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Distinctive [voice] does not Imply Regressive Assimilation: Evidence from Swedish

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ABSTRACT

In a recent paper, van Rooy & Wissing (2001) distinguish between the "broad interpretation" and the "narrow interpretation" of the feature [voice]. According to the broad interpretation, languages with a two way [voice] contrast may implement this contrast phonetically with any two of the following: voice onset precedes plosive release (prevoicing), voice onset immediately follows plosive release, voice onset substantially lags behind plosive release. According to the narrow interpretation, [voice] is employed only in languages with prevoicing in word-intial stops. According to van Rooy & Wissing, languages with prevoicing always have only regressive voice assimilation. The purpose of this paper is twofold: First we show that Swedish employs the feature [voice] on the narrow interpretation, but does not have regressive voice assimilation. Second, we present an OT account of the Swedish data which involves both features [voice] and [spread glottis].

KEYWORDS: Distinctive Features, Laryngeal Features, Optimality Theory, Prevoicing, Regressive Assimilation, [spread glottis], Swedish, [voice], Voice Assimilation.

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1. INTRODUCTION

In a recent paper, van Rooy & Wissing (2001) distinguish between what they call the "broad interpretation" and the "narrow interpretation" of the feature [voice]. According to the broad interpretation (Lisker & Abrarnson 1964, Kingston & Diehl 1994), languages with a two-way [voice] contrast rnay irnplernent this contrast phonetically with any two of the following: voice onset precedes stop release (prevoicing), voice onset irnrnediately follows stop release, voice onset substantially lags behind stop release. According to the narrow interpretation (Jakobson 1949: 389, Keating 1990; Iverson & Salrnons 1995; Jessen 1989, 1998; Jessen & Ringen 2002), [voice] is ernployed only when actual vocal fold vibration is present during closure. According to van Rooy & Wissing, languages that ernploy [voice], on the narrow interpretation, only have regressive voice assirnilation. They note:

> Various researchers have remarked that there is a close connection between negative voice onset time in plosives (the narrow use of the feature [voice]) and the occurrence of regressive assimilation (see Westbury 1975; Kohler 1984; Gustafson 1986; lverson and Salmons 1995: 382; Wissing and Roux 1995).[1]
>
> *Rooy & Wissing (2001: 297)*

In this paper we present ernpirical evidence about the distribution of voice and aspiration in Swedish. We show that Swedish ernploys the feature [voice] on the narrow interpretation: voice onset precedes stop release in utterance initial position, (voiced) stops are produced with vocal fold vibration intervocalically and word finally, but there is no regressive assirnilation of [voice]. Hence, van Rooy & Wissing's clairn cannot be rnaintained, at least in its strongest form. Finally, we present an Optirnality Theoretic account of the Swedish voice and aspiration data (McCarthy & Prince 1993, 1995; Prince and Srnolensky 199312002).

II. EXPERIMENT

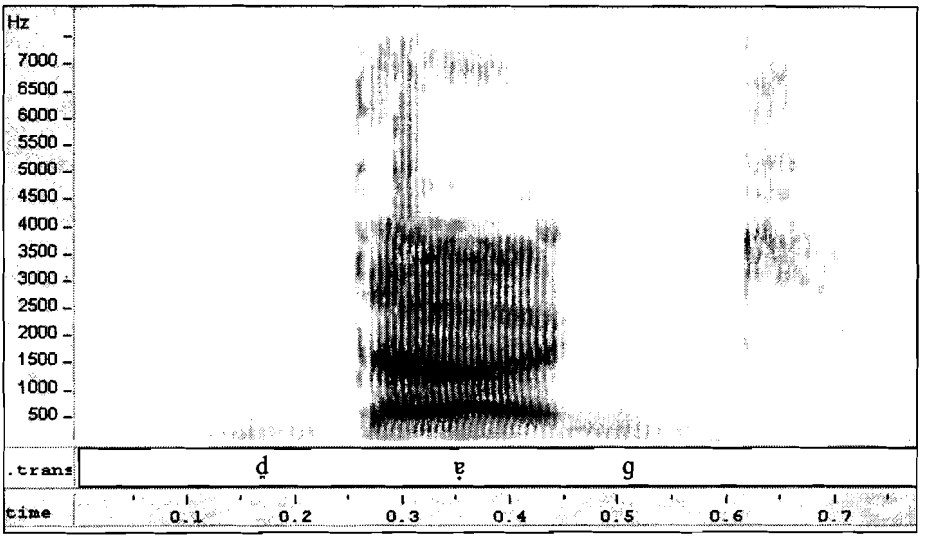
Six native speakers of Central Standard Swedish, three males and three females (ranging in age frorn 28 to 50), were recorded in a sound-treated room at Stockholrn University. The speakers read a list of words (see Appendix A) containing stops from both stop series found in Swedish, referred to here as fortis vs. lenis. The stops occurred in word-initial position, in intervocalic position and in word-final position, as well as in word-medial and final clusters. The duration of utterance-initial prevoicing was rneasured as the duration frorn voice onset to stop release. The arnount of voicing in word-medial and final stops was rneasured as the duration frorn closure onset to the point at which voicing ceased during the closure phase. In medial fortis stops in Swedish, voice offset tends to be initiated before the stop closure is made (cf. Helgason 2002). This results in a period of preaspiration, exarnples of which can be observed in the spectrograrns in (4), (5) and (7). Preaspiration duration was measured as the duration frorn the offset of rnodal voice in the vowel to the onset of the stop closure. Helgason (2002: 107ff) gives a more detailed discussion of the rneasurernent rnethod.

