ON CONTEXTUAL MODIFICATIONS OF PLOSIVES

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1. INTRODUCTION

Generative phonology recognizes two significant levels of representation: systematic phonemic (underlying) and systematic phonetic, the latter is understood to consist of a set of instructions given to the organs of speech, hence it must specify phonetic details of segments. It is generally assumed that at the systematic phonemic (phonological) level features are binary (but cf. Chafe 1970 : 119 ff.) and at the systematic phonetic level they are n-ary. These n-ary values are provided by late (low) phonetic rules which Postal (1968 : 66) calls Detail Rules and McCawley (1968 : 14) Feature Interpretation Rules. Late phonetic rules do not necessarily have to be restricted to those which give integral feature coefficients. Harms (1968 : 101) rightly suggests that a possible approach is to retain the plus/minus specifications together with n-ary features. As we shall, see there are rules which specify "superficial details" (McCawley 1968 : 14) and are not integral, though their relevance only at low phonetic stages is unquestionable. There are also many phonological rules which in spite of their quite early ordering produce all the values important for the systematic phonetic representation — cf. the rules for stress assignment in English (Chomsky and Halle 1968 : ch. 3); other phonological rules imply many phonetic details which, as will be demonstrated in this paper, can be specified by certain conventions. Schane notices quite rightly that linguists working within the framework of generative phonology have paid very little attention to low phonetic derivations. They have been mostly concerned with the rules of morphophonemic function (Schane 1971 : 519). Harms (1968 : 101) stresses that it remains to be worked out how low phonetic details are to be treated. A notable exception here is

Harris who devotes the second chapter of his *Spanish phonology* (1969) to a discussion of low phonetic assimilations which are connected with different tempos of speech.

The present paper is an attempt to analyse some low phonetic phenomena characteristic to plosives. We are concerned only with plain stops, i.e., exclusively those which are unambiguously specified by the feature [+abrupt offset] (Postal 1968: 71). The paper should be taken as a contrastive study in basically two languages: English (Received Pronunciation) and Polish (Warszawska Polszczyzna Kulturalna), however, references are also made to German and French and some conclusions of a general nature are drawn.

The phonetic phenomena under consideration are: nasal modifications of stops, lateral plosion and plosion or its absence in the case of combinations[1] of stops[2]. Since generative phonology operates with distinctive features some discussion of those which are relevant for our purposes is necessary.

2. A CHOICE OF FEATURES

As already mentioned we shall be dealing with plosives and their contextual modifications by nasals and laterals. It should be noticed that all the three types of consonants belong to a natural class of [−continuant] segments. This grouping comes from the definition of the noncontinuant feature which refers to "blockage of air flow past the primary stricture" which may be total as with plosives, affricates, and nasals or partial as with [l] (Chomsky and Halle 1968 : 318, cf. the discussion: 317 - 318). With both plosives and nasals there is a complete closure in the mouth passage and the articulatory difference rests upon the fact that the former have additionally a complete blockage of the nasal passage (velic closure) while for the latter the velum is lowered and air escapes through the nose. Laterals have a blockage in the mouth but it is not total in the sense that air can escape freely on one or both sides of the tongue; what remains completely blocked is the central passage through the mouth. Further on, the three types of [−contin] consonants can be said to have three articulatory phases: I — onglide, which specifies the articulatory movement for the closure (note that for [l] the closure of the central passage is complete — the tongue is pressed against the teeth or the teeth-ridge), II — hold, which denotes a blockage of the primary stricture, III — offglide, referring to the articulatory movement releasing the closure.

[1] By "combinations" we mean sequences of sounds with possible intervening word boundaries, the term "cluster" should be kept for combinations within words.

[2] I am grateful to my colleague, Edmund Gussmann, for helpful discussion.

With plosives offglide is associated also with plosion which in most cases (not in all, cf. section 5) is concomitant with the articulatory movement itself.

Figures 1, 2 and 3 illustrate the articulation of noncontinuant consonants, e.g. [t], [n], [l].

Fig. 1

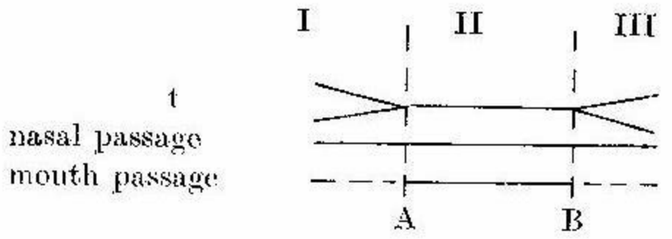


Fig. 2

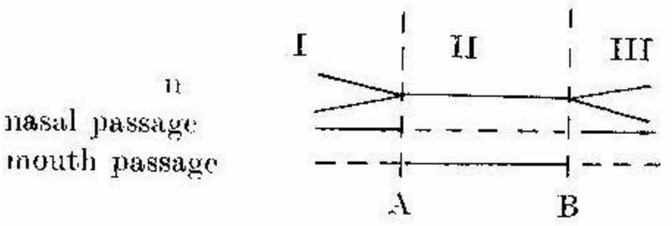
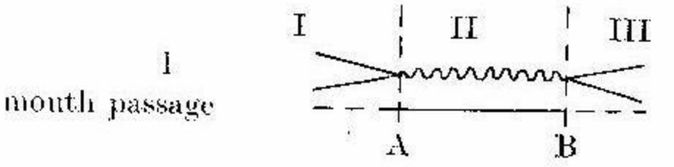


Fig. 3



where the solid line means "blockage" (in the case of the mouth passage: blockage past primary stricture), the broken line "no blockage", the wavy line with the [l] — a lateral escape. All oral sounds have velic closure, hence the blockage of the nasal passage for them is the normal state. The distance A — B specifies when the blockage past primary stricture actually occurs and thus gives a basis for denoting the segment by the [−contin] feature.

