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# Phonetically Motivated Parallels between Child Phonology and Historical Sound Change

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*ABSTRACT*

There is a long history of speculation in linguistics about the role of children, i.e., first language learners, in sound change. Many assume that the child is the initiator of sound change. More recently, however, important differences have been brought to light between child language phonology and diachronic phonology, thus calling into question the role of the child language learner in sound change. In this paper, we document several cross-language parallels between phonological processes exhibited by children learning their language and in "adult" phonology, i.e., allophonic variation, diachronic processes, dialect variation, etc. All are processes which can be explained phonetically by reference to acoustic-auditory factors. We argue, however, not that the "adult" sound patterns originated in child phonology, but that both stem from the same underlying physical phonetic causes, i.e., that both child and adult create such sound patterns independently, because they both possess the same phonetic apparatus. The question "who initiates sound change?" cannot, therefore, be answered by citing parallels, or lack of them, between child and adult phonology. Rather, we need to know who is it, child or adult, that is more likely to have his/her pronunciation mistakes copied by others, in this way leading to a pronunciation change characteristic of a whole linguistic community?

## INTRODUCTION

The role of children in linguistic change has been of interest to philologists for at least 100 years (Schleicher 1861–2, cited in Drachman 1978).[1] Grammont (1933) viewed children's linguistic behavior as a microcosm of historical change. Jakobson (1968) posited similar structural bases for both child and adult phonology. Stampe (1969 and 1972) attributed cross-linguistic similarities in phonological change to innate processes which all children bring to the task of language acquisition. In Stampe's view, (like Grammont's), the child had the role of prime mover in phonological change; similarities across languages in historical sound change could be at least partially attributed to the child's "mistake" in learning.

Although Stampe and his predecessors emphasized the global similarities between sound change processes in acquisition and those found in language history, recent studies of children's phonological development (such as Ferguson and Farwell 1975, Ferguson 1976, or Priestly 1977) have stressed the diversity of strategies which children may bring to the task of acquiring their native language. Just as differences between children acquiring the same language have been pointed out, differences between the phonological processes found diachronically and those used by children have also been noted. For example, Vihman (1978 and 1979) and Cruttenden (1978) have observed that consonant harmony processes, which occur in children's early phonologies, may be quite rare in adult language. Drachman (1978) concluded that these and other dissimilarities were such that they would argue against the role of children as initiators of phonological change: "The role of primary acquisition in language change seems to have been exaggrerated."

We believe that both children and adults may be responsible for the type of phonetic variation that can lead to sound change. While there are considerable differences in both developmental and diachronic sound shifts, there are nevertheless important similarities. These similarities should not be discounted, since they may potentially contribute to more "coherent" explanations of the origins for phonological change. See the examples provided further below.

As a basis for the discussion to follow, we assume a model of phonetically-caused sound change recently elaborated by Ohala (1974 and 1975) and Hombert, Ohala, and Ewan (1979). The model attempts to show how the physical constraints of the speech transmission and reception systems can leave their imprint on speech via sound change. In this paper, we focus only on sound changes (for the moment, using this as a cover term which also includes the kind of sound substitutions children make) which can be accounted for by the process of "[faulty] acoustic imitation" (Sweet 1891; Passy 1890).

Briefly, in faulty acoustic imitation, the listener confuses a sound or a group of sounds with items which are perceptually similar; a sound change may arise from this when the hearer takes on the speaker's role, incorporating his misperception or misinterpretation into his own articulation. Ohala (1975 and 1978) and Ohala and Lorentz (1977) have described the relevance of acoustic imitations in explaining synchronic and diachronic sound patterns. This misperception process can also provide insight into parallels between children's acquisition and adult language, since we assume that within certain developmental limits, the ability of children to make acoustic differentiations of the speech signal is similar to that of adult listeners (Eisenberg 1976; Kuhl 1979).

It should be emphasized that this model is intentionally incomplete in that it only attempts to account for "changes" that occur between a speaker and a hearer. Other models, presumably sociolinguistic ones, will have to be invoked to account for the transmission of the sound change once it has been initiated. This limitation has the advantage, however, of permitting us to duplicate in the laboratory the same type of perceptual misapprehensions that have occurred diachronically (Winitz, Scheib, and Reeds 1972; Wright 1975 and 1979; Javkin 1976; Ohala, Riordan, and Kawasaki 1978; Kawasaki 1978; Janson 1979).

In the following sections, we will cite some of the evidence we know of which suggests that certain sound changes are very common cross-linguistically, both in adult language data and in child language. The "adult" language data which we will cite include instances of diachronic sound change, as well as synchronic alternations and dialect variation. We must concede in advance that cross-linguistic data on children's speech are often sparse and only suggestive. In some cases, we are only able to cite child language data from one language, but in these cases we think the unusual character of the processes guarantees that, like the other cases, these represent parallels that cannot have arisen by chance.

In each case, we will first cite the evidence from sound change in adult language ("adult language data"), then, the child language data, and, finally, offer some brief remarks about the phonetic basis of the processes.

## STABILITY OF NASAL CONSONANTS

### Adult Language Data

A casual inspection of some of the accounts of the phonological history of various language families (e.g., Meillet 1964; Guthrie 1967–70; Chen 1973) provides ready justification for comments such as Ferguson's (1975) that initial nasals are "astonishingly stable," and that in some language families, "cases can be found in which almost all of the consonant system has changed while the initial nasals remain."

### Child Language Data

Diary studies of children's acquisition have usually shown that nasal consonants are separated from oral consonants, especially oral stops, at a very early age. Jakobson (1968) hypothesized that the distinction between oral and nasal consonants would be among the first consonant contrasts to appear in children's speech. Table 1 summarizes child language data from several studies, representing acquisition data for a variety of languages, on the mastery of selected consonants. Most of the child language data are drawn from 'diary' or case-study data collected over a long period of time (e.g., Vanvik); for some children, sound-mastery was examined synchronically at a particular age (e.g., Apronti). Although it is difficult to compare data collected using such different methods, nevertheless, the relative stability of nasal consonants in children's early production is clearly observable. From the diary data, it can be observed that ages cited for production of nasals and stops are nearly always earlier than those cited for fricatives. The Velten data are a notable exception. From the cross-sectional data, it can be observed that while stops and nasals are generally included among the inventory of sounds produced correctly between 1;6 and 2 years, fricatives may still be unstable at this stage.