III. RESULTS

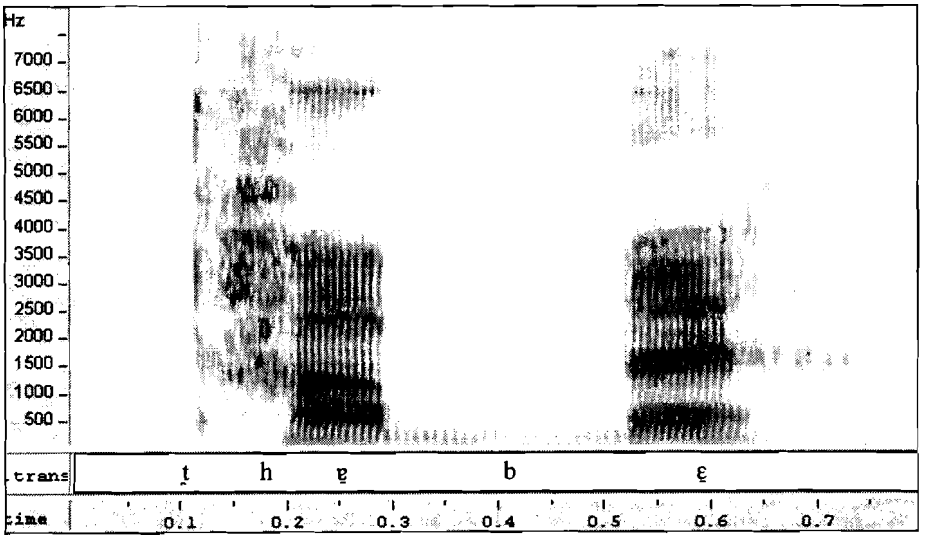
III.1. Lenis stops

212 of 228 tokens of word-initial lenis stops (93%) exhibited some degree of prevoicing (see Appendix B).[2] The average duration of prevoicing was considerably longer for the maie subjects (109 ms) than for the female subjects (66 ms).

(1) Spectrogram of MP's production of the word *dagg* 'dew'



(2) Spectrogram of MP's production of the word *tabbe* 'mistake'

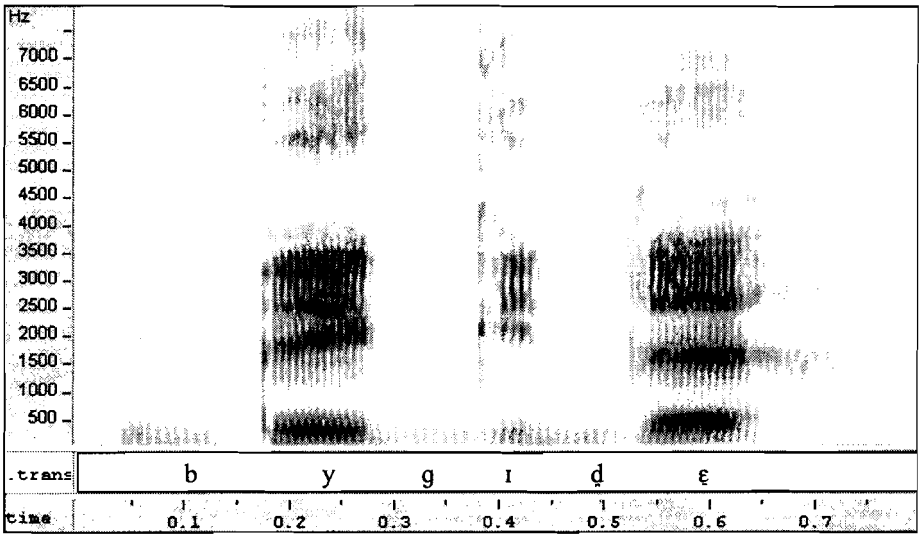


The vast majority (96%) of the non-initial lenis stops had voicing during more than half of the closure interval. For word-medial (intervocalic) lenis stops, 137 of the 144 tokens had voicing during more the 50% of the closure interval (72 in V:C sequences and 72 in VC: sequences). For word-final lenis stops, 140 of the 144 tokens had voicing during more the 50% of the closure interval (again 72 in V:C and 72 in VC:).

A spectrogram showing voicing of stops in word-initial and word-final position is given in (1). *An* example of a voiced stop in intervocalic position is given in (2).

A total of 24 lenis stop clusters were also analyzed. In 23 of these cases, both the first and the second lenis stop in the sequence had voicing during more than 50% of the closure interval. In the one remaining case approximately 50% of the first stop was voiced and the latter stop was voiceless. It may also be noted that the production of lenis clusters is generally characterised by an epenthetic vocoid that occurs between the two stops. This is evident in the spectrogram in (3). Thus, the release phase of the first stop is almost always produced with full voicing rather than showing any tendency for voicelessness.

(3) Spectrogram of MP's production of the word byggde 'built (past tense)'



