced gestures should generally tend to change more than neutral ones as a function of variation along the hyper-hypo scale. Also, displaced gestures should move in the direction to their neighbouring neutral gestures in the hypo

generally, speech sound reductions may be total or part-ial. In this context, the partial cases are of interest. The concept of "partial reduction" presupposes the notion of a more elaborately produced gesture. Consequently, the hyper-hypo di-mension is by definition implied by the reduction concept.

Hyper speech has been much more studied than hypo speech in earlier decades, for natural methodological reasons. Therefore, this inherited perspective has traditionally permeated much of the phonetic thinking. Even today, hyper style is the default case. Thus, when it is not explicitly mentioned, speech sound definitions and other descriptions concern hyper and not hypo style. However, in recent decades hypo speech has come into focus. For vowels, a seminal work was Lindblom [13]. Several later studies have treated vowel reduc-tion in un-stressed syllables as contrasted to hyperly pro-duced isolated cases, mainly from the acoustic aspect, e. g. [15]. Consonant reduction has been studied to a less extent. Thus, analyses of e. g. fricatives are generally made on produc-tion in only stressed syllables or isolated sounds, e.g. [4, 7, 18].

Obviously, there is a need for more information on reduc-tion of speech sounds in hypo style both per se and as oppo-sed to hyper style, not least concerning consonants and espe-cially from a direct, articulatory point of view. These data are of interest not only for theoretical reasons - e. g. in the debate on the quality-quantity nature of hyper-hypo articulatory variability - but also in their own right, representing most cases where speech sounds appear. Our study gives this kind of information, based on an EPG analysis of Swedish coro-nals. Before presenting Swedish coronals and our material, another basic dichotomy will be treated.

Generally, speech sound reductions may be total or part-ial. In this context, the partial cases are of interest. The concept of "partial reduction" presupposes the notion of a more elaborately produced gesture. Consequently, the hyper-hypo di-mension is by definition implied by the reduction concept.
2. SWEDISH CORONALS

According to Maddieson [16], 50% of the most common consonant phonemes of the world’s languages are coronal. The proportion of Swedish coronals is not far from this figure, as will be shown. The Swedish consonant system is generally considered to consist of the following phonemes: /p t k; b d g; f s n ʂ ʐ h; v j; l r; m n ŋ/. Six of these 18 sounds are exclusively coronal: /t d s ʐ urrets/, /l/ is coronally produced in Central but not South Swedish. /t/ has several allophones, one of which ([ ]) is a coronal. [ ]) is very similar to and often identical with English [ ]). Despite this, it is usually symbolised by [ ].

Both [ ]/ and [ ]) are postalveolar coronal sibilants, with very similar groove position, width and length [7, 10]. Their main difference is the front tongue size. In [ ]) this is larger, due to lip rounding - as contrasted to spreading in [ ]/ - and also to a larger sublingual cavity [7]. In consequence, [ ]) has lower energy distribution and a larger auditory shade than [ ]/ [7]. Also, [ ]/ is palatalized, which means that its area function backwards from the groove is more gradually widening than in [ ]/.

Traditionally, Swedish /t d l n/ are roughly described as dental. Compared to English corresponding sounds, they are generally more front. Also /s/ is sometimes classified as dental, although it is generally prealveolar [10] and thus similar to e. g. English /s/. Swedish coronal /l/ is however classified as alveolar. This sound varies greatly: trilled, fricative, and approximative; often it is totally reduced in weak positions.

Thus, 8 out of the 18 Swedish consonant phonemes are coronal. The proportion of front tongue sounds will be higher - 12 out of 22 - if also a postalveolar group of Swedish consonants is included, which are mostly regarded as allophones of /l/ plus one of /l d l n s/ in both. Most Swedes systematically produce a postalveolar or prepalatal coronal constriction not only for /s/ and the /l/-allophone [ ]) but also for allophonic variants of /t d l n s/ when following /l/, as in port, hår, Karl, törne, fars - "door, hard, thorn, Charles, farce". /l/ is not realised as a separate segment in these cases.