The [l] segment is usually described by the features $\begin{bmatrix} -\text{contin} \\ +\text{sonor} \\ -\text{nas} \end{bmatrix}$ where the [−contin] differentiates it from [r].

In English they are also different in anteriority: the former is [+anter] and the latter [−anter] (cf. Chomsky and Halle 1968: 177). Thus it seems that the feature [lateral] is redundant phonologically at least in English. It should be noted however, that [lateral] is indispensable for low phonetic derivations — as will be seen it describes lateral plosion of plosives. Wurzel (1970 : 195, 197) also uses it for phonological considerations. The question is open to discussion as the introduction of [lateral] on one hand simplifies the specifica-

tion of the [l] segment and makes it possible to avoid the addition of features at the low phonetic stages of derivation (to mark lateral plosion) but on the other it complicates the general shape of phonology ([lateral] can be relevant phonologically for one segment only). In this paper we shall be using [lateral] as a phonological feature, which however, does not imply that this is generally a better choice. Such decision can be taken only when a full analysis of all low phonetic processes has been made and no necessity for addition of other features has been found. The [abrupt offset] feature will be taken in this paper to refer primarily to plosion which characteristically appears with plain stops. The articulatory movements for onglides and offglides need not be marked by features since they are described by means of a convention. The convention in section 3 will be drawn up on the basis of nasal assimilation rules, hence some discussion of the feature matrix for nasals and plosives is necessary. It is suggested that the following feature specifications be accepted:

	m p b	n t d (dental)	n t d	(alveolar)	ŋ'k'g'	ŋ k g
Coronal	−	+	+		−	−
Anterior	+	+	+		−	−
Back	−		−		+	+
Distributed	+	−	+		+	−

The features are used in the sense Chomsky and Halle (1968) have described them. Our decision as to their assignment must be clarified in relation to a few points: — [±back] contrasts the postpalatal [ŋ'k'g'] and [ŋ k g] sounds with alveolo-palatals [ń ć ǵ] as in the Polish *niania, ciało, działo*. though those have not been included in the table as we have made the restriction to deal only with plain stops. The postpalatals seem to be [+back] since the body of the tongue is retracted from its neutral position (cf. Wierzchowska 1971: 195) though certainly to a lesser extent than with velars.

— [±distrib] is widely used particularly in the descriptions of Polish. If we compare, for example, the postpalatal [k'] and the velar [k] (cf. Wierzchowska 1971 : 196), then clearly the former is [+distrib] (the length of the zone of contact is definitely greater), and the latter [−distib]. Let us accept after Harris (1969 : 12) that dentals can be distiguished from alveolars by the opposition [−distrib] vs. [+distrib]. The above feature matrix specifies all the important plosive variants and their corresponding nasal variants.

We have assumed that the rule for palatalization in Polish has already applied.

The matrix does not distinguish, however, English alveolar from postalveolar [n]: *bent* vs. *country*. The postalveolar contrast, if insisted upon (it is a minor case), can be captured by introducing integral feature coefficients with

[distributed] or probably better with [coronal]. Quite naturally the blade of the tongue will be raised more with postalveolar sounds (hence a higher integer on [coronal]) than with alveolars.

3. NASAL MODIFICATIONS OF PLOSIVES

Three situations must be considered under this heading: a) a plosive is preceded by a nasal, b) a plosive is followed by a nasal, c) a plosive is both preceded and followed by a nasal. In each case the combination may be homorganic or non-homorganic.

In situation (a) the plosive is modified only if its combination with a nasal is homorganic. Consequently, the modification of the plosive should be understood as an entailment of general rules for nasal assimilation. Those are given for English and Polish by Gussmann (1974 : 114). in his recent paper on nasality His rule for nasal assimilation in Polish is:

$$\text{(1 a)} \qquad [+\text{nasal}] \rightarrow \begin{bmatrix} \alpha\ \text{coron} \\ \beta\ \text{anter} \\ \gamma\ \text{distrib} \\ \delta\ \text{back} \end{bmatrix} \Big/ \left\{ \begin{bmatrix} \text{V} \\ -\text{high} \\ -\text{low} \end{bmatrix} \right\} - \begin{bmatrix} \alpha\ \text{coron} \\ \beta\ \text{anter} \\ \gamma\ \text{distrib} \\ \delta\ \text{back} \\ -\text{contin} \end{bmatrix}$$

Condition: does not apply across morpheme boundaries.

