On keeping exchange rules in Czech

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The claim that phonological rules apply in a sequence is by now uncontroversial. Chomsky (1967) has noted, however, that the fact that some rules must apply sequentially does not imply that all rules can be applied in this way; and that there are situations that can be imagined that would pose problems for sequential application. One such problem, he suggested, would be the following: suppose that, in some phonological environment, underlying A is replaced by B, while underlying B is replaced by A. Assuming no further complications, such as intervening rules, it is easy to see that these two processes (A --> B / X___Y and B --> A / X___Y) cannot be applied sequentially, for either sequence would result in a neutralization of the distinction between A and B in X___Y.

Chomsky claimed that in fact examples of this formal structure do exist in natural languages, and cited as an example the rules which describe the

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synchronic reflex of the great vowel shift in English (discussed in Chomsky and Halle 1968). The rules in question apply to tense vowels at a particular stage of the derivation, and have the effect of interchanging high and mid vowels, and then of interchanging mid and low vowels. The result is that, depending on whether independently needed rules of tensing and laxing apply, a form may show major differences in vowel quality, resulting in well-known alternations of the type divine/divinity, etc.

Chomsky further noted however, that the rules of vowel shift have appropriate formal properties, such that they fall under the definition of the notational convention of abbreviation by variables over feature values, first proposed by Halle (1963) for treating assimilation. The significance of this observation is the following: in order to resolve the difficulty in applying the two parts of an exchange process, it is necessary not to apply the rules directly in sequence. They could, instead, be applied simultaneously (or disjunctively), so that neither would be able to affect the output of the other. Now there are no cases known of rules abbreviable by variables which must be applied in sequence, and it would therefore be possible to propose that (universally) any set of rules abbreviable by variables is to be applied simultaneously rather than

sequentially. In this case, the ordering problem would be resolved by giving a precise formal definition of the circumstances in which a non-sequential ordering principle obtains.

Unfortunately, the need for such a move has not been demonstrated with many other examples. The English vowel shift rule has remained virtually the only example of a true exchange rule which has received extensive discussion. Other authors, however (e.g. McCawley, 1971; Stockwell, to appear) have questioned Chomsky and Halle's account of the vowel shift. The surface alternation patterns are clear (at least for the front vowels) but alternative accounts can be imagined that deal with these same alternations without positing a direct exchange of two elements in the same environment. In particular, if the high vowels become centralized diphthongs before lowering, and the mid and low vowels are simply raised one step, no exchange is involved, and the ordering problem does not arise. In the discussion of these alternatives, an important point has been the question of whether exchange rules can exist in natural languages. Some authors have felt that their effect would be to impair intelligibility radically, and thus that they could not develop in grammars. If this is so, of course, it would provide motivation

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A priori objections based on the potentially dramatic effect of exchange rules as historical changes cannot be taken too seriously. When we consider the histories of languages such as Armenian and Arapaho, it is clear that languages can survive changes that are much more extreme than a simple exchange; and in any case, it has been pointed out that exchange rules could arise from other, non-exchange rules already in the grammar by restructuring. The question of whether exchange rules exist (and hence of whether an account of vowel shift in English which posits such a rule is plausible or not) remains an empirical one, and it is necessary to bring forward examples from other languages in order to resolve it.

In a previous issue of this journal, Wolfe (1970) has attempted to provide such evidence. She discusses some other examples in which exchange rules are apparently indicated, and concludes from them that such rules can exist in natural languages. Of these examples, three bear directly on the question of exchange rules; but two of these are such that they cannot really be said to carry much weight. One example concerns a drum-signalling system, in which it is claimed that an exchange of high tone for low and vice versa was not

even noticed. Further exact 'phonetic' data on the tones involved would be necessary to decide if a real exchange was involved, but in any case there is no obvious reason to expect that the formal properties of such auxiliary modes of communication will accurately reflect those of natural language in every detail. Another example concerns an alleged vowel shift in Old Prussian, based on somewhat ambiguous evidence from orthographic confusion. Again, precise phonetic data that would support an exchange rule are lacking, and in any case our knowledge of Old Prussian is so fragmentary that it would not be wise to base matters of formal detail on evidence from this source alone. Neither of these examples, then, can be taken to provide convincing proof of the existence of phonological exchange rules.