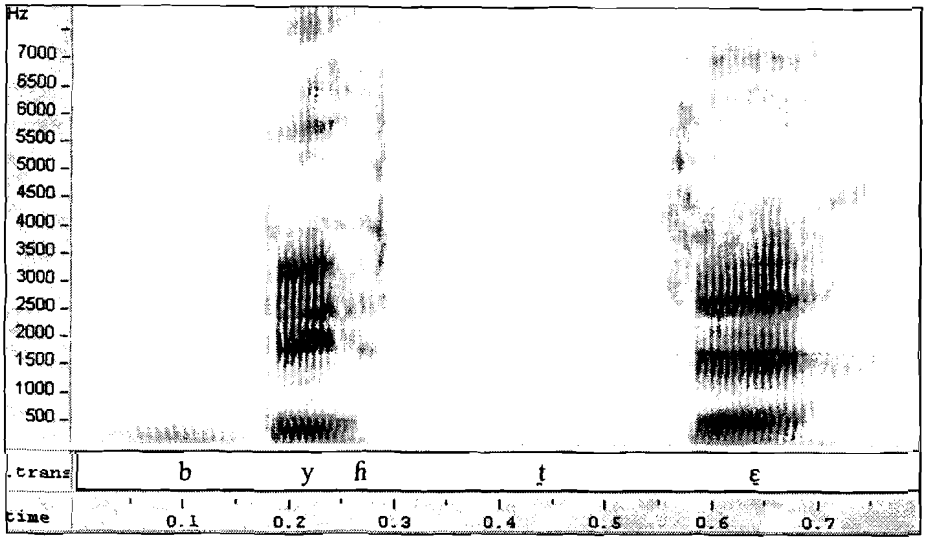
111.2. Fortis stops

In total, 96 word-initial fortis stops were recorded, 24 instances of /p/, 48 of /t/ and 24 of /k/. The mean postaspiration duration (measured as modal voice onset time, i.e. the time between the stop release and the onset of modal voice) for /p/ was 49 ms, for /t/ 65 ms, and for /k/ 78 ms. Aspiration on a word-intial stop can be seen in (2).

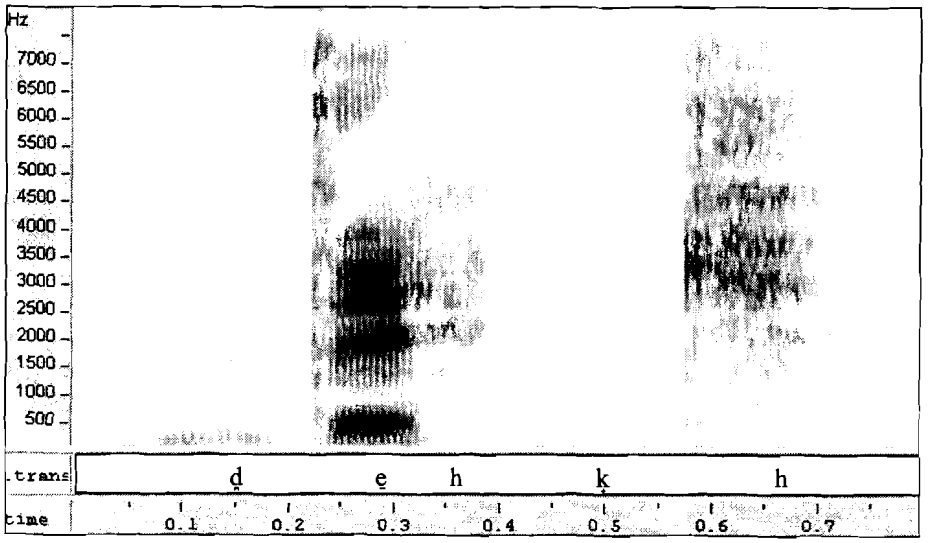
In total, 312 word-media1 and final fortis stops were analyzed (144 in V:C and 168 in VC:). Such stops were generally produced with some degree of preaspiration, i.e., voicelessness was initiated before the onset of the stop closure. An example of preaspiration on a medial stop is given in (4). *An* example of preaspiration of a final stop is given in (5). The mean duration for this preaspiration was 44 ms. Considerable inter-speaker differences were found. Two of the

female speakers, AE and JR, had the longest mean preaspiration durations, 56 and 58 ms. respectively. The shortest mean preaspiration durations were found for the male speakers PL, 27 ms, and DH, 34 ms. The remaining two speakers, GT (female) and MP (male) had mean preaspiration durations of 44 ms and 45 ms respectively.

(4) Spectrogram of MP's production of the word bytte 'exchanged'.



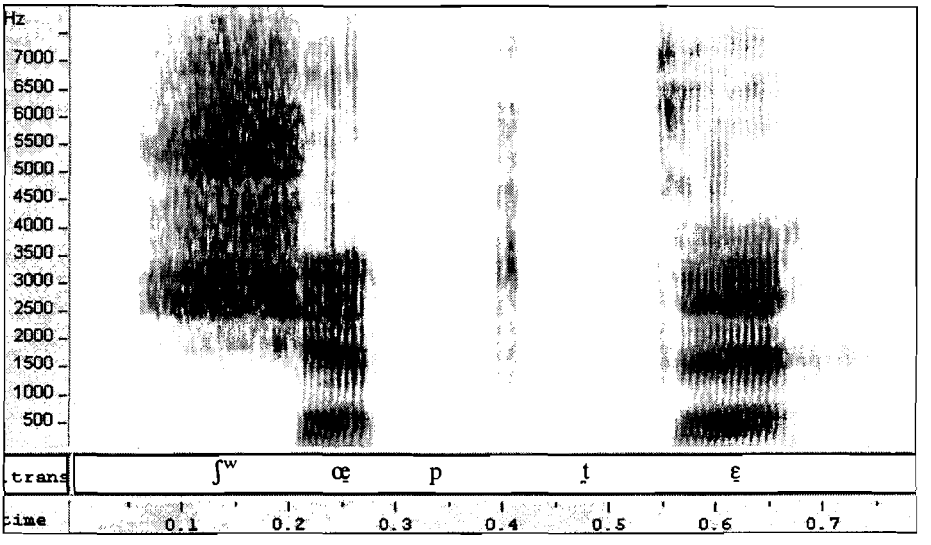
(5) Spectrogram of MP's production of the word ***dück*** 'deck'



A total of 144 instances of intervocalic fortis stops were analyzed (72 in V:C and 72 in VC:). Note that these are a subset of the 312 fortis stops discussed above. For these intervocalic stops, the mean duration of preaspiration was 42 ms (for all speakers pooled), 29 ms for /p/, 36 ms for /t/ and /55/ ms for /k/. Postaspiration duration was generally short and not indicative of any significant postaspiration percept. Mean postaspiration duration (i.e. the duration from release to the onset of modal voice) was 23 ms, 15 ms for /p/, 22 ms for /t/ and 28 for /k/. There was no correlation between preaspiration and postaspiration duration for the intervocalic fortis stops ($r^2 = 0.0375$).