The (hyper) gesture in those allophones is often classified as retroflex, but also as apicoalveolar, and supradental. The usual notations are [ \ 'r] respectively. However, the tongue tip position is probably very often not bent backwards (retroflex) but only lifted upwards. In accordance with Ladefoged & Maddieson [5], the most adequate notation for this sounds would therefore be the basic signs [t d l n s] with a dot below. The /l/-allophone denoted [ ] and the /l/-allophone [ ]) are identical. However, [ ]) varies as concerns the detailed front tongue shape and position, and degree of lip rounding [12].

Detailed investigations of the tongue gestures in coronal sounds - front ones as well as retroflex and other posterior ones - remain to be made, in Swedish as well as in other lan-guages. It is however easily felt and has also to some extent been objectively shown [2, 9, 11], that [t d l n s] are not produced in exactly the same position intralingually. This is caused by varying general production conditions, specific for each of these sounds. Considering unexpected data in Dart [2] about English and French common coronals that are some-times produced sublaminally (i. e. retroflexedly), it is not un-justified to expect (hyper) gestures of [t d l n] in other lan-guages to be not only apical or laminar but also sometimes sublaminal.

3. METHOD

3.1 Material.

In this study of Swedish coronals along the hyper-hypo scale, our materials consists mainly of the Swedish sibilants /s/, /n/, and [], pronounced in isolation and in read phrases with systematically varied vowel context - [i a u]. Each item was pronounced nine times. Unsystematically, we have also studied several cases of [t d l n r] in stressed and unstressed positions, from phrases and isolated nonsense words. All these non-sibilant coronals will be studied more systematically later on.

Both materials were produced by 10 Swedish speakers, 6 males and 4 females (F, G, H, I), age range 24-50 years. Six spoke central and 4 (G, H, I, K) South Swedish varieties. One male and 3 females were South Swedish. /t d l n s/ and [n] are found in all Swedish varieties, but South Swedish lacks [n r]. Data for the latter sound group are therefore based on only 6 subjects.

The material was registered by dynamic electropalatography (EPG) of the Reading type [3]. With this method, the speaker wears a thin palate, extending from the upper teeth back to the velum. In the palate, 62 electrodes are placed in a regular pattern.

3.2. Analysis

Each EPG registration frame is a kind of map, representing the tongue-palate contact every 10 milliseconds. In this map, each electrode is represented by a specific point as either touched or free (untouched). The map points are arranged in a pattern, similar to the electrode pattern, with eight transverse rows and eight longitudinal columns of points. For the sibilants and [l], we analysed in which row the frontmost minimum constriction was found (constriction place, CP). For the other coronals - all with a complete closure - CP was defined as the frontmost row of this closure with at least half the number of electrodes touched by the tongue.

The transverse rows of electrodes are denoted by numbers starting from the front. Thus, row no 1 is the frontmost one. In this row, at least one electrode covers an incisive. Tonge gestures contacting this row may therefore be classified as dental. Row no 2 is prealveolar, and the two following ones are post-alveolar. Inter-electrode distances in those four rows are about 4 mm, both sagitally and transversely. In the palatal region, inter-electrode distances are greater, especially sagitally.

This study concerns the variation of the constriction place analysed in EPG registrations - expressed as a row number - as a function of variation of speech articulation style along the hyper-hypo scale.

4. RESULTS AND DISCUSSION
4.1. [s], [n], and [\\]

As reported earlier [10], each of [s], [n], and [\\] is produced in phrases with great constancy in each subject as concerns constriction width, shape, and position. Also in the time dimension, sibilant constriction production is constant. Thus, there is no or very little temporal dynamics, unlike many other sounds. Also when the sibilants are produced in isolation, constriction width, shape, and position for each sound are constant in each speaker.

However, phrasal and isolated production differ. Thus, many speakers have different constriction width in each sibilant as produced isolated and in phrases. There is however no tendency in this width variation. In contrast, the variation in constriction position between phrases and isolation shows a clear pattern. As shown in Figure 1, the tendency is strong that [n] and [\\] are articulated clearly more in front in phrases than in isolation. Four out of 10 subjects (A, G, I, K) show this pattern for [n] and 4 out of 6 (A, C, D, F) for [\\]. The change is larger in [\\], resulting in identical phrasal articulation place for [n] and [\\] in all 6 out of 6 subjects with [\\]. In 3 subjects (B, E, H), the constriction place is the same for each sound in phrasal and isolated production. In no case the place is further back in phrases.

