# Modern Natural Phonology and phonetics

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## 1.  Introduction

Increasingly interdisciplinary nature of the 21st century research makes Natural Phonology a suitable candidate for a modern phonological theory. It has always relied on external evidence and is thus particularly well prepared to incorporate the newest developments in such disciplines as phonetics as well as speech technology, language acquisition, neurolinguistics or psycholinguistics. Its holistic approach to language allows for a wider perspective of a phonological study, from semantics and pragmatics, via syntax and morphology, through acoustic, auditory as well as articulatory phonetics. The theory is not hermetic and thus open to enrichments and modifications which do not violate its principles as long as the language user remains at its core. This paper will elaborate on one aspect of the theory, i.e., its interdependence on phonetics.

## 2.  Early criticisms of NP

In its early days, Natural Phonology was criticized for its excessive reliance on phonetics (cf. Anderson 1981; Dinnsen 1978; Dinnsen and Eckmann 1977; 1978, Drachman 1978, 1981; Dressler 1974; Hellberg 1980; Kodzasov and Krivnova 1981; Lass 1980, 1981, all reproached in Dressler 1985). Statements such as

> [t]he living sound patterns of languages, in their development in each individual as well as in their evolution over the centuries, are governed by forces implicit in human vocalization and perception. (Donegan and Stampe 1979: 126).

gave rise to an opinion among phonologists that Natural Phonology was just phonetics, and thus could not aspire to be a theory of phonology. Phoneticians, on the other hand, would accuse it of pretending to be phonology and thus not being technical enough, and thus not phonetics, either.

### 3.   Phonetics–phonology interface

Trying to distinguish between phonetics and phonology in any clear-cut fashion brings us to an extensively discussed topic of the phonetics–phonology "interface". Throughout the years a vast number of disputes on and around this topic have been held, to show a divergence of views, and no real consensus. Still, some progress can be noted in that the extreme isolationists have lost ground for more liberally oriented holists, who, rather than talk about "interface" would differently weigh "the phonological" and "the phonetic" in their models. However, phonetics as a motivating force for phonology remains controversial.

### 4.   Sub-categorical features

In this connection, it would be good to explain what Natural Phonology understands by this motivating force, since it was exactly the misunderstanding that led to the misconceptions which were subject to the above mentioned criticisms. I would like to concentrate on two essential points. First, "words are not only distinguished by sounds, they are made up of them" (Donegan and Stampe 1979: 129). This apparently simplistic statement not only ingeniously deprives the distinctiveness principle of its exclusive power, but also raises the question of sub-categorical differences in the realization of sounds. The question is how to resolve the clash between non-categorical phonetic realization of speech and its categorical phonological representation (supported by categorical perception). In Natural Phonology the solution lies in natural phonological processes which are based on categorical phonetic features (Donegan 2002: 61). Processes do not assign gradient, sub-categorical feature values to sounds (Donegan 2002: 63); rather, the specific phonetic result they obtain is due to the fact that each feature is dependent on other features it combines with paradigmatically and syntagmatically, as well as on a prosodic domain in which the processes apply. So, for instance, the more the jaw opens the less rounded the lips get; the features of a segment are more salient in the word-initial position or in a slower tempo of speech, etc. It should be thus predictable that a phonetic realization of a given segment with a given set of features in a given prosodic context will be the same across languages. This entails that we should be able to find an ultimately phonetic explanation for any phonological phenomenon. It is only a matter of how well we look for it whether we find it or not.

A challenge for Modern Natural Phonology is to resolve the following issue: is it indeed the case that the more informed phonetics, as we see developing nowadays, will enable us to find phonetic explanations for all phonological decisions? The answer might be, yes, of course, admitting that a whole array of

external and internal factors may create particular circumstances for particular configurations of phonological processes to apply in a given language. These explanations will, however, be of an *a posteriori* nature, since it is the role of phonology to decide what to take from phonetics, i.e. which of the options offered to overcome phonetic difficulties to adopt for a given language system, or type, or, in the most general case, universally. The latter leads us to the second point concerning phonetic motivation in Natural Phonology.

## 5.   Universality of processes

> The universality of processes does not mean that they apply in all languages – only that they are motivated in all speakers (Donegan 2002: 64).