Additional evidence on the relative stability of nasals in children's early speech comes from large-scale cross-sectional studies of pre-school children, such as those by Olmsted 1971 (for English), Yasuda 1969/70 (for Japanese), or Martinet 1974 (for French): nasal consonants are rarely a source of major errors by about 3 years of age. It is also significant that in American schools, nasal consonants are almost never listed as sounds misarticulated consistently by school-age children (Carrell 1937;

Table 1

Children's Mastery of Consonant Types: the Early Emergence of Nasals

1. Data considered diachronically ('diary data')

| Language | Source | Stops | Nasals | Fricatives |
|---|---|---|---|---|
| Arabic | Omar (1973) | t d k (2;0)[1] | m (1;5) n (2;0) | s, z (2;0) f (2;3) |
| English | Velten (1943) | p/b t/d (0;11–1;1)[2] | m (1;5–1;10) n (1;6–1;9) | s (1;0) f (1;2) |
| | Leopold (1947) | b d (0;10) | m (1;2) n→ŋ (1;8–1;11)[5] | ʃ (1;7) |
| Estonian | Vihman (1971) | p (1;7) t, k (1;8) | m (1;8) n (1;7) | v (1;7) s (after 1;10) |
| Garo | Burling (1971) | p t k (1;4) | m, n (1;4) ŋ (1;9) | s (1;7) |
| Hindi | Srivastava (1974) | p (1;0) t, k (1;1) | m (1;0) n (1;4) | s (1;0) ʃ (1;7) |
| Japanese | Nakazima (1972, 1974) | p b t d k g (by 1;9) | m (1;3) n (1;5) | 'unstable' (1;9) |
| Norwegian | Vanvik (1971) | b d (1;0) | m (1;0) n (1;1) ŋ (1;8) | s (appears 1;9) f (by 2;2) |
| Russian | Timm (1977) | p b t d (1;7–1;8) | m (appears 1;7–2;4) | s, ʃ 'low success' until (2;8) |
| Serbian | Pavlovitch (1920) | p(1;0) t (1;4) k (1;1) | m (0;7) n (1;1) ñ (1;8) | s, ʃ (1;7) |
| Spanish | Macken (1977) | p, t (1;7) k (1;8) | m, n (1;7) | f, s (2;0) |
| Taiwanese | Jeng (1979) | p t k (1;10) | m (1;5) n (1;5–1;11) ŋ (1;7–1;10) | s (1;6) f (2;5) |

2. Data considered synchronically ('cross-sectional data')

| Language | Age | Source | Stops | Nasals | Fricatives |
|---|---|---|---|---|---|
| Czech | (1;5–1;7) | Pačesova (1968)[3] | p t k | m n ñ | unstable, except h |
| Dangme | (2;0) | Apronti (1969) | p b d g | m nʲ | f |
| French | (1;6–1;8) | Cohen (1952) | p/b t/d k/g | m n ñ | f, v (1;9) s ('begins' 1;10) |
| Greek | (1;5) | Hinofotis (1976) | p t b d k | m n | 'unstable' |
| Romanian | (2;0) | Vogel (1975) | p b k g | m n | f s ʃ 'unstable' |
| Thai | (1;8) | Tuaycharoen (1977)[4] | All stops except velars | m n | 'unstable' |
| Zuni | (2;0) | Kroeber (1916) | p t | m n | s, ʃ 'unstable' |

NOTES:

1. Children's ages are given in approximate years and months e.g., 1;6 means "one year, six months." These figures are best interpreted with some caution, given the several methods of data collection and analysis used in the various studies cited. Age-figures are more meaningful in the context of relative, rather than absolute, chronology of sound mastery. It seems quite likely that Pavlovitch's very early age for emergence of [m] represents sound-production in a 'prelinguistic' or babbling period. Apparently [m] was produced correctly from the beginning of this child's meaningful speech.
2. Slashes between stop consonants indicate that the child does not yet distinguish these consonants on the basis of voicing characteristics.
3. Although Pačesova's study was collected over a long period of time, the child's mastery of speech sounds was sampled and analyzed in a series of stages according to vocabulary. In Table 1, consonant mastery during the period of the first 50 words is represented.
4. Tuaycharoen's method of data collection and analysis was similar to that of Pačesova. In Table 1, the child's mastery of speech sounds is shown at an advanced stage.
5. Adult /n/ was realized as a velar nasal by the child during the period 1;8–1;11.

Robinson 1947; Morley 1959).

### Phonetic Basis

The phonetic basis of nasal stability can be found both in the articulatory and acoustic properties of nasal consonants. In addition to their rather simple articulatory requirements, nasal consonants are acoustically distinct from all other classes of consonants (except perhaps [l], see below). Unlike the oral obstruents, they do not have any frication or noise burst, any interruption of voicing or perturbation of voice fundamental frequency. Unlike the glides or approximants, they do involve a sudden change in amplitude and spectrum when adjacent to vowels. Their spectrum also includes resonance peaks with very large band widths and, sometimes, clearly marked anti-resonances. (For a review, see Fant 1960, Heinz 1974, and Ohala 1975). Many perceptual studies have also verified the perceptual saliency of nasal consonants as a class (e.g., Miller and Nicely 1955).

Even though nasal consonants are as a class rather stable and appear very early in children's speech, they are occasionally the subject of some sound changes. In these cases, the parallels between phonological change in adult language data and in children's speech are again evident.