Gussmann (1974 : 115) gives an equally general rule for nasal assimilation in English:

$$\text{(1 b)} \qquad [+\text{nasal}] \rightarrow \begin{bmatrix} \alpha\ \text{anter} \\ \beta\ \text{coron} \\ \delta\ \text{distrib} \end{bmatrix} \Big/ - \begin{bmatrix} \gamma\ \text{anter} \\ \beta\ \text{coron} \\ \delta\ \text{distrib} \end{bmatrix}$$

Conditions: if $\beta \neq \gamma$, then $\alpha = +$; if $\beta = \gamma$, then $\alpha = \beta$

It should be noticed that Gussmann's rules, although primarily meant to be phonological, provide all the major phonetic variants. Rule (1 b) can provide the distinction between dentals and alveolars, it will not, however, distinguish alveolars from postalveolars. This can be solved by assigning intergers to the featufe [coronal], where [2 coron] refers to postalveolars.

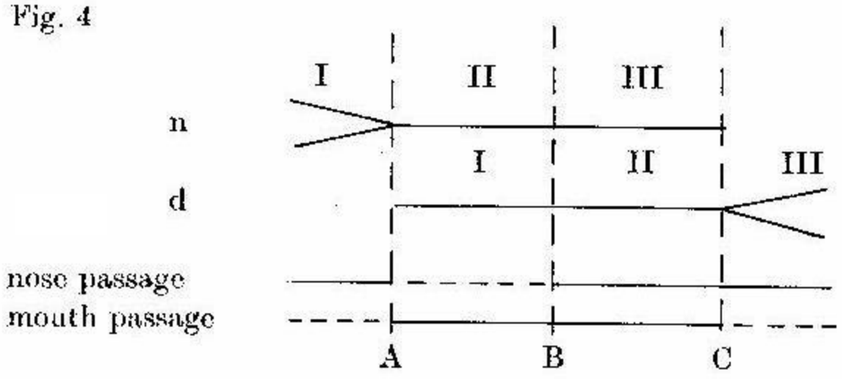
Thus in *country* one rule assimilates what is otherwise an alveolar [t] to postalveolar under the influence of [r] and then another rule makes the preceding nasal agree in the point of articulation with the postalveolar [t]. The latter rule may be formally expressed as:

$$\text{(1c)} \qquad [+\text{nasal}] \rightarrow [2\ \text{coron}] \Big/ - \begin{bmatrix} +\text{abr. offset} \\ 2\ \text{coron} \end{bmatrix}$$

Clearly (1c) is a late phonetic entailment rule to (1b) complementing it in the "superficial detail" which (1b) cannot account for. It should be noted also that for (1c) no conditions are necessary since by assigning the feature [+abr. offset] to the environment the rule is restricted to assimilations of nasal only before plosives and not before all obstruents.

Rule (1a) accounts for the assimilations in, e.g. *pompa, pęd, jądro, ręki, ręka*, rule (1b) for those in e.g. *pump, thousandth, enter, bank*, and (1c) for *country, husbandry*[3]. The above rules produce homorganic clusters of nasal and plosives. The homorganity of segments has certain articulatory entailments. There is only one articulatory movement of onglide and it is the one for the nasal, and only one offglide movement — the one for the plosive. Phase III of the nasal is blocked by the hold phase of the plosive, and inversely phase I for the stop is blocked by the oral hold for the nasal.

Fig. 4



where A—B, B—C show clearly that we are dealing with two noncontinuant segments. In other words, the art culators do not have to reach the place of articulation for the plosive since they are already there while producing the nasal. Thus from the articulatory point of view the plosive is incomplete. As already mentioned this phonetic situation is a natural result of the fact that the segments are homorganic.

Let us establish then homorganity *entailment convention*[4] which in a *first approximation* will read as follows: if a plosive is preceded by a homorganic

[3] If [tr] and [dr] were taken as affricates, as it is sometimes done (cf. Jones 1956 : 165 - 6) then rule (1c) is unnecessary and (1 b) can handle all cases.

[4] The use of conventions in generative phonology is quite legitimate and widespread. Apart from the obvious notational devices such as Greek letter variables (cf. Harms 1968 : ch. 7, comparing it with Wheeler's discussion in his 1972 article), cf. Kisseberth's (1970) functional unity of rules, Bach's "neighbourhood convention" (1968 : 29), Chafe's suggestion of "entailment conventions" (1970 : 118) for phonological considerations (we are using them but only at the low phonetic level), also Wilson's implicational rules" (1966 : 220) should be understood as conventions.

nasal segment then it (i.e. the plosive) lacks the articulatory movement of onglide. The convention is clearly an entailment to the assimilation rules. It is worth mentioning that the same convention will apply not only to English and Polish but also to other languages: German: *unter*, French: *montagne*. Now let us consider a reverse situation when a plosive is followed by a nasal. The combination may be either homorganic or non-homorganic. It seems more convenient to discuss the latter type first.