Phonological processes determine what a speaker can do, but not what they must do. Although processes are universal in form and motivation, they do not apply universally. Each language selects a set of processes which constitute its language-specific natural phonology. In this way, some processes are allowed to apply while some difficulties remain and have to be mastered by the native speakers. For example, Polish or German allow the process of word final obstruent devoicing to apply, while English requires its speakers to master the difficulty of producing word final *voiced* obstruent, i.e., to maintain voicing during the closure or obstruction. Still, the process of obstruent devoicing (*Auslautverhärtung*) itself does not lose its universal motivation.

Another example could be the vowel /i/ which is universally expected in vowel inventories of languages (cf. Disner 1983). Still, is it the same /i/ across different languages? We suspect and we know that it is not, at least not in the sense of its phonetic profile. While its "i-ness" is universal (described by the features [+high], [+front]), its realizations vary across languages. It remains unclear, however, whether they vary within the phonological features [high] and [front], or whether they require introducing additional features to be precisely specified. If so, these could be either sub-categorical or categorical, the latter being the choice of Natural Phonology. Another reason for the differences could be the process of diphthongization. Putative existence of sub-categorical differences would need to be proven acoustically. One thing is certain: quite diverse pronunciations of the same vowel by native speakers of the language do not invalidate their being native speakers of the language. That is, in perception, phonological processes apply which derive a [+high], [+front] vowel for the listener. In this example, thus, both discussed issues combine: that of subcategoriality and that of universality.

## 6.    The (ir)relevance of phonetics?

How relevant is then phonetics to phonology? Is it so that the more phonetic detail we are able to uncover, the less we know about phonological "underpinnings" of these details, and the further away we get from phonologically relevant generalizations? It seems that the phonetic details alone cannot be used to predict a direction or moment of change of a given phonological category when a certain critical value of accumulated factors is reached. Rather, such changes are phonological in nature and are, thus, a consequence of phonological decisions, which are systemic in nature, i.e., they are dictated by the needs of the whole system. The bottom-up phonetic prompts, however, either initiate or contribute to the top-down phonological decision-taking process. We talk then of either the motivating or explanatory or executional / implementational role of phonetics.

For instance, final obstruents in English may be voiced or voiceless due to the suppression of word-final devoicing process in the language. Voiced obstruents, however, may be phonetically partially or fully voiceless. The acoustic cue used to maintain the contrast in the word-final position is, in fact, the lengthening of the preceding vowel. Both the phonetic voicelessness and the phonetic lengthening are phonologically sub-categorical, no matter how voiceless a consonant and how long a vowel is. Even if they are identical to phonologically voiceless and phonologically long, they remain sub-categorical and will remain so unless phonology reshuffles the system (which wouldn't be easy, since both long vowels and voice contrast are lexically indispensible independently of the discussed case). If the reshuffling were indeed to take place, then we would be able either to refer to the listener-initiated change or otherwise explain it phonetically, while the ultimate decision would be systemic and phonological and not phonetic and local.

All this is not meant to imply, however, that categorical phonological features and phonological processes operating on them do not have phonetic values. Every natural phonological process has phonetic content and phonetic explanation. Their application, however, is phonologically constrained. But once a process applies, there must be a way to find a phonetic account for its performance.

### 6.1.

In view of the above discussion, let me refer to Gussmann's (2004) paper, entitled "The irrelevance of phonetics: the Polish palatalization of velars." The paper consists in the basic denial of phonetic explanation of the so-called velar palatalization in Polish. Gussmann refers to the traditional account of the Polish palatalization of velars, which regards the fronting of velar plosives /k, g/ as a

phonetically motivated historical process of articulatory assimilation before front vowels. The palatal spirant [ç] is traditionally seen as a result of borrowing or analogy (since it cannot be shown to result from a regular palatalization of the velar /x/). Thus, alternations between [c] ~ [k][1] before [i, e], as in:

(1)
  *skoki ~ skok*　　'jump, pl./sg.'
  *ptakiem ~ ptak*　　'bird, instr./nom.sg.'

as well as non-alternating [c], as in:

(2)
  *kiedy*　　'when'
  *bukiet*　　'bouquet'

while /x/ behaves differently, and shows no alternation with [ç], e.g.:

(3)
  *głucha – głuchy – głuchemu*　　'deaf, fem./masc./dat.'