## ALTERNATIONS BETWEEN NASALIZED VOWEL AND VOWEL PLUS VELAR NASAL

### Adult Language Data

In Achinese (Sawyer 1958), excrescent [ŋ] has developed in several forms. Usually the stem already contained a nasal, e.g., **huma* 'wet rice field' > [ʔumɔŋ]; **ləɲa* 'sesameseed' > [ləɲəŋ]. Presumably, the course of development was NV → NṼ → NṼŋ.

In Toura, Ivory Coast (Bearth 1971), [ū] is sometimes realized as a syllabic velar nasal [ŋ], e.g., */kũ/* 'to catch' [kũ] or [kŋ].

In Mbay (Caprile 1968), the final vowel in CVCV̌ words often has a light velar ending, e.g., /korə̃/ 'donkey' [kòrũᵏ] or (kòrŨᵑ]; /dànẽ/ 'earth' [danə̃ŋ] or [danæ̃ᵑ].

In Goajiro (Arawak) (Holmer 1949), nasal vowels often have a velar nasal offglide, e.g., /wĩ/ 'water' [ˀwiŋ].

French loans in Vietnamese (Barker 1969) are nativized with vowel plus velar nasal replacing nasalized vowels, e.g., original French [ãtɘŋ] 'antenna' becomes [ãŋtɜn]; [pɔ̃] 'deck of a ship' is [bɔŋ].

## Child Language Data

Gregoire (1947:252–3) found that two children learning French (Charles and Edmond) produced the nasal vowels "like foreigners" substituting a vowel "peu ou point nasalisée" followed by a velar nasal, e.g., *baton* 'stick' [batoŋ] or [batõŋ] until age 4;6 and *maman* 'mother' [mamaŋ] up to 4;0. (Adult speakers of some regional dialects of French show similar substitutions, e.g., the Avignon dialect.) Charles and Edmond apparently produced the nasal vowels of their native French very much in the way Vietnamese speakers nativize French loanwords containing these sounds.

Clumeck (1977a) reported that a child learning Mandarin produced final velar nasals as nasalized vowels between the ages of 2;1 and 2;5, e.g., 'help', /paŋmaŋ/, was said as [bãmã].

In data on children learning Japanese, Nakazima (1972) found that phrase-final/N/[2] was either a velar nasal, or nasalization of the preceding vowel, e.g., /kiriN/ 'giraffe' [kIIn] ~ [tidĩ] ~ [tɕIN] (1;5) /to:tsjaN/ 'father' [totɕaã] (1;4) or [to:taN] ~ [doʑaa] (1;5).

Straight (1975:69) found that children learning Yucatec Maya also showed variation between nasalized vowel and velar nasal: Alberto (3;8) produced phrase-final nasals nearly always as voiced [ŋ], sometimes as [Ṽh] or [Ṽŋ]. Humberto (5;11) also showed this pattern. Adult speakers of Yucatec Maya show "highly variable optional rules of reduction" for phrase final nasals, including "complete loss of obstruence" with only Ṽ remaining.

In all four of the languages for which children's forms have been cited above – French, Mandarin, Japanese, and Yucatec Maya – alternation between nasalized vowel and vowel plus velar nasal exists in the adult language, and it may be that children learning these languages merely reproduced variation which they heard in their language community.

**Phonetic Basis**

The acoustics of nasal consonants as well as the results of adult speech perception studies may aid in explaining why velar nasals – rather than those at other points of articulation – are likely to be confused with a nasalized vowel. One of the cues for a nasal consonant is an anti-formant caused by the absorption of acoustic energy by the the oral side cavity branching off the main nasal-pharyngeal airway. The frequency of the anti-formant is inversely proportional to the length of this branch. Thus [m] has the longest oral branch and the lowest and perceptually most evident anti-formant. Since [ŋ] has the shortest – often negligible – oral branch, any anti-formant it does have will be very high in frequency and will appear in that portion of the nasal spectrum already very much attenuated. Thus, the velar nasal will be perceptually less of a nasal consonant than [m], [n], etc. It will, in fact, very much resemble a simple nasalized vowel. In addition, the typically long transitions between velar consonants and adjacent vowels probably reduce the suddenness of the amplitude and spectrum changes that otherwise serve as cues for nasal consonants. For further details, see Ohala (1975) and works cited therein.

House (1957) investigated the confusability of nasals in a perceptual study. He found that the probability of confusing a nasal consonant with a nasalized vowel is far greater in the case of the velar nasal [ŋ] than for [m] or [n].

## ALTERNATION BETWEEN [n] AND [l]

As mentioned earlier, it is somewhat rare to find nasal consonants alternating with or changing into other classes of consonants. One exception to this tendency is the alternation of [ŋ] with the lateral [l].

**Adult Language Data**

In Bengali (Ferguson and Chowdhury 1960:30), "except in very careful speech," /n/ before /l/ results in nasalized [l̃].

In Palaun (Foley 1975:220), /l/ occurs as a reflex of Proto Austronesian (PAN) **n*. Sample correspondences are: PAN **nanaq* 'pus' Pal.

/lalɔʔ/; PAN **manuk* 'chicken' Pal. /malk/.

In Melanesian (Codrington 1885), the following alternations are found: Ceran [nima] 'hand' is represented in other dialects as [lima]; there is free variation in such forms as Santa Cruz [napnu] ~ [lapnu] 'ten' and Malanta [niu] ~ [liu] 'coconut'.

Korean (Martin 1951 and 1954) shows word-initial [n] for /l/ in the Sino-Korean part of the vocabulary.

### Child Language Data

In children's early phonology, by far the more common substitutions for lateral consonants are glides ([j] or [w]) or, for syllabic and pre-consonantal /l/, vowels (Pačesova 1968; Stoel 1974; Ingram 1976). However, there are instances in which children have substituted a nasal consonant for the lateral. These are presented in Table 2.

### Phonetic Basis

The alternation between nasal and lateral consonants in both types of data can be explained on the grounds of acoustic similarity. Both nasals and laterals have transitions to a following vowel which involve sudden shifts in amplitude and spectral configuration; both types of consonants have anti-resonances; and both leave voicing and pitch unperturbed.