Wolfe's main example, however, is taken from Modern Czech, about which the facts are reasonably clear. Her discussion is based on Kučera's (1958, 1961) account of the relation between two forms of modern Czech.[1] One of these, the Czech literary language (LL) was originally based on Central Bohemian dialects, and has a long and reasonably continuous tradition reaching back at least to the fourteenth century. The literary language has evolved in ways that are to some extent independent of the evolution of 'popular' or conversational Czech, and the modern Bohemian dialect of Prague and its

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surroundings differs from the literary language in many ways. This dialect is the basis of a more or less standard variety of spoken Czech, called the Czech Common Language (CC). There are in addition numerous regional and local peculiarities identifying non-standard dialects, but it is the relation between CC and LL that is of interest here. In fact, most Czech speakers have both of these dialects available to them, and to some extent intermix features from both in ordinary conversational utterances, dependent on social context and other non-linguistic factors.

Among the systematic differences between LL and CC, Wolfe claims that the following are of significance: LL [i:] corresponds to the diphthong [ej] in CC; LL [e:] corresponds to CC [i:]; and LL [u:] corresponds to CC [ow]. In addition, Wolfe claims that the vowel /o:/ does not appear in underlying forms in either dialect. We will return below to the discussion of the back vowels, and for the present will concentrate our attention on the long non-low front vowels. Wolfe suggests that in fact the phonology of CC can "be described by means of optional phonological rules applied to the same underlying forms as are used for LL; if these optional rules are applied throughout wherever possible then CC results; when (...) the rules are sometimes applied and sometimes not, we get the normal type of

conversational utterance" (1970, p. 223). In fact, the relation between the two is not so simple, as remarked by Havránek (1929):

> Le système phonologique du tchèque littéraire ni ne concorde avec le système actuel du tchèque courant et populaire, ni n'est simplement l'image d'un stade antérieur de la langue populaire de Prague ou du centre de la Bohême; la langue littéraire a echappé à certains changements qui ont atteint le parler courant à partir de la fin du XIVème siècle tandis qu'elle a subi d'autres changements parfois plus récents.
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> Havránek 1929, p. 110

As a result, it is not accurate to characterize CC as simply LL with the addition of some late, optional rules. For the purposes of discussion, however, we will accept this idealization of Wolfe's, and assume (confining our attention to front vowels) that CC contains rules converting /e:/ to [i:] and /i:/ to [ej].

On that basis, Wolfe could be justified in assuming that the diphthongization in CC [ej] is secondary, and that the rule in question first interchanges /i:/ and /e:/ before diphthongizing the derived /e:/ (from /i:/) to [ej]. This interchange of /i:/ and /e:/ would be an exchange of the type that is to be demonstrated, and would therefore (granting the necessary assumptions about the relation between CC and LL) provide evidence for the existence of exchange rules.

There is an important problem with this example, however. As pointed out by Kučera (e.g. Kučera 1961

fn 1, p. 88), not all of the [i:]'s [ej] in CC. While all LL [e:]'s are in CC,[2] only those [i:]'s that arise earlier [i:] are lowered to [ej]; th arise from earlier [i:] remain as [i CC. Taken by itself, of course, thi only historical validity. The fact (LL) [i:] is the reflex of both [i:] Czech is not sufficient reason to po between two morphophonemic sources f synchronically. The fact that LL [p [zi:tra] 'tomorrow', [hluxi:ma] 'dea correspond to CC [pejxa], [zejtra], but LL [pi:še] 'writes', [mi:sto] 'p 'spoils' correspond to CC [pi:še], [might not be related to any aspect o structure. One could simply mark th second set of words as exceptional, undergo the vowel shift rule in CC. rule has exceptions would not, of co status as a rule.

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The distinction between original [i:] and [i̯:] is not just a historical one, however. It is necessary to make a synchronic distinction in modern Czech (in both CC and LL) between palatalizing and non-palatalizing /i:/, /i/, and /e/. The case of /e/ is clearer, since

palatalizing /e/ appears with preceding [j] after consonants that do not participate in palatalized/non-palatalized pairs.[4] With the palatalizing /-e/ of the prepositional case singular, for example, we have alternations such as [kočka]/[(o)kočce] 'cat/(about)the cat'; [praha]/[(f)praze] 'Prague/(in) Prague'; [okno]/[(v)okňe] 'window/(in) the window'; [kra:va]/[(o)kra:vje] 'cow/(about) the cow'.