Gussmann argues against the phonetic naturalness of a statement: "Velars are fronted before front vowels". Let me summarize shortly his arguments. Firstly, non-palatalized forms are attested in dialects, i.e., [ke, ki, kɨ] (and the voiced counterparts), as in:

(4)
  *cukierek* 'sweet', *kiedy* 'when', *kij* 'stick'

This implies that palatalization *may but does not have* to apply. Secondly, a front *nasal* vowel, assumed to have blocked palatalization, *does not have to* block it (cf., e.g., *gęś* 'goose'). Thirdly, the putative high front vowel causing palatalization is in fact a reflex of the central vowel [ɨ]. Thus, the innovation involved not just the fronting of a consonant before a front vowel, but a simultaneous change of a consonant *and* a vowel, i.e., a change from [kɨ] to [ci] (a velar plosive and a high central vowel changed into a palatal plosive and a high front vowel). In other words, there is no palatalization before [i], since [i] *does not appear* after velar plosives (cf. also such examples as:

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[1] I will provide examples with voiceless velar plosives with the implication that the same comments concern the voiced counterparts.

(5)

> *słaby* 'weak', *głuchy* 'deaf' vs. *taki* 'such'

in the latter [i] being a contextual variant of [ɨ]). Consequently, Gussmann concludes, "no causal link can be established between the nature of the vowel and the palatal character of the preceding plosive."

Further argumentation brings about the fact that there is mostly no palatalization before [e] in loan words, e.g., in:

(6)

> *kelner* 'waiter', *kemping* 'camping', *kefir* 'kefir'

Also, those dialects which preserve the central vowel after velar plosives, e.g.:

(7)

> *kij* as [kɨj], *taki* as [takɨ]

do not palatalize the consonants. Another problem concerns the non-systematic behaviour of the velar fricative. On the one hand, it seems to resist palatalization (recall *głuchy*, *głuchego*), on the other, there is dialectal variation between

(8)

> [xɨba] ~ [çiba] *chyba* 'possibly', etc.

varied treatment of both native and foreign derivatives and loans as in:

(9)

> *szachy* ~ *szachista* 'chess / chess player'
> *hydrant* ~ *historia*, 'hydrant / history', etc.

as well as a systematic palatalization of [x] in derived imperfectives, e.g., *zakochać* ~ *zakochiwać*, cf.:

(10)

> *załamywać* 'break down', *pisywać* 'write', *wskazywać* 'point' with [-ɨv]
> vs.
> *opłakiwać* 'cry', *wczołgiwać* 'crawl in', *zakochiwać* 'fall in love' with [-iv]

In view of the above facts, it appears to be difficult if not impossible to maintain the phonetic explanation of the so-called palatalization of velars in Polish. According to Gussmann, the only way to rescue the phonetic explanation would be

to admit that not all cases of [e] are front, that [ɨ] *is* indeed front, and that most instances of [x] are not velar. "Few phoneticians will be prepared to say that", comments Gussmann.


6.2.

The question remains, however, why then [k] and [ɨ] both undergo fronting when combined? After all, *some* phonetic explanation is due, it must only come from a better informed phonetics. My prediction is that [ki] (non-palatalized stop + front vowel) cannot be "comfortably" pronounced as a CV. If [kɨ] (non-palatalized stop + central vowel) is not maintained, [ci] (some variant of a palatalized velar + some variant of a fronted vowel) seems to replace it as a result of a phonetic trade-off in search of the best available CV shape, from the articulatory/acoustic perspective. It is not the case of unidirectional assimilation in which a segment imparts its robust feature on the neighbouring segment (which typically palatalization would be). Rather, it is the case of a mutual search for a better *pattern of phonetic coexistence*. As a result of this search, both segments acquire a certain degree of the same feature (in this instance [frontness]), which makes them more similar to each other as it would be in the case of assimilation. The resulting CV is functionally better for the speaker, i.e., easier to articulate than [ki]. It may also, paradoxically, be more functional in perception, being less confusing than a front vowel preceded by an *un*assimilated velar. Let us remember that natural phonological processes work in perception, too. In [ki] a process of depalatalization would try to unravel the input to the putative palatalization process before [i], and thus attempt to depalatalize [k]. This certainly might be confusing.