A total of 48 intervocalic fortis clusters were recorded, consisting of the sequences [pt] and [kt] (24 of each). These clusters were invariably produced as voiceless, with both stops released. Like simple intervocalic fortis stops, they were generally preceded by a slight preaspiration. The mean duration of this preaspiration was 31 ms. Also, mean postaspiration duration was short, 26 ms, which is not indicative of any significant postaspiration percept. ***An*** example of an intervocalic fortis cluster in *köpte* < *kö*/pd/*e* 'bought (past)' is given in (6).

(6) Spectrogram of MP's production of the word *köpte* 'bought' (past).

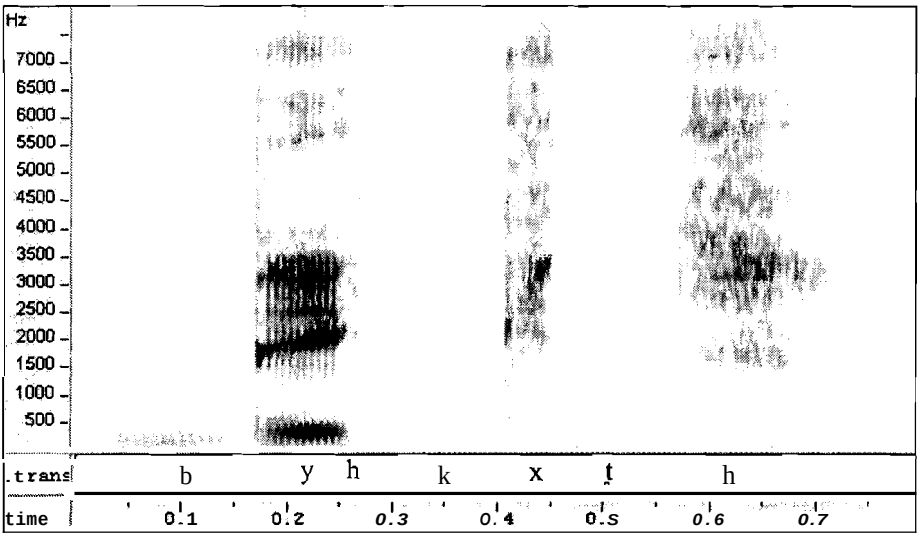


Word-final clusters with fortis stops were also examined. ***An*** example is given in (7). These were divided into two categories. First, there were clusters that can be derived from /pt/ and /kt/ sequences, in words such as kopt 'bought' (with a short vowel; supine of kopa 'buy') or *läkt* 'healed' (with a long vowel; supine of *läka* 'heal'). Second, there were clusters that can be derived from /gt/ sequences, in words such as *byggt* 'built' (with a short vowel; supine of bygga 'build') or vagt 'weighed' (with a long vowel; supine of vaga 'weigh'). Phonetically, the two types of clusters were found to be very similar. In both types, the two stop components were released and voiceless, and the cluster tended to be preceded by a slight preaspiration. The mean

preaspiration duration was shorter for these clusters than for the simple fortis stops, ranging from ***18–28*** ms for the four different word types listed above ***(vagt, byggt, läkt, kopt).***

These results can be interpreted as follows. Lenis stops are voiced, irrespective of their position within the word. Lenis stop clusters are also voiced, both word-medially and finally. Word-initial fortis stops are postaspirated. Word-medial and final fortis stops are either preaspirated or unaspirated, depending on speaker. When followed by a vowel, word-medial fortis stops are not postaspirated. Fortis clusters are either preaspirated or unaspirated, and when followed by a vowel they are not postaspirated. Thus they are treated very much like simple fortis stops. Further, there is no appreciable phonetic difference between stop clusters that derive from /kt/ sequences on the one hand, and those that derive from /gt/ sequences on the other.

(7) Spectrogram of MP's production of the word ***byggt*** 'built (sup.)'



IV. OT ANALYSIS

Examples of stops in word-initial position are given in ***(8).*** These are either aspirated or prevoiced.

(8)	[p^h]acka	'pack'	[b]ad	'bath'
	[t^h]ak	'roof	[d]äck	'deck'
	[k^h]ub	'cube'	[g]ap	'mouth'

Examples of stops in intervocalic and word-final position are given in (9). Here we find voiced stops or voiceless stops. The voiceless stops are either preaspirated or unaspirated.

(9)	vä[g]a	'weigh'
		'lie'
	kö[p]a – kö[^{h}p]a	'to buy'
	ta[k] – ta[^{h}k]	'roof

Our data indicate clearly that in underlying mixed voice/voiceless clusters, the surface cluster is voiceless, regardless of whether the input voiceless stop precedes or follows the voiced stop.[3] In Swedish. both progressive and regressive assimilation of ***voicelessness*** are found. Hence, the claim that languages with narrowly defined voiced plosives exhibit regressive assimilation of voice is incorrect. The basic facts of voice alternations in stop clusters are given in (10).

