

## Consequences of Voicing Acquisition for the Representation of Laryngeal Features

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This research contrasts two current theories of how laryngeal features are represented. One theory is offered by Wetzels & Mascaró (2001). Expanding on Lombardi (1999), Wetzels & Mascaró argue that laryngeal representations involve a binary feature [-/+ voice], based on cross-linguistic data of voicing contrasts, and patterns of voicing assimilation and final devoicing. Under this approach, Dutch and German have identical laryngeal features as the distribution of voicing in the languages is similar (they only differ in voicing assimilation in obstruent clusters). Another theory on the representation of laryngeal features is offered by Iverson & Salmons (1995). Based on phonetic properties and processes related to voicing, laryngeal contrasts are represented with monovalent features such as [voice] and [spread glottis]. Dutch voiced phonemes are prevoiced, and German voiceless phonemes are voiceless aspirated phonemes; therefore, Dutch has an active [voice] feature, whereas German has an active [sg] feature, respectively.

The actual difference between the phonemes in both languages in terms of VOT, and the feature representations offered by the two theories are illustrated in Table 1.

Table 1: VOT's and representations for Dutch and German word-initial stops

LANGUAGE	VOICING LEAD	SHORT LAG VOT	LONG LAG VOT
Dutch	-4 ms: b, d	0-25 ms: p, t	
Wetzels & Mascaró	[+voice]	[-voice]	
Iverson & Salmons	[ voice ]	[        ]	
German		16 ms: b, d	51 ms: p, t
Wetzels & Mascaró		[+voice]	[-voice]
Iverson & Salmons		[        ]	[sg]

Acquisition of the voicing contrast amounts to the task of building up a representation of laryngeal features. Hence, acquisition patterns of Dutch and German provide a way of testing the different theories' claims for the representation of laryngeal features. Although the theories make the same predictions for children's acquisition of medial segments (here passive voicing from the vowels will determine voicing) or final segments (here laryngeal features are neutralized in Dutch and German, possibly by delinking), in initial position, the theories are differentiated with respect to their predictions. Wetzels & Mascaró's theory would predict that in both languages, children's voicing errors in initial position would neutralize to the unmarked value [-voice]. Therefore, because Dutch and German have the same laryngeal representations, the predictions are the same for both languages – one would expect voiceless stops in initial position. Iverson & Salmons's theory, however, would predict that children's errors would result from a lack of specification of the active feature for their language – predicting voiceless stops for Dutch and unaspirated voiced stops for German.

For this study, data from 5 Dutch children were taken from the CLPF database (~10,000 utterances) and data from 2 German children were taken from the Nijmegen database (~10,000 utterances). Children's productions of words with initial voiced and voiceless obstruents were analyzed for patterns of voicing. The results show that children's productions differ across Dutch and German. Children learning Dutch tend to produce voiceless stops in initial position, whereas children learning German exhibit the opposite pattern and produce more voiced stops (Table 2).

Table 2: Children's production of initial voiced and voiceless obstruents

LANGUAGE	NO. OF CHILDREN	AGES	TYPICAL PRODUCTION PATTERNS
Dutch	5	1;1-2;11	b, d → p, t
German	2	1;6-2;0	p, t → b, d

Wetzels & Mascaró's binary feature [voice] cannot account for the difference between Dutch and German early acquisition data, which seem to show the reverse substitution patterns in word initial position. If we adopt the theory of Iverson & Salmons (1995), it follows that Dutch and German substitution patterns are different because the languages are of different types, i.e. have different laryngeal representations. In Dutch, children over-produce unmarked voiceless stops (as these are not specified for [voice]), whereas in German, children over-produce unmarked voiced stops (as these are not specified for [sg]). This type of featural representation can then account for the acquisition patterns seen in Table 2.

An alternative account of the acquisition patterns from Dutch and German would be that children's productions simply reflect an initial preference for Short lag VOT, hence an avoidance of prevoicing (Dutch) or aspiration (German). Here children's phonetic/physical constraints could be argued to play a larger role than phonological categorization. One clear difference between a purely phonetic account versus a phonological account is that the former would predict across-the-board effects in children's productions, and the latter would predict cases where the specified feature plays an active role in the phonology. A test case for these hypotheses is illustrated by the hypothetical English words in (1) and (2). Note that in Iverson & Salmons' theory, English represents laryngeal features with [sg], given that English contrasts voiceless aspirated stops with voiced unaspirated stops, like German. In (1) and (2), 'P' represented an English voiceless stop /p, t, k/, while 'B' represents an English voiced stop /b, d, g/. Focusing on errors in onset position, in (1) we would predict that initial /b/ would become [p] when the final /p/'s [sg] feature is spread to the onset. In (2) we would predict that the initial /p/ would not undergo assimilation from the final /b/ as it has no specification for [sg].

- (1)                    B    V    P    → PVP  
                          |                    |  
                          [    ]                    [sg]
- (2)                    P    V    B    ↯ BVB  
                          |                    |  
                          [sg]                    [    ]

This prediction was tested by looking at the acquisition data of a child (Seth) acquiring English, taken from the Peters corpus (~ 11, 300 utterances). Preliminary results confirm the prediction that the feature [sg] is active in the child's phonological representations. Although substitutions in word onsets occur in both directions, P → B and B → P, the error patterns are not quantitatively symmetrical. Of all the errors which could be characterized as (1) or (2), 75% matched the pattern seen in (1) and (25%) matched that in (2) – that is, the majority of errors were of type (1). Most B → P substitutions occur in target words of the type BVP (with P typically in coda, e.g. *box* → [p]ox, *drink* → [t]runk). Conversely, P → B substitutions (neutralizing deletions of [sg] in our view) are apparently not conditioned by a B-type consonant. Because B → P substitution in onset strongly depends on the presence of a P-type consonant in coda, this suggests that the feature [sg] is active, triggering coda-to-onset harmony. A purely phonetic account based on ease of articulation has difficulties explaining the substitution pattern. Since P-type consonants are phonetically realized by aspiration (Long lag VOT) in onsets, but by shortening of the preceding vowel and glottalization in codas, the harmony effect cannot be seen as involving articulatory gestures; rather, it must involve featural specification of [sg]. Children's production patterns, therefore, are better accounted for by the representation of laryngeal features offered by Iverson & Salmons, where laryngeal contrasts are represented with monovalent features such as [voice] and [sg].