As mentioned, the pattern of significantly smaller sibilant sagittal range in phrasal as compared to isolated production is not all-pervading. Three subjects (B, E, H) show no difference between each sibilant in isolation and phrases. However, their range is small in both cases.

The exact sagittal position of this narrow range, where the front tongue produces all Swedish sibilants in phrases in our material, varies to some extent. As is shown in Figure 1, in 5 subjects (A, D, F, G, H) it is found in rows 2-3 and in 3 subjects (B, C, K) in row 3-4. These positions correspond to the alveolar crest immediately behind the upper incisives and to the back part of the alveolar crest, respectively. Somewhat deviating from this pattern, subject I uses the range 1-2 and subject E the range 2-4. This variability is expected, since there is intersubject variation in the size and shape of the front tongue, the alveolar ridge, and the upper incisors as well as in the bite, which is connected with the neutral position of the mandible in relation to the upper jaw. Due to this intersubject anatomical variation, it is natural that the neutral coronal tongue position will vary to some extent.

All those phrasal productions of [s], [n], and [\\] sound normal and are well distinguished. The articulatory place of [s] is about 4 mm in front of [n] and [\\]. The latter sounds do not differ significantly in constriction place or width. As was argued in [7, 10], the groove anterior cavity size is the main distinguishing articulatory feature for [n] and [\\]. The larger cavity in [\\] makes it darker. In isolation, most subjects produce [\\] with a constriction place more back than in [n]. Naturally, this feature contributes to a larger front cavity. However, this is
no necessary condition. Also the sublingual cavity and lip section are larger in [ʃ] [7, 10].

This hyper-hypo variation of constriction place of sibilants is obviously connected to the distinction between a neutral and a displaced gesture. Consequently, the result corroborates our hypothesis that in cases that are more hypo, displaced gestures will tend to be produced more similar to the corresponding neutral configuration. Thus, compared to isolated pronunciation, the neutral position was approximat-ed in phrasal speech. According to Laver [6], the neutral coronal gesture implies front tongue contact with the front alveolar crest and/or the back of the upper front incisors.

In our study, especially [ʃ] but also [n] tended strongly to be produced further in front in phrasal speech than in isolated one. Both sounds have displaced gestures, so this tendency is expected. Since the coronal gesture of [ʃ] was more back in isolated production, it is natural that it tended to change more. The fact that [s] was produced a bit further back in phrasal speech in 3 subjects seems to imply that the neutral coronal gesture of these speakers does not coincide with the hyper production of [s] but is situated a bit further back.

4.2. Non-sibilant coronals
Also several observations in our wide - but from the hyper-hypo point of view less systematically varied - material of nonsibilant Swedish [t d l ɾ n s] support the hypo-thesis that coronals tend to aggregate in a smaller sagittal range as speech gets more hypo. Thus in hypo style, the den-tals [t d l n] share with [s] a certain tendency of backing, and the supradentals [ɾ n s] get more fronted. However, we also hypothesise that a close, systematic study will show differing detailed variation patterns, due to different produc-tion conditions for coronals with nominally the same place of articulation, cf [9]. For example, in hyper speech, [t] has a larger front tongue contact area than other comparable coronals and tends to be produced furthest in front, whereas [l] has a transverse tongue body narrowing and a lower mandibular position [8, 9, 11]. We also propose as a global hypothesis that [l] tends to be apical to a greater extent than [t d n s], due to its lower jaw position [9].

5. CONCLUSION
It has been shown that constriction place patterns in EPG registrations of Swedish /s/ and post-alveolar /ʃ/ and [ʃ] in hypo as compared to hyper speech is characterized by an aggregation in a much smaller sagittal range along the middle part of the alveolar range, covering the neutral gesture. We hypothesise that this aggregation is closely connected with the neutral coronal gesture: The front tongue articulates closer to this gesture in phrases than in isolated productions. Un-systematic studies of the Swedish coronals [tdn] and [ɾn] support this hypothesis. Speech material that is more hypo will probably show a still more narrow range.

REFERENCES