## /s/ + NASAL CLUSTERS

### Adult Language Data

The voiceless nasals in Burmese developed from initial clusters of /s/ + nasal, as evidenced by a comparison of cognate forms in Modern Burmese and Written Tibetan, the latter of which preserves the older phonetic form (data from Graham Thurgood, personal communication), e.g., Written Tibetan *sna*, Burmese /n̥a/ 'nose'.

Sturtevant (1940:63) concludes that Indo-European *sm* and *sn* became [m̥] and [n̥] in Primitive Greek, just as *sr* and *sl* became [r̥] and [l̥], respectively. A similar development for voiceless nasals in Old Irish is described by Thurneysen (1946:84).

**Table 2**

**Alternations between Nasals and Laterals in Children's Speech**

| *Language* | *Source* | *Adult form* | *Child form* | *Age* | *Gloss* |
|---|---|---|---|---|---|
| Arabic | (Omar 1973) | allah | [ʔənnɛh] | 2;3 | 'god' |
| English | (Salus & Salus 1974) | pillow | [pInuw] | 1;7 | 'pillow' |
| Estonian | (Oksaar 1977) | muna | [mun̠ʲa] ~ [mul̠ʲa] ~ [muna] | 1;7 | 'egg' |
| French | (Martinet 1974) | banane | [balan] | 4;8–5;5 | 'banana' |
| Spanish | (Macken 1977) | leche | [nɛtʃe] | 2;1 | 'milk' |
| | | reloj | [Bʷlno] | 2;1 | 'watch' |
| | | pastel | [pltɛn] | 2;0 | 'pastry' |
| | | leche | [ñetʃi] | 2;4 | 'milk' |
| Yucatec Maya | (Straight 1975; transcription simplified) | nook' | [luuk'] ~ [luk'] | 3;8, 5;11 | 'clothing' |
| | | neet' | [leet'] | 4;0, 5;8 | 'to bite off' |
| | | nuup' | [luut'] | 8;6 | 'nape' |
| | | luub' | [nuup'] | 8;3 | 'league' |

Some instances of Awadhi /–nɦ–/, i.e., a breathy-voiced nasal, derive from original Old Indo-Aryan *–sn–*, e.g., *jyotsna* 'moonlight' > /jonɦʌija:/ (Saksena 1971:45).

## Child Language Data

A number of writers have reported that children learning English substitute voiceless nasals for /s/ + nasal clusters, e.g., 'Smith' [m̥it], 'sneeze' [n̥id] at 2;9 (Smith 1973); 'smack' [m̥æk], 'snip' [n̥Ip] at 3;0–3;1 (Greenlee 1973); 'snail' [n̥ejl] (Hooper 1977).

**Phonetic Basis**

As noted by Ladefoged (1971:11), in reference to Burmese, many instances of voiceless nasals, at least in initial position, are phonetically partially voiced just before release. This is true as well of the voiceless nasals recorded in child language by Greenlee. Acoustically, a sequence of voiceless nasal + voiced nasal represents a very close approximation to a sequence of /s/ + voiced nasal, i.e., both constitute a sequence of voiceless broad band noise followed immediately by the nasal consonant. The sequence N̥N- also is much simpler in terms of articulation: rather than requiring synchronization of tongue and/or lip movements with soft palate movements, the soft palate may be left in the same lowered position for both parts of the N̥N sequence – only the transition from voiceless to voiced is required.

## NASAL + OBSTRUENT CLUSTERS

Another pattern involving nasal consonants concerns the probability of retention of a post-vocalic nasal before a syllable final voiced C̬, as opposed to voiceless C̥ obstruent.

**Adult Language Data**

Among native vocabulary in Hindi, long nasalized vowels occurring before final obstruents must have a homorganic nasal consonant intervening, if the obstruent is voiced, but must not have any intervening nasal, if the obstruent is voiceless (M. Ohala 1972). Thus, [sĩ:k] 'twing' and [sĩ:ŋg] 'horn' are existing morphemes; *[sĩ:ŋk] and *[sĩ:g], however, could not be native morphemes.

In Breton, a VNC sequence may become VC, especially if the C is a voiceless obstruent C̥ e.g., [jowəŋk] ~ [jowə̃k] 'young', and [domp] ~ [dõp] 'to us' (Timm 1978).

In American English, the nasal in an original VNC̥ sequence may be deleted or may be so short as to be perceptually insignificant, thus leaving the vowel distinctively nasalized. Where the stop is voiced C̬, however, the nasal consonant is relatively long and not liable to be deleted : e.g., 'send' is [sɛ̃nd], but 'sent' may be [sɛ̃t] (Malécot 1960; Ohala 1975; and

Lovins 1978).

**Child Language Data**

In acquisition data for English and other languages, it has been noted that children have different productions for NC clusters, depending on the voicing of the obstruent; in general, children produce the nasal consonant, if the obstruent in such clusters is voiced, but delete the nasal consonant, when the obstruent is voiceless.

In data for 16 children (2;5–5;10) acquiring Spanish, Hernández-Chávez, Vogel, and Clumeck (1976) found that "in . . . medial NÇ's, the nasal appears earlier than the homorganic voiced obstruent, and in the case of medial NC̣'s it is the obstruent that is articulated earlier."

Contreras and Saporta (1971) reported the following Spanish forms: *chancho* 'pig' [tʃata] or [tʃaʃo] (1;7), but *grande* 'big' [gan] and *anda* 'he walks' [ana] at the same age.

English examples of this pattern can be drawn from several studies: 'ants' [ats], but 'hand' [han] (1;10) (Velten 1943); 'don't' [dot], but 'hand' [hã] (2;0) (Leopold 1947); 'tent' [d̥ɛt], but 'mend' [mɛn] (2;2) (Smith 1973).