A number of observations made in the relevant phonetic studies might give support to the above prediction.


1. Articulatory and acoustic data on back velars (e.g., [k]), contextually fronted velars (e.g., [k̟] or [x̟]), palatalized velars (e.g., [kʲ]), and palatals ([c, ɟ, ç]) suggest that *all of them differ* (Keating and Lahiri 1993). It is thus not obvious that the use of the symbols for palatals [c, ɟ, ç] and referring to the sounds as palato-velar obstruents (as Gussmann does) gives us the clue which sounds are meant.

2. The above sounds need to be described with reference to both dorsal/coronal articulation as well as anterior/nonanterior articulation[2] and also a lateral con-

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[2] Active articulator: dorsal, or tongue body, articulations, and coronal, or tongue blade, articulations; place: anterior, in front of the corner of the alveolar ridge, and nonanterior, on or behind the corner.

tact of the tongue. All these might be present to *different degrees* depending on a language (cf. Keating and Lahiri 1993).

For example, palatal stops in Czech have both a coronal and dorsal component, the coronal being primary, the dorsal secondary (while reverse is true for glides). Palatal stops in Hungarian have first contact more to the back of the palate and slide it forward towards the diagonal; palatal fricatives have longer lateral contact than the stops, while the center of the tongue remains open (like for [i]). Icelandic palatal stops proceed from small to large to small contact, with a more fronted contact at the release (while, e.g., Catalan is released from back to front).

3. In Russian, [kʲ] appears before front vowels, non-palatalized [k] before back vowels. However, when non-palatalized [k] appears before a front vowel (only if [k] is a preposition), then /i/ is realized as a retracted allophone (cf. Polish [kɨ]). Also, the X-ray contact seen for [kʲ] is longer before /i/ than before /a/; the whole tongue is moved forward, as for the vowel. "Palatalization quite generally involves a forward raising of the entire tongue blade, body and root, with the body approaching the roof of the hard palate" (Keating and Lahiri 1993: 85). "In the /i/ context, of course, *the palatograms confound the consonant and vowel articulations* (italics mine)" (Keating and Lahiri 1993: 86).

4. In English, velar fronting is a continuous process during closure, which points to the fact that *articulatory gradience* is involved, which is characteristic of surface underspecification, according to Keating and Lahiri 1993. Also in Polish, Rumanian, Serbian, Finnish, Wallon, French, Breton, Japanese and Italian: the more front the vowel, the more front the velar (Keating and Lahiri 1993: 88). The authors notice (p. 89) that this influence (across the languages) appears to be temporally gradient. "Fronting of velars is not indicative of a specified feature value for frontness on the velar" (p. 89) but it constitutes a range of possible tongue positions in the front-back dimension of the vowel space. "There is no sense in which back velars are basic and front velars special; all are equally dependent on context" (p. 90).

5. Also for palatalized velars, "there is no way to tell (...) whether the lateral contact seen in [kʲi] comes from the [i] or the [kʲ] or both" (p. 90).

6. Palatal stops are complex segments (they involve both a coronal and body component, with either as primary or secondary); they have "very little in common with palatalized or fronted velars" (p. 91). "In front vowel contexts, the distinction [between palatalized and nonplatalized velars] would be at best sub-

tle. Presumably because of this difficulty, Russian nonplatalized velars do not occur before front vowels within words" (p. 98).

7. According to Guion (1996), velar palatalization is the result a perceptual re-analysis of velars before front vowels in faster speech. Fronted velars are acoustically similar to coronals, especially in faster speech. The faster (with reference to the citation style) speech tokens of the velars are more like palato-alveolars. In perception, velars are heard as palato-alveolars before front vowels.

8. Directional asymmetries of consonant change have been observed, both in perception and in sound change (Chang *et al*. 2001), e.g.:

    kiki  >  tʃiʃi
    pipi  >  titi
    kuku  >  pu

As in visual perception, the confusions are unidirectional (e.g., a letter E is visually perceived as F, and not the other way round, since the character on the left has an extra feature that the one on the right lacks).