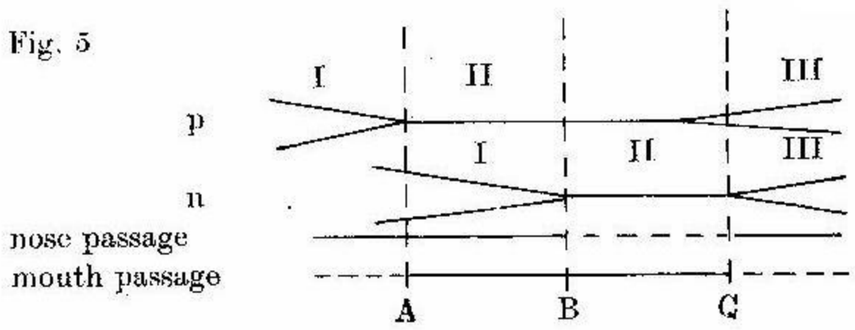
In Polish if a nasal is not homorganic with the preceding plosive, the plosive is not affected at all, i.e., it is complete in its articulatory movements and the plosion is oral. This generally accepted statement should be viewed, however, with certain caut on. It may not be entirely true if some stylistic variations are taken into account. Our observations show that there might be nasal plosion in non-homorganic combinations in Polish (e.g. *astma na dnie*, where the latter is taken in its low phonetic shape[5]) though oral plosion is definitely more common here. The situation in English is much simpler: there does not seem to be any variation — if a plosive is followed by a nasal the plosion is normally nasal (cf. Jassem 1971 : 175 ff.; Gimson 1966 : 153).

The articulatory process is interesting: "the plosive closure is not normally released until the articulatory movements for the nasal consonant, i.e., the second oral closure and the lowering of the soft palate, have been accomplished" (Gimson 1966 : 153).

In other words, the plosive has both onglide and offglide movements but since the hold of the nasal largely extends over phase III and partly over phase II of the plosive, air cannot escape through the mouth but it must flow through the nose as the velic closure is released the moment the hold of the nasal begins.

Figure 5 illustrates the process:

Fig. 5



as in *hypnotize, that mother, big monkey, black man*.

At first glance it seems that a rule like (2) can account for the above pho-

[5] Phonologically *dnie* has a homorganic cluster as the form is an obvious reflex of the word *dno*.

netic phenomenon:

(2) $$[+\text{abr. offset}] \rightarrow [+\text{nas}]/-(\#)[+\text{nas}]$$

The rule would read: a [+abr. offset] segment becomes nasalized in the context of the following nasal where the presence or absence of word boundary is immaterial. This suggests that the nasalization is of the same type as in the Polish *sq* [s õ w̃]. A solution like this is clearly unacceptable since the nasalisation of the vocalic segments in *sq* and the nasal plosion of a stop cannot intuitively, i.e. even without doing a far-going linguistic analysis, be put on a par. Evidently the nasalization in the Polish example extends over whole segments and with plosives only over parts of segments. What actually happens in e.g. *hypnotize* is the nasalization of the plosion, i.e. phase III. Hence a rule like (3) is necessary:

(3) $$[+\text{abr. offset}] \rightarrow \text{⁅}+\text{nas}\text{⁆}/-(\#)[+\text{nas}]$$

The rule specifies two things: a) the feature on the right side of the arrow is imposed only on a certain part of the segment which appears on the left side of the arrow, b) by convention it is the last part of the left side segment which is affected by the rule. The working of rule (3) is described by the notational device which we have introduced: the dotted brackets denote that the feature embraced by them modifies the last part of the segment which undergoes the rule.

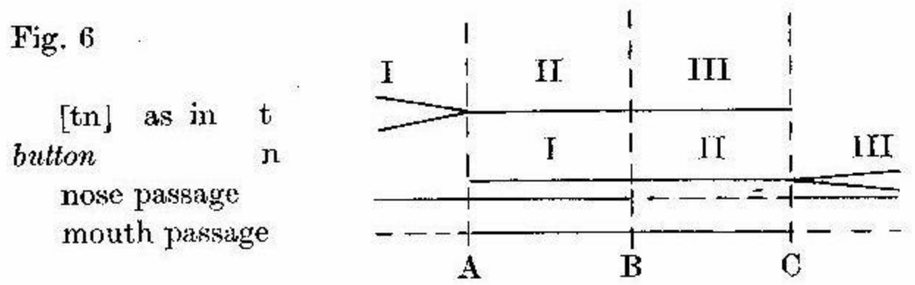
Rule (3) highlights an important general conclusion. It seems that *in low phonetic derivations rules may refer not only to whole segments* (as is always the case phonologically) *but also to parts of segments*. As will be seen later the analysis of lateral plosion and the clusters of plosives provide further support for this statement.

In our earlier discussion we mentioned that basically only English permits nasal plosion with non-homorganic plosive-nasal combinations. Thus rule (3) having no homorganity condition applies to English and possibly to some variant stylistic pronunciations in Polish; these are, however, uncommon. Polish has a regular nasal plosion only with homorganic combinations (cf. Jassem 1971 : 175 ff.), for English this restriction is unnecessary. However, as previously some allowances must be made for stylistic variations in Polish. We have observed that there are occasional oral plosion pronunciations of plosives in words such as: *Etna* (although this example is quoted as typical for nasal plosion, cf. Benni 1959 : 21), *biedny* in spite of the fact that the clusters are homorganic. Oral plosion is quite common if the cluster appears in the word-initial position: *dno, tnę*. These variations may only suggest the optionality of some low phonetic rules in certain styles, and they cannot be taken

as evidence against the statement about the regularity of nasal plosion in homorganic combinations in Polish.