(10)	kö[p]a ~ kö[^{h}p]a	'to buy'
	kö[^{h}p-t]e ~ kö[p-t]e < kö/p+d/e	(past)
	kö[^{h}p-t]~kö[p-t] < kö/p+t/	'bought supine'
	väga	'weigh'
	vä[g-d]e < vä/g+d/e	(past)
	vä[^{h}k-t] ~ vä[k-t] < vä/g+t/	'weighed supine'

The past suffix, /-d/e has a voiceless stop when preceded by a root-final voiceless stop as in kö[^{h}p-t]e~kö[p-t]e, but a voiced stop when preceded by a root-final voiced stop as in vä[g-d]e < vä/g+d/e (past). This is a result of progressive assimilation to voicelessness. In contrast, the supine suffix, /-t/ is voiceless following a root-final voiceless stop as in kö[^{h}p-t]~kö[p-t] 'bought supine' < kö/p+t/ and causes in the devoicing of a preceding root-final voiced stop in vä[^{h}k-t]~vä[k-t] 'weighed supine' < vä/g+t/. this is regressive assimilation to voicelessness.[4]

We turn now to an Optimality Theoretic account of these facts.[5] We assume that Swedish has both underlying [spread glottis] and [voice] stops.[6] Both features are assumed to be privative.[7]

To account for the facts in (8) and (9) we must assume that faithfulness constraints for [voice] and [spread glottis] ([sg]) (11) and (12) are ranked above markedness constraints against voice and spread glottis features (13) and (14). The first faithfulness constraint requires that a segment that is specified with [voice] in the input be specified as [voice] in the output.[8] The second faithfulness constraint requires that a segment that is specified as [spread glottis] in the input be specified as [spread glottis] in the output.

(11) **FAITH$_{[VOICE]}$** An input [voice] segment must be [voice] in the output.

(12) **FAITH$_{[SG]}$** An input [sg] segment must be [sg] in the output.

(13) ***VOICE** Voiced obstruents are prohibited

(14) ***[SPREAD GLOTTIS]** (*SG) [spread glottis] stops are prohibited.

The tableaux in (15) illustrate that input [voice] and [spread glottis] features are preserved in the output. The first tableau in (15) shows that FAITH$_{[SG]}$ must be ranked above *SG, or [k]ub would

be optimal. The second tableau in (15) shows that FAITH$_{[VOI]}$ must be ranked above *VOI, or [k]ap would be optimal. Given richness of the Base, the grammar must map inputs with voiced spread glottis stops or with voiceless unaspirated stops in word-initial position to possible output forms. However, with only the constraints outlined so far, impossible surface forms would be designated as optimal with such inputs, as illustrated in (16).

(15)

/k^{sg}/ub	FAITH$_{[SG]}$	FAITH$_{[VOI]}$	*SG	*VOI
a. [k]ub	*!			
b. [g]ub	*!			*
☞ c. [k^{sg}]ub			*	
/g/ap	FAITH$_{[SG]}$	FAITH$_{[VOI]}$	*VOI	
a. [k]ap		*!		
b. [k^{sg}]ap		*!	*	
☞ c. [g]ap				*

FAITH$_{[sg]}$ » *SG; FAITH$_{[voi]}$ » *VOI

(16)

/g^{sg}/ub	FAITH$_{[SG]}$	FAITH$_{[VOI]}$	*SG	*VOI
a. [k]ub	*!	*		
b. [g]ub	*!			*
c. [k^{sg}]ub		*!	*	
☹ d. [g^{sg}]ub			*	*
/k/ap	FAITH$_{[SG]}$	FAITH$_{[VOI]}$	*SG	*VOI
☹ e. [k]ap				
f. [k^{sg}]ap			*!	
g. [g]ap				*!

Since neither of these is a possible surface form in Swedish, we assume the constraints SPECIFY in (17), requiring that a stop be specified for a laryngeal feature (Beckman & Ringen to appear), and *VOI/SG in (18), prohibiting voiced spread glottis stops:

(17) **SPECIFY** A stop must be specified for a laryngeal feature.[9]

(18) ***VOI/SG** Voiced spread glottis stops are prohibited.

As illustrated by the tableaux in (19), the impossible outputs in (16) will not be optimal if these two constraints are high-ranking. The first tableau in (19) shows that *VOI/SG and FAITH$_{[sg]}$ must be ranked above FAITH$_{[voi]}$, and the second tableaux shows that SPECIFY must be ranked above *SG.

(19)

/g^{sg}/ub	SPECIFY	*VOI/SG	FAITH$_{[sg]}$	FAITH$_{[voi]}$	*SG	*VOI
a. [k]ub	*!		*	*		
b. [g^{sg}]ub		*!			*	*
c. [g]ub			*!			*
☞ d. [k^{sg}]ub				*	*	
/k/ap	SPECIFY	*VOI/SG	FAITH$_{[sg]}$	FAITH$_{[voi]}$	*SG	*VOI
a. [k]ap	*!					
☞ b. [g]ap						*
c. [k^{sg}]ap					*!	

*VOI/SG, FAITH$_{[sg]}$ » FAITH$_{[voi]}$; *SG » *VOI; SPECIFY » *VOI

Finally, we assume a constraint that requires that adjacent obstruents agree in laryngeal features.

(20) **AGREE**
Obstruents in clusters must agree in laryngeal specifications.

In (21) we illustrate how progressive devoicing is accomplished with these ranked constraints. The first candidate is eliminated because there are no laryngeal specifications on the stops. The second is eliminated because the stops do not agree in laryngeal specifications, and the third candidate is eliminated because it violates the faithfulness constraint on [spread glottis]. A candidate with a voiced, aspirated stop would be excluded by the high-ranked constraint against voiced, spread glottis stops which we omit from the tableaux. The tableau in (21) shows that AGREE must be ranked above FAITH$_{[voi]}$.

(21) progressive

kö/p^{sg}+d/e	SPECIFY	AGREE	FAITH$_{[sg]}$	FAITH$_{[voi]}$	*SG	*VOI
a. kö[pt]e	*!*		*	*		
b. kö[p^{sg}+d]e		*!*[10]			*	*
c. kö[bd]e			*!			**
☞ d. kö[p^{sg}t^{sg}]e				*	**	

AGREE » FAITH$_{[voi]}$

In (22) we illustrate regressive assimilation. The first candidate is elirninated because one of the stops has no laryngeal specification. The second is eliminated because the stops do not agree in laryngeal specifications. The third is eliminated because it violates the [sg] faithfulness constraint.