The non-palatalizing /e/ of the prepositional plural ending /-ex/, however, leaves the root final unchanged: [okno]/[(v)oknex] 'window/(in) the windows', [mravi]/[(o)mravex] 'morals/(about) morals', etc. A natural account of this fact would follow if we simply represent palatalizing /e/ as /je/; the /j/ is then absorbed into a preceding palatalized consonant, preserved initially and after labials, and deleted elsewhere.[5] The distinction between palatalizing and non-palatalizing /i/, /i:/ is not so clear, however, since palatalizing /i/, /i:/ are not typically preceded by /j/. In the declension of /bratru:v/ 'brother's' and /sestřin/ 'sister's', for instance, we find palatalization in the prepositional singular (before /-je/) and animate masculine nominative plural (before /-i/): [bratrovje], [sestřiňe], [bratrovi], [sestřiňi]. There is no palatalization before the endings of the feminine

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The distinction between palatalizing and non-palatalizing /i:/, /i/, and /e/ is a pervasive one in Czech morphology (cf. for example Newman, 1971) and must be represented in any adequate description of the language. The relevance of this distinction to the relation between LL and CC is that it is precisely the non-palatalizing /i:/'s which lower to [ej] in CC; palatalizing /i:/ is preserved. This fact is reflected in Kučera's statement that /i:/ in LL preceded by /t,d,k,x,h,r,n/ corresponds uniformly to CC [ej], while /i:/ in LL preceded by /p,b,s,z,m,l,v,c,ž/ may or may not (unpredictably, depending on the word involved) correspond to CC [ej]. After consonants which arise from palatalization, however, such as /ř,ť,ď,ň,š/, LL [i:] always corresponds to CC [i:]. The first group of these consonants can never be followed by palatalizing /i:/, since that would convert /t,d,k,x,h,r,n/ into /ť,ď,c,š,z,ř,ň/. The second group (/p/, etc.) could be followed by either palatalizing or non-palatalizing /i:/ with no resultant difference, and the third group (/ť/, etc.) could only be followed by palatalizing /i:/, since they arise only through palatalization.

This distribution confirms the fact that it is exactly non-palatalizing /i:/ (synchronically) which undergoes the change of /i:/ to [ej] in CC.

The difference between palatalizing and non-palatalizing /i:/, /i/ is most naturally represented in terms of a feature which is involved anyway in palatalization. This is produced by /j/ and by /je/ (if this is the correct representation of palatalizing /e/); it is of course well known that high front vowels and glides produce palatalization in many languages. Non-palatalizing /i:/ and /i/, then, should differ from palatalizing /i:/ and /i/ in one of the features high and back, and since high is already necessary to distinguish /i:/, /i/ from /e:/, /e/, back seems most appropriate. We will represent non-palatalizing /i:/, /i/, then, as /ɨ:/, /ɨ/, and assume a rule which follows palatalization which merges /ɨ:/, /ɨ/ with /i:/, /i/. In that case, however, the CC vowel shift takes on a completely different character. Instead of the exchange process /e:/ --→ /i:/, /i:/ --→ /e:/, the vowel shift is now composed of the rules /e:/ --→ /i:/, /ɨ:/ --→ /e:/. In CC, the rule /ɨ:/ --→ /i:/ is thus no longer needed, though the corresponding rule for short vowels is still necessary.

The analysis that we have just proposed posits an abstract segment /ɨ:/ (as well as its short counterpart,

/ɨ/) which never appears as such on the surface. is of course an example of absolute neutralizati which would be prohibited by a constraint such a suggested by Kiparsky (1968). Numerous other pa have shown, however, that Kiparksy's position ca maintained (cf., for example, Brame 1972, Vago 1 and that absolute neutralization processes and a segments are sometimes necessary in phonological scriptions. The alternative proposed by Kiparsk the use of exception features, rather than phono composition; but that alternative would be inapp here. Notice that we would have to mark all of palatalizing /i:/'s as exceptions to palatalizat exactly the same set of /i:/'s as exceptions to chift. The fact that the same segments are invo both cases would be unexpressed, and it seems be attribute both facts (non-palatalization and fai undergo vowel shift) to the same feature of the phonological composition. It is exactly in such where two or more kinds of exceptionality are di related that the mechanism of exception features inappropriate and an abstract segment is indicat