Articulatorily, such combinations have two implications for the plosive: a) there is no offglide movement since the closure for the nasal is made at the same place in the mouth and phase II of the nasal blocks the offglide for the plosive, b) the oral closure for the nasal is simultaneous with the lowering of the soft palate, hence the air compressed for the plosive escapes through the nose — the plosion is nasal.

Fig. 6



Further examples — English: *topmost, submit*; Polish: *kupmy, samotny*; German: *halten, Halden*; French: *tu tapes mal* (Grammont 1933 : 37).

It is immediately clear that as far as the articulatory movements for the plosive are concerned Fig. 6 is a mirror image of Fig. 4. We should recall that the lack of onglide was expressed by first approximation to the homorganity entailment convention. It seems natural that the lack of the offglide movement be expressed by the same convention. In order to do it the convention must be extended to include not only the nasal — plosive context but also the plosive — nasal one. Thus in its extended version the *homorganity entailment convention* should be phrased as follows: if a plosive is preceded by a homorganic nasal segment then it lacks the articulatory movement of onglide, if it is followed by such segment it lacks the articulatory movement of offglide. As we shall see later, the convention may be extended still further to cover all types of homorganic segments appearing in a combination with plosives, hence the above wording of the convention cannot be treated as final but rather as a *second approximation*.

As has already been mentioned it is normal for Polish disregarding the unnumerous stylistic variations to have nasal plosion with stops in homorganic combinations. Rule (3) is too general here since the homorganity condition is not placed on its application. Thus specifically for Polish rule (3) should be restricted to (3'):

(3') $$\begin{bmatrix}+\text{abr. offset}\\ \alpha\ \text{coron}\\ +\text{anter}\end{bmatrix} \rightarrow \text{⁅}+\text{nas}\text{⁆}/-(\#)\begin{bmatrix}+\text{nas}\\ \alpha\ \text{coron}\\ +\text{anter}\end{bmatrix}$$

The Greek letter variable with the feature [coronal] shows that the plosive and the nasal must agree in their place of articulation in order for nasal plosion to occur. Thus the rule does not normally apply, for example, to *chleb nasz* since [p] is

$$\begin{bmatrix}-\text{coron}\\+\text{anter}\end{bmatrix} \quad \text{and} \quad [\text{n}] \quad - \quad \begin{bmatrix}+\text{coron}\\+\text{anter}\end{bmatrix}.$$

It is not necessary to have a variable with [anterior] because the rules of segment combinations for Polish plosive — nasal sequences are in fact restricted to labials and dentals; therefore the feature [anterior] will be invariably "plus". Furthermore, it is interesting to notice that in English and German the homorganity of plosive — nasal clusters may be an output of progressive assimilation within words. The progressive assimilation rule should be regarded as having phonological status. It is clearly ordered after the Schwa Deletion Rule.

The rule affects [n] and assimilates it either to [m] or to [ŋ] depending on whether the plosive preceding the nasal is bilabial or velar:

(4)

$$\begin{bmatrix}+\text{nas}\\ \\+\text{coron}\end{bmatrix} \rightarrow \begin{bmatrix}-\text{coron}\\ \\ \alpha\ \text{anter}\end{bmatrix} \Big/ \begin{bmatrix}-\text{contin}\\-\text{sonor}\\-\text{coron}\\ \alpha\ \text{anter}\end{bmatrix} - \#$$

Wurzel (1970: 220) has rightly drawn attention to the fact that the word boundary (here symbolized #) is necessary in the environment specification to inhibit the derivation of forms like *[gŋ-] or *[kŋ-] in word—initial position, e.g. in *Knabe* and to explain why in [troknɔn], [ɛbnən] there is no progressive assimilation.

Rule (4) applies to German: *haben, sagen, Wappen, stecken* (after Martens 1961: 233) and English: *happen, bacon, taken*, etc. In English at least the applicability of (4) is optional in the sense that although the schwa has been deleted, intermediate non-assimilated forms are possible, hence we may have [beikən], [beikn] or [beikŋ]. These are not exactly free variants since they will be obviously associated with different styles or more accurately tempos of speech. Thus in Allegro pronunciation one may expect that the assimilated, [beikŋ] type forms will be always used. It suggests then that rule (4) be primarily associated with rapid speech.

We should recall that at the beginning of this section we mentioned the possibility of a plosive being both preceded and followed by a nasal. As previously let us consider two situations: a) a plosive is followed by a non-homorganic nasal, b) it is followed by a homorganic nasal. If the plosive is followed by a non-homorganic nasal it has the articulatory movement of offglide but

its plosion is nasal. This clearly refers only to English, as in Polish the plosion would be normally oral, hence the plosive is not modified at all.