(22) regressive

vä/g+t^{sg}/	SPECIFY	AGREE	FAITH$_{[sg]}$	FAITH$_{[voi]}$	*SG	*VOI
a. vä[k^{sg}t]	*!	*	*	*	*	
b. vä[gt^{sg}]		*!*			*	*
c. vä[gd]			*!			**
☞ d. vä[k ^{sg}t^{sg}]				*	**	

We are assurning that aspiration (whether preaspiration or post-aspiration) is the phonetic realization of the feature [spread glottis]. However, postaspiration does not occur on a [sg] stop that precedes an obstruent, and preaspiration does not occur on a [sg] stop that follows an obstruent. Hence, sorne segments will be specified as [sg] which are not preaspirated because of their position in the word.

Following Cohn (1993) and Keating (1988, 1990), we assume that phonology accounts for the categorical aspects of sound structure and phonetics accounts for the gradient and variable aspects. For exarnple, the variable voicing that occurs with Gerrnan non-spread glottis stops between sonorants is a result of phonetic voicing, not something to be treated in the phonology (Jessen & Ringen 2002). In Swedish, there is variation in the amount of preaspiration as a function ofrate of speech, stress, and individual speaker (Helgason 2002). Hence we assurne that the fact that sorne (non-initial) stops are not preaspirated has to do with the phonetic implementation of the feature [spread glottis], and is not appropriately handled in the phonology.

V. CONCLUSION

In conclusion, we have presented ernpirical evidence about the distribution of voice and aspiration in Central Standard Swedish. We have shown that Swedish ernploys distinctive [voice] on the narrow interpretation of van Rooy & Wissing (2001). Initial stops are prevoiced, and stops with vocal fold vibration occur intervocalically, both as singletons and in clusters, and word-finally. Yet Swedish has no regressive assirnilation of voice; rather it has progressive and regressive assimilation of voicelessness. Thus, van Rooy & Wissing's claim that languages with distinctive voice, on the narrow interpretation, only have regressive assirnilation of [voice] cannot be rnaintained, at least in its strongest forrn. It may be that languages with a two-way stop contrast with prevoicing and no aspiration, have regressive assimilation, but this is an empirical question.[11]

Finally we have shown how the Swedish data can be described in Optimality Theory assuming privative [voice]. Wetzels & Mascaró (2001) use Swedish as an exarnple to argue *against* privative voice, suggesting that it is a language in which [-voice] is active. As we have seen, Swedish "bidirectional devoicing" comes about because stops in clusters agree in the

feature [spread glottis]. Hence, contrary to the claim of Wetzels & Mascaró (2001), Swedish does not provide evidence for [-voice].[12]

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NOTES:

1. They note that two apparent counter-examples are Dutch and Afrikaans, which employ voice on the narrow interpretation, but which exhibit (some) progressive assimilation. They suggest, however, that these languages are actually consistent with the claim that language with prevoicing exhibit regressive assimilation of voicing.

2. Note that this is very different from German where essentially no prevoicing occurs. See Jessen (1998) and Jessen & Ringen (2002) for discussion of voice and aspiration in Getman.

3. One reviewer suggests that our data would only be convincing if we had shown that regressive assimilation of voicing does not occur across word boundaries in Swedish. We have not systematically investigated this question, but we do have some data from a pilot study: In compounds we found no regressive or progressive assimilation of voicing (or voicelessness) except in one form, *högtid* 'festival' (literally 'high time') *hö*[kt]*id* which has, arguably lost its status as a conipound.

4. Many discussions of Swedish voice assimilation cite data from Hellberg (1974), including the claim that devoicing only occurs in the second of two (underlying) voiced obstruents before /s/. Hence, the claim is that *bygds*, district gen.', < /byg:d+s/ is pronounced as [byg:ts]. We have not gathered data for clusters with fricatives or clusters of more than two stops.

5. Lombardi (1999) proposes a set of constraints which, she claims, account for the voice assimilation pattems in a number of languages, including Swedish. For a discussion of the problems with this set of constraints for German, see Jessen and Ringen (2002). For discussion of the empirical inadequacies of her accounts of Russian and Hungarian, see Petrova et al. (2000, to appear). Since the set of constraints she assumes do not make the correct predictions for German, Russian, or Hurigarian, an altemative account of Swedish involving constraints that also play a role in voice assimilation in these languages is called for. See Petrov et al. (to appear) for discussion. Lonibardi (2001) suggests that her (1999) faithfulness constraints be replaced by MAX feature constraints. If this is done, however, the Swedish and Yiddish facts cannot be handled.

6. See Becknian and Ringen (to appear) for arguments that, as a consequence of the OT tenets of Richness of the Base and Lexicon Optimization, both [voice] and [spread glottis] can appear in underlying forms in Swedish.

7. The assumption that [spread glottis] is privative is not particularly controversial. It has been widely assumed in the recent phonological literature that [voice] is privative, (but see Rubach 1996 and Wetzels & Mascaró 2001). One reviewer suggests that the feature [spread glonis] is doing the same work as would [-voice], and that it is not obvious how the analysis proposed here is different from one in which stops are specified as [-voice] and realized as pre- or postaspirated by phonetic implementation. One problem with this idea is that there are languages such as Thai in which there is a three-way contrast: voiced. voiceless unaspirated, and voiceless aspirated. In such a language the voiceless stops are not all aspirated, so [-voice] could not be realized phonetically as aspiration. To account for these languages, we need a feature such as [spread glottis]. Moreover, in languages such as German and Icelandic. it seems clear that there is a contrast is between those stops that are [spread glottis] and those that are not. In other words, there is an aspiration contrast. If the feature [spread glottis] is the feature that is realized phonetically as aspiration, the presence of aspiration would seem to implicate the feature [spread glottis].