**Phonetic Basis**

As mentioned above, the differential treatment of NC clusters can probably be accounted for by the effects of obstruent voicing on the nasal consonant. Nasal consonants (in English at least) are considerably longer when the following obstruent is voiced; thus, they would be more perceptible and less likely to be deleted in the listener's reproduction.

So far, the parallels we have documented have to do with nasal consonants. The following two cases are similar to some of the previous ones in that they appear to be motivated by acoustic similarity, but they do not involve nasals.

## FRICTION + [w] RESULTS IN A LABIAL FRICATIVE

**Adult Language Data**

Henderson (1975) found free variation between the initial cluster

[$k^hw$] and [f] in Songkhla, a Thai language, e.g., [fai] ~ [$k^h$wai] 'fire'.

In Tuscarora (Willaims 1976), the fricative variant of /w/ (described as a velar glide) is bilabial [ɸ], e.g., /Vˀw/ [ə̃ˀɸ] 'it arrived'. (Tuscarora has no labial phonemes.)

In Sentani, /h/ is optionally realized as [f] or [ɸ] before [w] (Cowan 1965).

Clumeck (1977b) cited the following examples of Chinese dialect variants:

| | Standard Mandarin | Wu | Xiang | Gan | Hakka |
|---|---|---|---|---|---|
| 'be able' | w̥ei | vai | fei | ɸ ui | fi |
| 'draw' | w̥a | – | fa | ɸ ua | fa |

Ohala and Lorentz (1977) reported similar trends in many other languages: when friction is added to the labial-velar [w], the result is much more likely to be a labial, rather than a velar, fricative.

### Child Language Data

Both Chao (1973) and Clumeck (1977b) found parallels between the speech of children learning Mandarin and the dialet variation noted in the adult data above.

At 2;4, the child studied by Chao said adult Mandarin *hual* [w̥al] 'flower' as [ɸua].

Clumeck noted the following forms in the speech of a child between the ages of 1;10 and 2;10; like Chao's granddaughter, the child used [f] for adult [w̥]: /hua/(reduplicated) [w̥aw̥a] 'draw' > [fafa]; /huei/ [w̥ei] 'be able' > [fei].

Many authors have reported that English-speaking children replace initial *sw* clusters with [f] or [w̥] (the latter described as a "voiceless labial"), e.g., Lewis (1936) 'sweet' [fi:t] (2;3); Webster (1975) 'sweater' [fw ɛ $t^h$ ɛ h] (2;6); Velten (1943) 'swim' [fub], 'sweep' [fup] (1;10); Smith (1973) 'switch' [w̥lt] (2;9), Greenlee (1973) 'switch' [fltʃ] (3;0).

In deviant English phonology (Lorentz 1972, cited in Ingram 1976) several labials are realized as [f] when the adult model word contains a cluster of /s/ + labial consonant: 'swat' [fat], 'spoon' [fun], 'small' [fal].

A related example from German (Stern and Stern 1927, cited by Lewis 1936) is *Schwanz* 'tail' as "fatz" at 1;9.

### Phonetic Basis

Ohala and Lorentz (1977) suggest that the reason a fricated [w] usually becomes a labial, rather than a velar fricative, is that of the two potential noise sources, labial and velar, the latter noise source is greatly attenuated by the low-pass filtering characteristics of the air space anterior to it, whereas the former (the labial) noise source is not subject to any such filtering. Therefore, the labial noise source is perceptually more evident.

## PALATALIZED LABIALS BECOME APICALS

### Adult Language Data

There is abundant phonological evidence that palatalized labials have a tendency to change to apicals, e.g., Standard Czech [mʲɛstɔ] ~ East Bohemian [nɛstɔ] 'town (Bělič 1966); Lungchow /pjaa/ ~ T'ienchow /čaa/ (Li 1977); Roman Italian [bjanko] ~ Genoese Italian [dʑanku] 'white' (Jaberg and Jud 1928–1940); Pre-Classical Greek **kom-yo-* ~ Classical Greek *Koinós* 'common' (Meillet and Vendryes 1924). See Ohala 1978 for further examples and discussion.

### Child Language Data

Timm (1977 and personal communication) recorded the sound substitutions of one child learning Russian. Her data reveal that the most common substitution was that of palatalized labials being replaced by dentals (37 instances) as opposed to palatalized dentals by labials (23 instances) and palatalized dentals by velars (24 instances).

### Phonetic Basis

As detailed in Ohala 1978, the second formant transition characteristic of palatalized labials is virtually identical to that characteristic of dentals. In the absence of other cues (e.g., stop burst), listeners are liable to mistake palatalized labials for dentals and, then, repeat them as such.

Perceptual experiments such as those by Lyublinskaya (1966) and Winitz, Scheib, and Reeds (1972) also present evidence of the perceptual similarity of dentals and palatalized labials or labials followed by palatal vowels.

## CONCLUSION

We have reviewed above evidence which shows that there are remarkable parallels between phonological processes in adult and child language. We think the parallels are too specific to be attributed to chance. Does this mean that children are the cause of sound change? Not necessarily. What we do not know, and what is crucial to this issue is: once a speaker makes a sound substitution (or 'mispronunciation'), whose speech, child or adult, is more likely to serve as a model for others' pronunciation? The distinction we are making here is that between the **initiation** of sound change and the **transmission** or spread of sound change (Weinreich, Labov, and Herzog 1968). We would claim that all speakers, children and adults, by virtue of shared articulatory and perceptual constraints, are eligible to be the initiators of "mini" sound changes of the type documented here. But whose sound changes, once initiated, spread to other speakers to become "maxi" sound changes, i.e., sound changes proper, characteristic not only of an isolated speaker, but of whole speech communities?

As far as we know, there is no definite evidence at present which would answer this question. But until it is answered, we would maintain that studies of parallels between child and adult phonologies tell us more about the human universal phonetic factors that lead to sound change, rather than the scenario which converts a mispronunciation into a full-fledged sound change.