Consider the modification of [t] in English *Saint Martin*:

Fig. 7

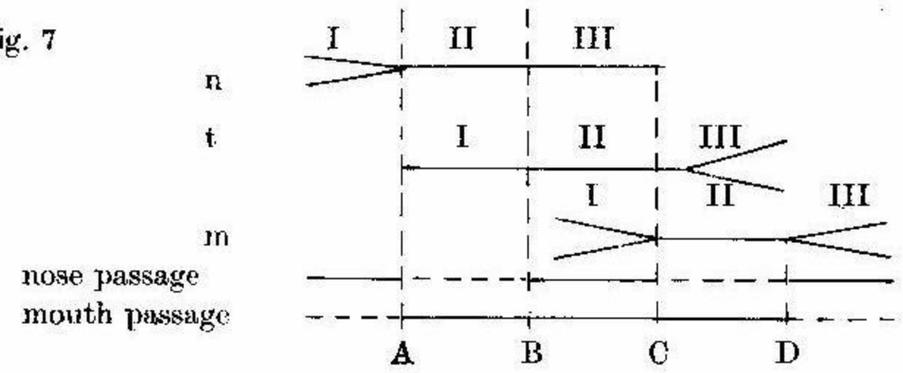
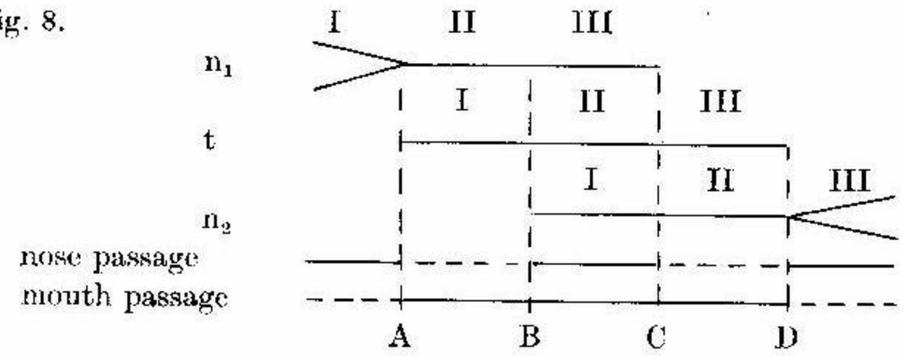


Figure 7 combines figure 4 (to illustrate the relations holding between [n] and [t]) and figure 5 (to show the relation holding between [t] nad [m]). The relations between [n] and [t] (the lack of onglide for [t]), are expressed by the homorganity assimilation convention—its first part applies— the nasal is homorganic with the following plosive; the relations between [t] and [m] (the nasal plosion of the stop) are handled by rule (3). If the nasal following the plosive is homorganic with it the homorganity entailment convention applies in both its parts. It specifies that the plosive has neither onglide nor offglide movements. The plosion is nasal, which is expressed by rule (3) or to be more accurate by rule (3'). Consider figure 8 which is a combined representation of figure 4 and figure 6.

Fig. 8.



as in *Saint Nicholas* or *błędny*.

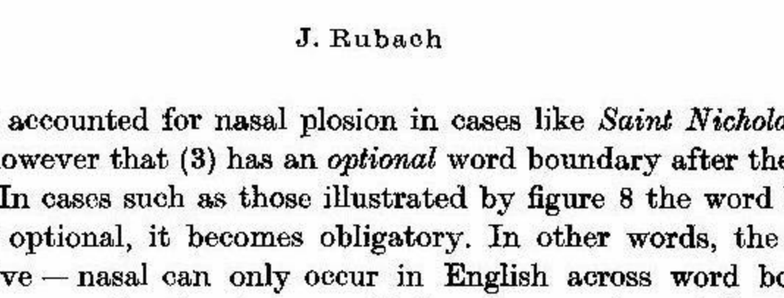
Further examples: English: *stamp machine, pump more*; Polish *wstąpmy, mętny, błąd nasz*; German: *Lampen, Bomben, Finten, finden, schenken* (Martens 1961: 235). It should be noticed that in German the final [—mpm], [—mbm] [—ndn] [ŋkŋ] are outputs of rule (4). Furthermore, rule (3') should be modified for German as the homorganity extends also to velar clusters. Thus instead of having [+anter] we must allow this feature to take the variable β.

We have accounted for nasal plosion in cases like *Saint Nicholas* by rule (3). Recall, however that (3) has an *optional* word boundary after the environmental bar. In cases such as those illustrated by figure 8 the word boundary is no longer optional, it becomes obligatory. In other words, the sequence nasal — plosive — nasal can only occur in English across word boundaries, where the # comes after the plosive and before the second nasal. Consequently, in words such as *London*, *correspondence*, *sentence*, *incumbent* the schwa [ə] cannot be deleted (Jones 1956 : 97)[6]. This has to be borne in mind while formulating the Schwa Deletion Rule.

4. LATERAL PLOSION

Articulatorily, lateral plosion signifies the lowering of one or both sides of the tongue, which allows the air compressed for the plosive to escape laterally. Clearly lateral plosion occurs when a plosive is followed by a lateral, i.e. [l]. In the case of [p b k g] it may not be contextually conditioned as these plosives can themselves have a lateral release (Gimson 1966 : 153). Thus only the lateral plosion of [t d] is truely conditioned by the context. Consequently, we shall analyse only these cases. The above described articulatory process can be illustrated by figure 9:

Fig. 9



[tl] as in *little*.

The analysis of the velic action is not necessary here as both [t] and [l] are oral sounds, hence the soft palate remains raised all the time. As previously the distances A — B and B — C show that we are dealing with noncontinuant segments (the mouth passage is blocked at its primary stricture). The wavy line denotes a lateral escape of air.