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This re-analysis results in the elimination of Czech vowel shift as support for the existence of exchange rules, since the two segments affected are not interchanged. /e:/ is raised to /i:/, but the

segment which is lowered to /e:/ is not /i:/ but /ɨ:/. We are, thus, left in approximately the same position as before with respect to the existence of exchange rules: the English vowel shift is the only substantial example known. If exchange rules are possible processes in natural languages, it is peculiar that more examples are not forthcoming. Since an alternative view of vowel shift is possible (indeed, several have been argued for in the literature), we might want to strengthen the claims made by phonological theory by prohibiting such rules altogether. Such a prohibition would be extremely easy to introduce, of course; all we have to do is remove the special exception to sequential ordering proposed by Chomsky for rules involving variables over feature values. If such rules apply sequentially, it will be impossible to formulate an exchange process, as we saw above. The prohibition against exchange rules, then, would follow not from any putative disruption that such a rule would produce in the linguistic system, but rather from the formal property of grammars that the rules of the phonology generally apply in a sequence.

When we look at a wider range of languages, however, we see that examples do appear in which a grammatical process interchanges two elements. One such is discussed in Chomsky and Halle (1968): in some forms of Arabic, there is an imperfect form of verbs which is

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Other exchange processes can be
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formed from verbs whose stem vowel in the perfect is /a/ by replacing this with /o/, but from verbs whose stem vowel in the perfect is underlying /o/ by replacing this with /a/. Thus, /a/ and /o/ are exchanged in the verbal category in question. There seems no doubt that this is, indeed, an exchange rule, and it is necessary to inquire about whether it has any other properties that might distinguish it from the sort of process we have considered prohibiting above.

Other exchange processes can be attested from the Nilotic languages of Africa. According to Gregersen (1972), Luo has a process which exchanges voiced and voiceless stops in two categories: before the plural marker /-E/ (realized as [e] or [ɛ], depending on harmony which is disregarded here); and in the "singular appertentive". Thus, corresponding to got 'mountain', we get gode 'mountains' and god 'mountain-of'; while corresponding to lwedo 'hand', we have lwete 'hands' and lwet 'hand-of'. The correspondences thus established are between p, θ, t, c, k and w, ð, d, y, g, respectively, and include not only the native vocabulary but also Swahili loanwords such as kitabu 'book', pl. kitepe, and debe '4-gallon tin can', pl. depe. The related language Shilluk also displays an exchange process in plural formation: cf. pairs such as lep 'tongue' pl. leb; tuyc 'rifle', pl. twaj; rejo 'fish', pl. rij;

bak 'fence', pl. bag; jago 'chief', pl. jak. In several languages (including Luo, Alur, Adhola, and Anuak) this exchange of voicing is also paralleled in stems ending in a nasal. All of these languages show plural and appertentive forms with nasal plus homorganic stop (or perhaps prenasalized stops): thus, buom 'wing', pl. buombe, app. sg. buomb; toŋ 'spear', pl. toŋge, app. sg. toŋg, etc. In general, corresponding forms with final nasal-stop clusters remain unchanged: thus, Luo rombo 'sheep', pl. rombe. In the Pari dialect of Anuak, however, the process is apparently extended to roots in final nasal+stop, as well, so that in addition to the above, we have aweendo 'guinea fowl', pl aweene; reembo 'blacksmith', pl. reeme. Thus, in addition to the exchange between voiced and voiceless obstruents, this dialect also shows an exchange between simple nasals and clusters (or between nasals and prenasalized stops).

A related Nilotic language, Dinka (described by Nebel, 1948) also displays an exchange rule, though of a completely different sort. Dinka uses a large number of processes to form noun plurals, including suffixation and suppletion, but most plurals are formed by alternations of the stem vowel. There is a substantial class of nouns with long stem vowels in the singular, which form their plurals by shortening this vowel. Thus,

we have pɛɛi 'moon', pl. pɛi; čiin 'hand' agɔɔk 'monkey', pl. agɔk. On the other h another class of nouns with short stem vo their plurals by lengthening the vowel: pl. paal; nin 'sleep', pl. niin; atuel 'c atueel. In this language, then, there is is involved in plural formation which exc and short vowels. The same rule is also plural formation in the Yuman language Di Walker, 1970 for details).