In speech, the cues for the differentiation are temporal and spectral properties of acoustic events. These cues have different salience/robustness, and they are subject to degradation in transmission due to an increase in entropy. Non-robust cues are more susceptible to degradation, which may lead to an irreversible confusion. For instance, there is an asymmetrical confusion in stop place: [ki] heard as [ti], but not the reverse:

   – the formant (F2) transitions of both are similar;
   – the stop burst in [ki] has an extra non-robust feature, i.e., a mid-frequency spectral peak (corresponding to the front cavity resonance F3);
   – if this feature is degraded to lose contrastiveness, the listeners confuse [ki] as [ti].

Importantly, *this confusion is not induced before non-high, non-front vowels*.

9. C-Place and V-Place interaction calculated from lexical frequency shows more and less preferred combinations of CV (Cole and Iskarous 2001: 108):

*more frequent combinations:*

    –alveolar +front V
    –labial +back, round V
    –velar +back, round V

*less frequent combinations:*

>     *–velar +front V*
>     –velar +round V

Cole and Iskarous (2001) examined the identification of the C-Place feature of an intervocalic stop consonant [g], [d], [b] in noise. Facilitation of identification of all three consonants occurs in the context of a back V (the second V); *identification of all three consonants is worst when both preceded and followed by a front V.*

## 7.   Final remarks

There are many ways in which the studies referred to above corroborate my prediction. I only hope I have managed to show that there is much more to phonetics than a phonologist might suspect. By the same token, however, language specific phonology is there to enable a language to function with a limited set of phonetically motivated options. Natural Phonology is optimal in the sense of incorporating this reasoning into its epistemology. As far as velar palatalization in Polish is concerned, it remains to be shown how rigid Polish phonology needs to be to curb phonetic freedom.

## References

Chang, Steve, Madelaine Plauché, and John Ohala
   2001     Markedness and consonant confusion asymmetries. In *The Role of Speech Perception in Phonology*, E. Hume, and K. Johnson (eds.), 79–101. San Diego: Academic Press.
Cole, Jennifer, and Khalil Iskarous
   2001     Effects of vowel context on consonant place identification. Implications for a theory of phonologization. In *The Role of Speech Perception in Phonology*, E. Hume, and K. Johnson (eds.), 103–121.
Disner, Sandra Ferrari
   1983     Vowel quality: The relation between universal and language specific factors. *UCLA Working Papers in Phonetics 58*, 1–158.
Donegan, Patricia
   2001     Constraints and processes in phonological perception. In *Constraints and Preferences. Trends in Linguistics*, K. Dziubalska-Kołaczyk (ed.), 43–68. Berlin: Mouton de Gruyter.

2002 Phonological processes and phonetic rules. In *Future Challenges for Natural Linguistics*, K. Dziubalska-Kołaczyk, and J. Weckwerth (eds.), 57–82. Muenchen: Lincom Europa.

Donegan, Patricia, and David Stampe
1979 The study of Natural Phonology. In *Current Approaches to Phonological Theory*, D. Dinnsen (ed.), 126–173. Bloomington: Indiana University Press.
1983 Rhythm and the holistic organization of language structure. *CLS* 19: 337–353.

Dressler, Wolfgang
1985 Explaining Natural Phonology. *Phonology Yearbook* 1: 29–50.

Dziubalska-Kołaczyk, Katarzyna (ed.)
2002 *Beats-and-Binding Phonology*. Frankfurt: Peter Lang.

Guion, Susan Guinard
1996 Velar palatalization: Coarticulation, perception, and sound change. Ph.D. diss., The University of Texas at Austin.

Gussmann, Edmund
2004 The irrelevance of phonetics: the Polish palatalization of velars. In *Corpus. Usage des Corpus en Phonolgie*, T. Scheer (ed.), 125–152. Nice: Université de Nice-Sophia Antipolis, CNRS.

Keating, Patricia, and Aditi Lahiri
1993 Fronted velars, palatalized velars, and palatals. *Phonetica* 50: 73–101.

Stampe, David
1969 The acquisition of phonetic representation. *CLS* 5: 443–453.
1979 *A Dissertation on Natural Phonology*. Bloomington: IULC.