[6] Our observations confirm Jones's statement: an R.P. native speaker who had a very good command of German (over year's studies in Austria) was asked to pronounce *Finten* in German. He insisted on the pronunciation ['fintən].
Also other examples proved his inability to produce a nasal-plosive-nasal cluster within one word. A common mistake for Polish learners of English is the pronunciation of words like *sentence* with nasal plosion, i. e., they delete [ə] and then automatically nasal plosion must occur.

At first glance one can notice that the situation as described by figure 9 is parallel to that illustrated by figure 6 for *button*. The plosive is modified in two respects: it has no articulatory movement of offglide, its plosion is not central but lateral. Lateral plosion can be expressed by a rule formulated along the same lines as for nasal plosion (rule (3)) since in both cases it is the plosion which is modified, the only difference being that of the segment to which the plosion is assimilated.
Thus rule (5) mirrors (3):

(5)

$$\begin{bmatrix} +\text{abr. offset} \\ +\text{coron} \\ +\text{anter} \end{bmatrix} \rightarrow \{+\text{lateral}\} / -(\#)\,[+\text{lateral}]$$

The articulatory incompleteness of the plosive is due to the fact that [l] is homorganic with [t]. This can be adequately expressed by our *homorganity entailement convention* in its second approximation with one proviso — the conditioning segment need not be a nasal, it may be a lateral.

Notice that if [l] precedes [t] or [d] (*belt*, *folder*) the plosives lack onglides. Thus the lateral modifies the articulatory movements of the plosive in exactly the same manner as the nasal. Therefore in a *third approximation* the convention is changed only in the sense that the option is given to the conditioning homorganic segment to be either a nasal or a lateral.

Lateral plosion is a common phenomenon in English, Polish, and German: *little*, *bottle*, *middle*, *exactly*, *at last*, *at least*; *butla*, *dla*, *pętla*, *podlać*; *Mantel*, *Mittel*, *Windel*, *Handel* (note lateral plosion after the schwa has been deleted), *Handlung*, *Handler*.
Rule (5) is obligatory in educated speech. The lack of lateral plosion in [t d] plus [l] combinations would mean the introduction of a certain vocalic segment (or aspiration — as in English with voiceless stops) between the plosive and [l]. In English it is attested in the speech of children (Gimson 1966 : 153), in Polish a pronunciation like [butəla] sounds quite unnatural.

5. LACK OF PLOSION

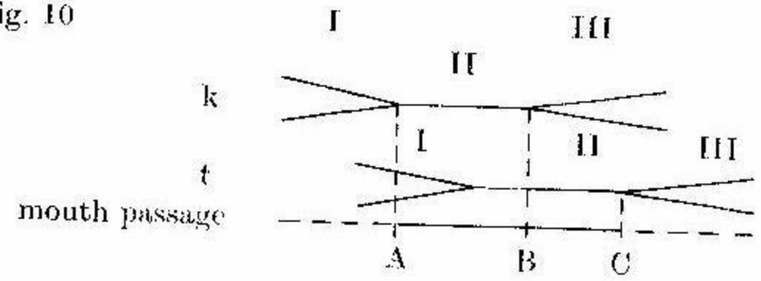
In section 3 and 4 we were discussing the modifications of plosives by nasals and laterals, i.e. by noncontinuant segments. It is to be expected then that plosives can be modified by all types of noncontinuants, that is to say, also by plosives and affricates. As we shall see this expectation is correct in many respects.

Plosives can appear in sequences either within words or across word boundaries.

Let us first consider clusters of plosives within words. In English always

and in Polish normally (notable exceptions are *lekko* and the like) they are non-homorganic, which is also a frequent case at word boundaries. Such clusters in Polish are uninteresting since plosives are not modified in any way unlike as in English. A widely accepted statement is that if we have two plosives in English (even non-homorganic plosives) the first is described as "unexploded" i.e., it has no plosion. Cf. figure 10 showing the articulation of [k] and [t] in *act*[7]:

Fig. 10



[k] has no plosion because although the articulators can glide off freely the escape of air is blocked by the closure (phase II of [t]) made for the other plosive, hence auditorily [k] is felt as a period of silence.

The process can be expressed by a rule functionally similar to rules (3) and (5):

$$(6) \qquad [+\text{abr. offset}] \rightarrow [-\text{abr. offset}] / -(\#) \begin{bmatrix} -\text{contin} \\ -\text{sonor} \end{bmatrix}$$

The rule says that abrupt offset segments (plosives) lack abrupt offset (plosion) in the context of obstruent noncontinuants, where the presence of word boundary is immaterial. Characteristically the environment includes also affricates as they also cause the lack of plosion of the preceding plosive.

Examples are numerous: *fact, apt, inspector, big car, that church*, etc. Our practical observations show that in some cases Rule (6) may not be absolutely obligatory, particularly in slow or overcareful speech. This is especially true of clusters with the Past morpheme suffix. It seems that, for instance, in *cooked, worked, marked, hoped*, etc. one can sometimes detect two plosions, i.e., the first stop is complete not only articulatorily but also auditorily. The presence of two plosions in such cases does not immediately label a non-native speaker of English as a foreigner[8].