8. See Pater (1999) for unidirectional (input-output) faithfulness constraints. A reviewer suggests that these are actually MAX (feature) constraints. They are not. MAX (feature) constraints prohibit the deletion of a feature, but do not require that the feature in question be associated with the same segment in the output as it was in the input. Unidirectional (input-output) constraints, on the other hand, require that if a segment is specified with a feature in the input, that its output correspondent be specified with that same feature. MAX (feature) constraints are violated if a segment with the feature in question is deleted, unidirectional constraints are not.

9. This constraint suggests that there should be languages with only voiced or only voiceless aspirated stops. Whether this is corrector not is an empirical question that cannot be answered without careful investigation of the phonetic facts of languages with only one stop series. One alternative to SPECIFY would be to assume only input [spread glottis] stops and a phonetic enhanceinent constraint that maximizes laryngeal contrast (Avery and Idsardi 2001), thereby supplying [voice] to the stops not specified as [spread glonis]. A second alternative would be to assume an underlyingcontrast between [-voice] and [+voice], with aspiration the result of a (probabalistic) constraint to enhance the voicing contrast, as in Boersnia (2003). The idea is that an underlying [-voice] stop should be pronounced with aspiration to avoid being *perceived* as [+voice]. Full discussion of the differences in these approaches goes beyond the scope of this paper.

[10] Here we assume one violation for each feature not in agreement.

[11] Turkish is another language that has a two-waystopcontrastand both aspirated and voiced (narrow interpretation) stops, but does not have regressive assimilation of the feature [voice]. See Beckman and Ringen (to appear), Kallestinova (2004) and Petrova et al. (to appear) for further discussion.

[12] Consideration ofthe otherexamples discussed by Wetzels & Mascaró (2001) goes beyond the scope ofthis paper. For alternatives to some of the cases they discuss, including Parisian French which cannot involve the feature [spread glottis] because there is no aspiration, see lverson & Salmons (2003).

REPERENCES

Avery, Peter & William ldsardi (2001). Laryngeal diineiisions, cornpletion and eiihancemeiit. In T. Alan Hall (Ed.), *Distinctive Feature Theory*. Berlin: de Gruyter, 4-70.

Beckinan. Jill & Ringen, Catherine (to appear). Contrast aiid Reduiidancy in OT. Proceediiigs of *WCCFL 23*.

Boersina, Paul (2003). The control of comprehension. In Jennifer Speiiader, Anders Eriksson & Östen Dahl (Eds.), *Proceedings of the Stockholm Workshop on Variation within Optimality Theory*. Department of Linguistics, Stockliolrn University, 47-56.

Cohn, Abigail C. (1993). Nasalization in English: Phonology or phonetics? *Phonology*, 10, 43-81.

Gustafson, Kjell (1986). Aspiration and voicing assimilation. *Progress Report from Oxford Phonetics*, 1, 46-54.

Hellberg, Staffan (1974). *Graphonomic Rules in Phonology*. Goteborg: Acta Universitatis Gothoburgensis.

Helgasoii, Pétui. (2002). *Preaspiration in the Nordic Languages: Synchronic and Diuchronic Aspects*. Ph.D Thesis, Stockliolrn University.

Iverson, Gregory K. & Salmons, Joseph C. (1995). Aspiration aiid laryngeal representation in Germanic. *Phonology* 12, 369-396.

Iverson, Gregory K. & Salinons, Joseph C. (2003). Legacy specification in the laryngeal phonology of Dutch. *Journul of Germanic Linguistics*, 15:1, 1-26.

Jakobson, Roinan (1949). On tlie identification of phonemic entities. *Selected Writings 1: Phonological Studies*. s'Gravenhage: Mouton. 418-425

Jesseii, Michael (1989). Laryngale Mechanismen in der Phonetik uiid Phonologie des Deutschen. Auslautverhartuiig, Stimmassimilation uiid Vokaleiiisatzeaus universalgrainmatischer Sicht. Ms., [revised version of 1989 M.A. Thesis, University of Bielefeld].

Jessen, Michael (1998). *Phonetics and Phonology of Tense and Lax Obstruents in German*. Amsterdam: John Benjainiiis.

Jessen, Micliael & Ringen, Catherine (2002). Laryngeal features in German. *Phonology*, 19, 189-218.

Kallestinova, Eleiia (2004). Voice and aspiration of stops in Turkish. In Gregorz Dogil (Ed.). *Folia Linguistica: Special Issue on Voice*. 117-143.

Keating, Patricia (1988). Underspecification in plionetics. *Phonology*, 7,275-297.

Keating, Patricia (1990). Phonetic representations in geiierative grainmar. *Journal of Linguistics*, 18, 321-334.

Kohler, Klaus J. (1984). Phonetic explanation iii phoiiology: the feature fortis/lenis. *Phonetica*, 41, 150-174.

Lisker, Leigh & Abrainson, Arthur S. (1964). A cross-laiiguage study of voicing in initial stops: acoustical measurements. *Word*, 20, 3844422.

Loinbardi, Liiida (1999). Positional faithfulness aiid voicing assiinilatioii in Optiinality Tlieory. *NLLT*, 17, 276-302.

Loinbardi, Linda (2001). Wliy place aiid voice are different: constraint-specific alternatioiis in Optimality Theory. In Liiida Loinbardi (Ed.), *Segmental Phonology in Optimality Theory*. Cambridge: Cainbridge University Press, 13-45.

Kingston, Jolin & Diehl, Randy L. (1994). Phonetic knowledge. *Language*, 70, 419–454

McCarthy, John & Priiice, Alan (1993). Prosodic Morpliology I: Constraint Interaction aiid Satisfaction. Ms., Uiiiversity of Massacliusetts, Ainherst aiid Rutgers Uiliversity.

McCarthy, John & Prince, Alan (1995). Faitlifulness and reduplicative identity. In J. Beckinan, Urbanczyk, J.S. & Walsh, L. (Eds.), *University of Massachusetts Occasional Papers 18*. Ainlierst, MA.: GLSA, 249-384.