## NOTES

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2. Nakazima's original transcription of the nasals is retained here. 'N' represents a nasal *mora* which assimilates in place of articulation to a following consonant in adult speech. In word-final position, this symbol may represent an "incompletely closed velar nasal" (Lovins 1974).

Abbreviations Used in References

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|---|---|
| CLS | Chicago Linguistic Society Annual Meeting, Proceedings |
| IJAL | International Journal of American Linguistics |
| JASA | Journal of the Acoustical Society of America |
| JSHD | Journal of Speech and Hearing Disorders |
| PRCLD | Papers and Reports on Child Language Development, Stanford |
| RPL | Report of the Phonology Laboratory, Berkeley |
| SELAF | Société d'Études Linguistiques et Anthropologiques de France |

## REFERENCES

Apronti, E.O.
1969 "The Language of a Two-year-old Dangme," paper presented at the Eighth Congress of West African Linguistic Society.

Barker, Milton E.
1969 "The Phonological Adaptation of French Loanwords in Vietnamese," *Mon Khmer Studies 3, Publication* 4. 138–47, Linguistic Circle of Saigon.

Bearth, Thomas
1971 "L enoncé toura (côte d'Ivoire)," *SIL Publications in Linguistics and Related Fields 30*, Norman: Summer Institute of Linguistics.

Bělič, J.
1966 "K otázce zaniklého litomyšlského *t, d, n* za někdjši *p', b', m'*," *Slavica Pragensia* 8, Acta Univ. Carolinae, Philologica 1–3.
Burling, Robbins
1971 "Language Development of a Garo and English-speaking child," in *Child Language: A Book of Readings*, pp. 170-85, A. Bar-Adon and W.F. Leopold (eds.), Englewood Cliffs: Prentice-Hall.
Caprile, J–P.
1968 "Essai de phonologie d'un parler mbay," *Bulletin de la Société d'Études Linguistiques et Anthropologiques de France*.
Carrell, James
1937 "The Etiology of Sound Substitution Defects," *Speech Monographs* 4.17–37.
Chao, Yuen-Ren
1973 "The Cantian Idiolect: an Analysis of the Chinese Spoken by a Twenty-eight months old Child," in *Studies of Child Language Development*, pp. 13–33, C.A. Ferguson and D.I. Slobin (eds.), New York: Holt, Rinehart, and Winston.
Chen, Matthew
1973 "Nasals and Nasalization in the History of Chinese," Ph. D. Dissertation, University of California, Berkeley.
Clumeck, Harold
1977a "Topics in the Acquisition of Mandarin Phonology: a Case Study," *PRCLD* 14.37–73.
1977b "A Parallel between Child and Adult Language: a Study in the Phonetic Explanation of Sound Patterns," unpublished manuscript.
Codrington, Robert H.
1885 *The Melanesian Languages*, Oxford: Clarendon Press.
Cohen, Marcel
1952 "Sur l'étude du language enfantin," *Enfance* 5.181–249. (Excerpt and English translation in *Child language: a Book of Readings*, pp. 205–09, A. Bar-Adon and W.F. Leopold (eds.), 1971, Englewood Cliffs: Prentice-Hall.)

Contreras, Heles, and Sol Saporta
1971 "Phonological Development in the Speech of a Bilingual Child," in *Language Behavior: a Book of Readings in Communication*, pp. 280–94, J. Akin, A. Goldberg, G. Myers and J. Stewart (eds.), the Hague: Mounton.

Cowan, H.K.J.
1965 *Grammar of the Sentani Language*, Le Hague: Martinus Nijhoff.

Cruttenden, Alan
1978 "Assimilation in Child Language and Elsewhere," *Journal of Child Language* 5.373–8.

Drachman, Gaberell
1978 "Child Language and Language Change: a Conjecture and Some Refutations," in *Recent Developments in Historical Phonology*, pp. 123-44, J. Fisiak (ed.), the Hague: Mouton.

Eisenberg, Rita
1976 *Auditory Competence in Early Life: The Roots of Communicative Behavior*, Baltimore: University Park Press.

Fant, Gunnar
1960 *Acoustic Theory of Speech Production*, The Hague: Mouton.

Ferguson, Charles A.
1975 "Universal Tendencies and 'Normal' Nasality," in *Nasálfest*, pp. 175–96, C.A. Ferguson, L.M. Hyman, and J. Ohala (eds.), Stanford University: Language Universals Project.
1976 "Learning to Pronounce: the Earliest Stages of Phonological Development in the Child," *PRCLD* 11.1–27.

Ferguson, Charles A., and Munier Chowdhury
1960 "The Phonemes of Bengali," *Language* 36.22–59.

Ferguson, Charles A., and Carol B. Farwell
1975 "Words and Sounds in Early Language Acquisition: English Initial Consonants in the First Fifty Words," *Language* 51.419–39.

Foley, William A.
1975 "Some Rules Involving Nasals and Their Implications," in *Nasálfest*, pp. 213-30, C.A. Ferguson, L.M. Hyman, and J. Ohala (eds.), Stanford University: Language Universals Project.

Grammont, Maurice
1933 *Traité de phonétique*, Paris: Delagrave.
Greenlee, Mel
1973 "Some Observations on English Initial Consonant Clusters in a Child Two to Three Years Old," *PRCLD*, 6.97-106.
Grégoire, Antoine
1947 *L'apprentissage du langage*, Vol. 2, Paris: C. Klincksieck.
Guthrie, Malcolm
1967-70 *Comparative Bantu*, 4 vols, Gregg.