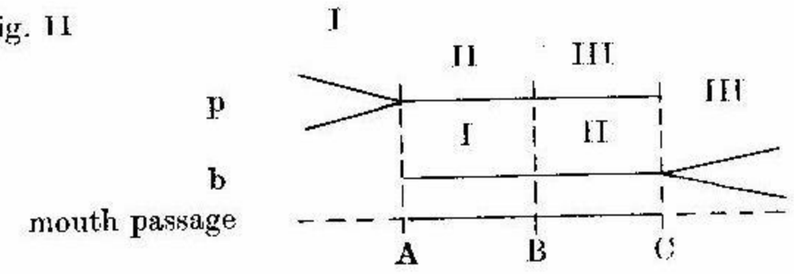
[7] The figure is a modified version of Abercrombie's (1965 : 146) diagram.

[8] A native speaker of English was asked to identify the features of a foreign accent in the speech of one of the readers in *Say it with us*, a well-known record course of English for advanced Polish learners. He pointed out a number of cases, however, none of them being the two plosions in non-homorganic combinations of plosives. In a later discussion he insisted that the presence of two plosions in *talked*, for example, could not label anybody as a foreigner.

These observations are supported by the carefulness with which Jones (1956 : 139 ff.) refers to the lack of plosion of the first stop in non-homorganic combinations. In German and French the situation is the same as in Polish: in non-homorganic combinations plosives are not affected in any way they have a central oral plosion (cf. Abercrombie's figure 1965 : 147), e.g. *gesagt, gibt, la fatique de..., apt, apteka, takt, tkać*.

All the four languages referred to in this paper are similar in one respect: in combinations of homorganic plosives the first is incomplete both articulatorily (lack of offglide movement) and auditorily (lack of plosion), the second is modified only articulatorily in the sense that it has no onglide movement:

Fig. 11



as in *scrap book* or in *pod domem, kalt Tee, avec, calme*. The lack of plosion of the first plosive is adequately expressed by Rule (6) but for Polish, German, and French it must be restricted only to homorganic combinations:

$$(6') \qquad \begin{bmatrix} +\text{abr. offset} \\ \alpha\ \text{coron} \\ \beta\ \text{anter} \\ \gamma\ \text{back} \end{bmatrix} \rightarrow [-\text{abr. offset}] / -(\#) \begin{bmatrix} -\text{contin} \\ -\text{sonor} \\ \alpha\ \text{coron} \\ \beta\ \text{anter} \\ \gamma\ \text{back} \end{bmatrix}$$

In the environment of (6') the presence of word boundary is given as optional. In fact in most cases the # will be present. It is only absent in a few cases, such as *lekko* in Polish, where the Cluster Simplification Rule (probably existing not only for English but also for Polish) has not applied. The articulatory incompleteness of both plosives is due to the fact that they are homorganic. It follows then that this case should also be incorporated into the homorganity entailment convention. As it stands (cf. approximation 3) it refers only to nasals and laterals as conditioning segments. Now we add up plosives and affricates. As these four groups of consonants belong to the noncontinuant class *the homorganity entailment convention in reference to* plosives reads in its final version as follows:

> if a plosive is preceded by a homorganic noncontinuant segment it lacks the articulatory movement of onglide.

It is tempting to generalize this convention still further. Another look at figures 4, 6, 8, 9, 11 tells us that in fact not only plosives but also other noncontinuants (cf. nasals and laterals) are modified in their articulatory movements in exactly the same manner. Thus the above version of the *homorganity entailment convention* can be generalized to apply to all noncontinuant segments preceded or followed by other noncontinuants.

Larger combinations of plosives do not complicate matters. They should be analysed as complex two-term combinations. Thus in *act badly* the relations between [k] and [t] on one hand, and [t] and [b] on the other, are described by rule (6). In *looked down* in addition to (6) the homorganity entailment convention applies. In the Polish *akt ten* rule (6') and the convention specify the relations between $[t]_1$ and $[t]_2$. The processes at work in such combinations can be symbolized by a joint representation of figures 10 and 11.

6. CONCLUSIONS

A contrastive analysis shows that some phenomena are common to both English and Polish (nasal plosion — English rule (3), Polish — (3'); lateral plosion — rule (5), lack of plosion — rule (6) for English and (6') for Polish). Since the low phonetic processes are basically the same, English differs from Polish particularly in the scope of rule application — for Polish the rules have to be restricted in most cases to apply only to homorganic combinations (hence (3') and (6')). Attention has been drawn to the importance of stylistic variations which might sometimes cause a rearrangement of rules — thus, for instance, rule (3) may apply to Polish without restricting it to (3') if we describe a certain style in Polish which allows for nasal plosion to occur also in non-homorganic combinations. As these stylistic variations are not common, they cannot in any way call into question the correctness of the general statements of rule application as given above. We have analysed all the noncontinuant segments as consisting of three phases from the articulatory point of view. Onglides and offglides can be modified in different ways due to the late phonetic assimilatory processes. For the modifications of the articulatory movements we have established the homorganity entailment convention which in its generalized version specifies articulatory interdependence of all noncontinuant segments.

Finally probably the most important conclusion drawn on the basis of the analyses made in this paper: in low phonetic derivations rules may refer not only to whole segments but also to parts of segments. For this phenomenon we have established the notional convention of dotted bracketing used in rules 3, 5 and 6. Furthermore, these rules should be regarded as functionally similar as they refer to the modifications of plosion.

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