Moosmüller, Sylvia & Riiigeii, Catherine (2004). Voice and aspiration in Austrian German plosives. In Gregorz Dogil (Ed.), *Folia Linguistica: Special Issue on Voice*, 38, 43-64.

Pater, Joe (1999). Austroiiesian nasal substitutioii and other NÇ effects. Iii R. Kager, H. van der Hulst & W. Zonneveld (Eds.), *The Prosody-Morphology Interface*. Cainbridge: Cambridge Uiiiversity Press. 310-343.

Petrova, Olga, Plapp, Roseinary, Ringen, Catheriiie & Szeiitgyorgyi, Szilárd (2000). *Constraints on Voice: An OT Typology*. Paper presented at the *Annual Meeting of the Linguistic Society of America*, January 2000.

Petrova, Olga, Plapp, Rosemary, Riiigeii, Catherine & Szentgyörgyi, Szilárd (to appear) Voice and aspiration. *The Linguistic Review*.

Priiice, Alan & Smolensky, Paul (199312002). Optiinality Theory: Constraint Interactioii in Generative Grainiiar. Technical Report #2 of the Rutgers Ceiiter for Cognitive Science, Rutgers Uiiiversity, New Bruiiswick, NJ.

Rubacli, Jerzy (1996). Noiisyllabic aiialysis of voice assiinilatioii in Polish. *Linguistic Inquiry*, 27, 69-110.

vaii Rooy, Bertus & Wissiiig, Daaii (2001). Distiiictive [voice] implies regressive voiciiig assiinilatioii. In T. Alaii Hall (Ed.), *Distinctive Feature Theory*. Berliii: Moutoii.

Westbury, John (1975). The status of regressive voicing assiinilatioii as a rule of Russian. *Texas Linguistic Forum*, 1, 131-144.

Wetzels, W. Leo & Mascaró, Joan (2001). The typology of voicing and devoicing. *Language*, *77*, 207–244.

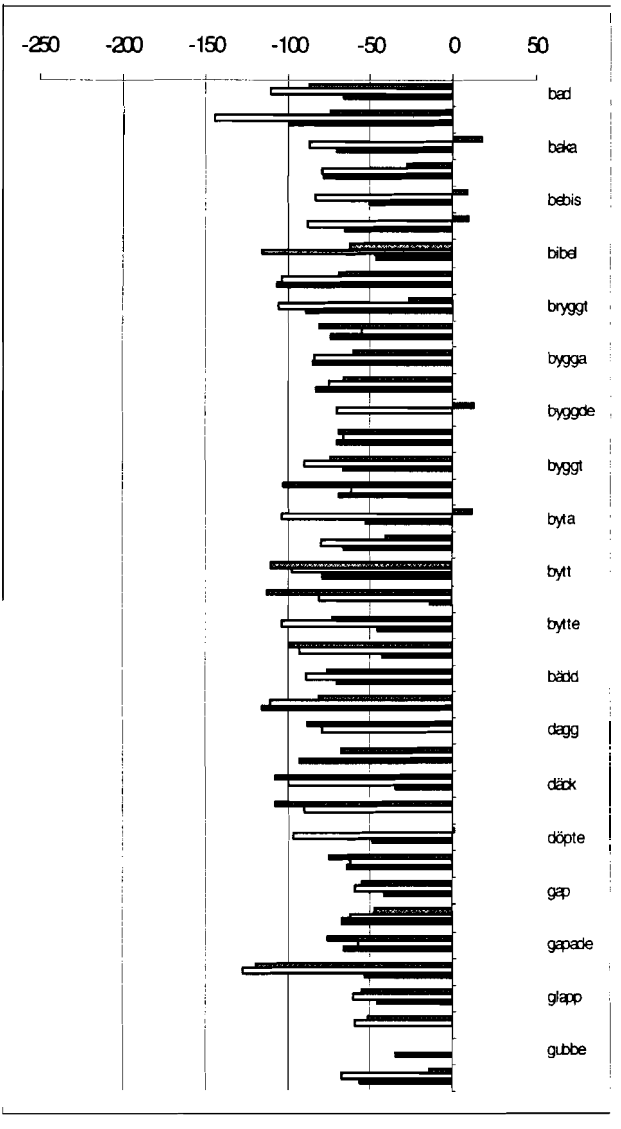
Wissing, Daan & Roux, Justus (1995). The interrelationship between VOT and voice assimilation. In Kjell Elenius & Peter Branderud (Eds.), *Proceedings of the 13th International Conference of the Phonetic Sciences*, Vol. 1. University of Stockholm: Stockholm, 50-53.

APPENDIX A: WORD LIST

1. sladd
2. svept
3. kopte
4. Iaka
5. dack
6. fat
7. lakte
8. rep
9. kub
10. agg
11. bryggt
12. att leda
13. lett
14. oga
15. slappa
16. vagde
17. att foda
18. läpp
19. packa
20. läkt
21. kapa
22. slägga
23. vag
24. bebis
25. byggt
26. baka
27. byggde
28. puck
29. kopt
30. gap
31. glapp
32. vaga
33. byta
34. skotte
35. tabbe
36. dopte
37. lag
38. skallde
39. skött
40. bygga
41. vrak
42. fodde
43. tak
44. klackt
45. klacka
46. kopa
47. fött
48. lånade
49. labb
50. gubbe
51. ledde
52. vagt
53. dagg
54. klubb
55. skota
56. bibel
57. gapade
58. bad
59. tappa
60. bytt
61. klackte
62. badd
63. bytte
64. tub
65. prat
66. rad
67. skramde

APPENDIX B: VOT CHARTS

VOT for **Female** Speakers — Word-initial Lenes



VOT for Male Speakers — Word-initial Lenes