Heinz John M.
1974 "Speech Acoustics," in *Current Trends in Linguistics*, Vol. 12, *Linguistics and Adjacent Arts and Sciences. Part 10: Phonetics*, pp. 2241–80. T.A. sebeok (ed.), the Hague: Mouton.
Henderson, Eugenie J.A.
1975 "Feature-shuffling in South East Asian languages: or How Big is a Segment" Paper presented at the Eighth Sino-Tibetan conference, Berkeley, California.
Hernández-Chávez, Eduardo, Irene Vogel, and Harold Clumeck.
1975 "Rules, Constraints, and the Simplicity Criterion: an Analysis based on the Acquisition of Nasals in Chicano Spanish," in *Nasálfest*, pp. 231–48, C.A. Ferguson, L.M. Hyman, and J. Ohala (eds.), Stanford University: Language Universals Project.
Hinofotis, Frances
1976 "An Initial Stage in a Child's Acquisition of Greek as his Native Language," *Workpapers in TESL* (UCLA) 11.85-96.
Holmer, Nils M.
1949 "Goajiro (Arawak) I: Phonology," *IJAL* 15.45–56.
Hombert, Jean Marie, John J. Ohala, and William G. Ewan
1979 "Phonetic Explanations for the Development of Tones," *Language* 55.37-58.
Hooper, Joan Bybee
1977 "Substantive Evidence for Linearity: Vowel Length and Nasality in English," *CLS*, 13.152–64.
House, Arthur S.
1957 "Analog Studies of Nasal Consonants," *JSHD* 22.190-204.

Ingram, David
1976 *Phonological Disability in Children*, London: Edward Arnold.
Jaberg, K. and J. Jud
1928-40 *Sprach und Sachatlas Italiens und der Südschweiz*, Zurich.

Jakobson, Roman
1968 *Child Language, Aphasia, and Phonological Universals*, the Hague: Mouton
Janson, T.
1979 *Mechanisms of Language Change in Latin*, Acta Universitatis Stockholmiensis, Studia Latina Stockholmiensia 23, Stockholm: Almqvist & Wiksell.
Javkin, Hector
1976 "The Perceptual Basis of Vowel Duration Differences associated with Voiced/Voiceless Distinction," *RPL* 1.78-92.
Jeng, Heng-Hsiung
1979 "The Acquisition of Chinese Phonology in Relation to Jakobson's Laws of Irreversible Solidarity," *Proc. 9th Int'l Cong. of Phonetic Sciences*, Vol. 2, pp. 155-61, Copenhagen, Institute of Phonetics.
Kawasaki, Haruko
1978 "The Perceived Nasality of Vowels with Gradual Attenuation of Adjacent Nasal Consonants," *JASA* 64.S19.
Kroeber, Alfred L.
1916 "The Speech of a Zuni Child," *Am. Anthro.* 18.529–34.
Kuhl, Patricia K.
1979 "The Perception of Speech in Early Infancy," in *Speech and Language: Advances in Basic Research*, Vol. 1, pp. 1–47, N. J. Lass (ed.), New York: Academic Press.
Ladefoged, Peter
1971 *Preliminaries to Linguistic Phonetics*, Chicago: University of Chicago Press.
Leopold, Werner F.
1947 *Speech Development of a Bilingual Child*, Vol. 2, Chicago: Northwestern University Press.
Lewis, Michael M.
1936 *Infant Speech: a Study of the Beginnings of Language*, New

York: Harcourt Brace.
Li, Fang-Kuei
1977 *A Handbook of Comparative Tai*, Hawaii: University Press of Hawaii.
Lorentz, James P.
1972 "An Analysis of Some Deviant Phonological Rules of English," unpublished manuscript, Berkeley.
Lovins, Julie B.
1974 "Why Loan Phonology is Natural Phonology," in *Papers from Parasession on Natural Phonology*, pp. 240-50, *CLS*.
1978 "Nasal Reduction in English Syllable Codas," *CLS* 14.241–53.
Lyublinskaya, V. V.
1966 "Recognition of Articulation Cues in Stop Consonants in Transition from Vowel to Consonant," *Soviet Physics – Acoustics* 12.185–92.
Macken, Marlys A.
1977 "Developmental Reorganization of Phonology: a Hierarchy of Basic Units of Acquisition," *PRCLD* 14.1–36.
Malécot, André
1960 "Vowel Nasality as a Distinctive Feature in American English," *Language* 26.222–9.
Martin, Samuel E.
1951 "Korean Phonemics," *Language* 27.519-33.
1954 *Korean Morphophonemics*, Baltimore: Linguistic Society of America
Martinet, Jeanne
1974 "A proros d'un enquête sur la phonologie des enfants d'une école maternelle," *Linguistique* 10.93–103.
Meillet, Antoine
1964 *Introduction à l'étude comparative des langues indo-européennes*, University: University of Alabama Press.
Meillet, Antoine, and Joseph Vendryes
1924 *Traité de grammaire comparée des langues classiques*, Paris: Librairie Ancienne Edouard Champion.
Miller, George A., and Patricia E. Nicely

1955 "An Analysis of Perceptual Confusions among Some English Consonants," *JASA* 27.338–52.

Morley, Muriel E.

1959 "Defects of Articulation," *Folia Phoniatrica* 11.65-124.

Nakazima, Sei

1972 "A Comparative Study of the Speech Development of Japanese and American Children, part 4: the Beginning of the Phonemicization Process," *Studia Phonologica* 6.1–37.

1974 "A Comparative Study of the Speech Development of Japanese and American children, part 6: Preparation for the Developmental Interrelation of the Phonemicization, the Symbolization, and the Syntacticization Process," *Studia Phonologica* 8.1–22.

Ohala, John J.

1974 "Experimental Historical Phonology," in *Historical Linguistics II: Theory and Description in Phonology*, pp. 353-89, J.M. Anderson and C. Jones (eds.), (Proceedings of the First International Conference on Historical Linguistics, Edinburgh) Amsterdam: North Holland.

1975 "Phonetic Explanation for Nasal Sound Patterns," in *Nasálfest*, pp. 289–316, C.A. Ferguson, L.M. Hyman, and J.J. Ohala (eds.), Stanford University: Language Universals Project.

1978 "Southern Bantu vs. the World: the Case of Palatalization of Labials," *Berkeley Linguistic Society* 4.370–86.

Ohala, John, and James P. Lorentz

1977 "The Story of [w]: an Exercise in Phonetic Explanation for Sound Patterns," *Berkeley Linguistic Society* 3.577–99.

Ohala, John, Carol J. Riordan, and Haruko Kawasaki

1978 "The Influence of Consonant Environment upon Identification of Transitionless Vowels," *JASA* 64:S18

Ohala, Manjari

1972 "Topics in Hindi-Urdu Phonology," Ph. D. Dissertation, UCLA.

Oksaar, Els

1977 *Spracherwerb im Vorshulalter: Einführung in die Pädolinguistic*, Berlin: Kolhammer.

Olmsted, David L.
1971 *Out of the Mouths of Babes*, the Hague: Mouton.
Omar, Margaret K.
1973 *The Acquisition of Egyptian Arabic as a Native Language*, the Hague: Mouton
Pačesova, Jaroslava
1968 *The Development of Vocabulary in the Child*, Brno: Universita J.E. Purkyne.
Passy, Paul
1890 *Étude sur les changements phonétiques*, Paris: Librairie Firmin-Didot.
Pavlovitch, Milivoie
1920 *Le langage enfantin: acquisition du serbe et du français par un enfant serbe*, Paris: Champion.
Priestly, T.M.S.
1977 "One Idiosyncratic Strategy in the Acquisition of Phonology," *Journal of Child Language* 4.45–65.
· Robinson, Frank
1947 "A Study of the Articulation Errors in a Group of 240 Speech Defective Children between ages 5 to 10," M.A. Thesis, University of Minnesota (Abstract in *Speech Monographs*, 1948, 2109–10).
Saksena, B.R.
1971 *Evolution of Awadhi*, Delhi: Motilal Banarsidas.
Salus, Mary W., and Peter H. Salus.
1974 "Rule-ordering in Child Phonology," *Candian J. Ling*. 19.29–39.
Sawyer, Jesse O., Jr.
1958 "Achinese Historical Phonology," Ph. D. Dissertation, University of California, Berkeley.
Schleicher, August
1861-2 "Some Observations made on Children," in *Child language: a Book of Readings*, pp. 19–20, A. Bar-Adon and W.F. Leopold (eds.), 1971, Englewood Cliffs: Prentice-Hall. (Translated from a note in *Beiträge zur vergleichenden Sprachforschung*).

Smith, Neil V.
1973 *The Acquisition of Phonology: a Case Study*, London: Cambridge University Press.
Srivastava, G.P.
1974 "A Child's Acquisition of Hindi Consonants," *Indian linguistics* 35.112–8.
Stampe, David
1969 "On the Acquisition of Phonetic Representation," *CLS* 5.443–54.
1972 "A Dissertation on Natural Phonology," Ph. D. Dissertation, University of Chicago.
Stern, Clara, and William Stern
1927 *Die Kindersprache*, Leipzig: Barth (1st ed. 1907).
Stoel, Carol
1974 "Acquisition of Liquids in Spanish," Ph. D. Dissertation, Stanford University.
Straight, H. Stephen
1975 *The Acquisition of Maya Phonology: Variation in Yucatec Child Language*, New York: Garland Publishing Co.
Sturtevant, Edgar H.
1940 *Pronunciation of Latin and Greek*, New Haven: Yale University Press.
Sweet, Henry
1891 *A New English Grammar*, Oxford: Clarendon Press.
Thurneysen, Rudolf
1946 *A Grammar of Old Irish*, Dublin: The Dublin Institute for Advanced Studies.
Timm, Leonora A.
1977 "A Child's Acquisition of Russian Phonology," *Journal of Child Language* 4.329–39.
1978 "The Segmental Phonology of Carhaisien Breton," unpublished manuscript, University of California, Davis.
Tuaycharoen, Pintip
1977 "The Phonetic and Phonological Development of a Thai Baby," Ph. D. Dissertation, School of Oriental and African Studies, London.

Vanvik, Arne
1971 "The Phonetic-phonemic Development of a Norwegian Child," *Norsk tidsskrift for sprogvidenskap* 24.270–325.
Velten, H.V.
1943 "The Growth of Phonemic and Lexical Patterns in Infant Language," *Language* 19.281–92.
Vihman, Marilyn M.
1971 "On the Acquisition of Estonian," *PRCLD* 3.51–87.
1978 "Consonant Harmony: Its Scope and Function in Child Language," in *Universals of Human Language*, pp. 281–334, J.H. Greenberg, C.A. Ferguson, and E. Moravcsik (eds.), Stanford: Stanford University Press.
1979 "Sound Change and Child Language," Paper presented at the Fourth International Conference on Historical Linguistics, Stanford.
Vogel, Irene
1975 "One System or Two: an Analysis of a Two-year-old Romanian-English Bilingual's Phonology," *PRCLD* 9.43–62.
Webster, B.
1975 "Children's Development of Fricative plus Oral Sonorant Blends," unpublished paper, Stanford University.
Weinreich, Uriel, William Labov, and Marvin I. Herzog
1968 "Emprical Foundations for a Theory of Language Change," in *Directions for Historical Linguistics*, pp. 95-188, Y. Malkiel and W.P. Lehman (eds.), Austin: University of Texas Press.
Williams, M.M.
1976 *A Grammar of Tuscarora*, New York: Garland Publishing Co.
Winitz, Harris, M.E. Scheib, and J.A. Reeds.
1972 "Identification of Stops and Vowels for the Burst Portion of /p, t, k/ Isolated from Conversational Speech," *JASA* 51.1309–17.
Wright, James T.
1975 "Nasal-stop Assimilation: Testing the Psychological Reality of an English MSC," in *Nasálfest*, pp. 389–97, C.A. Ferguson, L.M. Hyman, and J.J. Ohala (eds.), Stanford: Language Universals Project.

1979 "The Effect of Nasalization on Vowel Quality," Paper presented at Conference on Experimental Phonology, Berkeley.

Yasuda, Akiko

1969-70 "Articulatory Skills in Three-year-old Children," *Studia Phonologica* 5.52–71.