A similar process can be attested in fact. Diminutives are formed from noun s -ek, -ka, or -ko (perhaps preceded by -e express endearment). Many masculines an with long vowels in the stem shorten this utive: thus, [du:m] 'house', dim. [domek 'gate', dim. [braŋka]; [ma:ma] 'Mamma', Other nouns with short stem vowels, howe these vowels in forming diminutives: [d [da:rek]; [list] 'leaf', dim. [li:stek]; dim. [kni:ška]. While not all nouns beh there may be[7] at least a semi-productive which interchanges long vowels and their parts in the formation of diminutives in

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A similar process can be attested in Czech, in fact. Diminutives are formed from noun stems by adding -ek, -ka, or -ko (perhaps preceded by -ec or -in to express endearment). Many masculines and feminines with long vowels in the stem shorten this in the diminutive: thus, [du:m] 'house', dim. [domek][6]; [bra:na] 'gate', dim. [braŋka]; [ma:ma] 'Mamma', dim. [mamiŋka]. Other nouns with short stem vowels, however, lengthen these vowels in forming diminutives: [dar] 'gift', dim. [da:rek]; [list] 'leaf', dim. [li:stek]; [kniha] 'book', dim. [kni:ška]. While not all nouns behave in this way, there may be[7] at least a semi-productive exchange rule which interchanges long vowels and their short counterparts in the formation of diminutives in Czech.

Given the set of exchange rules just cited, it would seem that the existence of such processes is not

seriously in doubt. The fact that the LL-CC vowel shift in Czech did not turn out to have that form would appear to make it simply irrelevant: after all, most (if not all) rules are not exchange rules, so this result is unsurprising for any given rule. But if we consider the rules that have just been presented, we see that they have a common feature which is not shared by rules of the LL-CC vowel shift type (in Wolfe's formulation). All of these rules have the property that they apply in an environment whose specification is given in morphological terms, rather than in terms of the phonological properties of the string. In West Semitic verb ablaut, Luo and Pari Anuak plural and appertentive formation, Dinka and Diegueno plural formation, and Czech diminutive formation, the phonological properties of the environment of the affected segment are essentially irrelevant. In each case, the change is one which is associated with some specific grammatical category (or categories) for which no phonological characterization can be given. Such morpholexical rules (to use Bloomfield's term) specify the phonological realization of a grammatical category (which may, of course, involve other processes such as affixation, in addition), and do not specify modifications based on the phonological composition of the string. They

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have the form of ablaut processes, such as the relation of English ring/rang/rung, rather than of (e.g.) assimilations. Since they are not determined by phonological conditions, they are hardly (if at all) amenable to phonetic explanation, and typically relate classes of segments that are otherwise unnatural.

An ideal phonological theory, like an ideal syntactic theory, would be as highly structured and restricted as possible. An important aspect of such structuring is the isolation of distinct types of rules, and the imposing on each such class of as narrow as possible a set of restrictions. Thus, for instance, while the environment of a phonological process can in general extend over considerable parts of a form, it has been proposed (cf. Palacas, 1971) that a class of assimilation rules can be isolated and constrained so that the segment to which an element is assimilated is always adjacent to it (or at least is the closest segment of the relevant type). Another example concerns the principle of disjunctive ordering, discussed in Chomsky (1967). Consideration of rules of types other than those Chomsky originally discussed leads to the conclusion (cf. Anderson, 1973) that the domain of this principle is limited to the class of phonological rules specifying categorial (+/-) values of features, and that it does not extend to rules specifying numeric

(phonetic detail) values for features.

A number of recent writers have argued that more attention needs to be paid to the properties of morphological processes in language. It is probably fair to say that current practise is to relegate all of the processes traditionally treated as part of morphology either to phonology or to syntax (or perhaps to an as yet unformulated theory of 'lexical structure'). Yet there is no reason not to expect that a class of processes can be isolated, with structural changes similar to those of phonological rules (and thereby distinguished from the quasi-syntactic processes of prefixation, infixation, and suffixation) but with structural descriptions specified (primarily) in terms of morphological categories rather than phonological features. If such a class of processes is to be interestingly definable, it should be possible to discover formal properties and restrictions which are peculiar to it, and the above discussion of exchange rules suggests that this is indeed the case. We suggest, that is, that the class of segmental[8] exchange rules is limited to the domain of morpholexical processes[9]. Such a limitation can be achieved, as we noted above, simply by limiting the principle of simultaneous application of the subparts of a rule schema involving variables over feature coefficients to the class of morpholexical

rules. In that case it will be impossible
a purely phonological exchange process.

With this proposal in mind, we can now
the discussion of Czech, to take up the pro
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rules. In that case it will be impossible to formulate a purely phonological exchange process.

With this proposal in mind, we can now return to the discussion of Czech, to take up the problem of the back vowels. Wolfe claims, as we noted, that the LL vowel [u:] corresponds to [ow] in CC, and that there are no instances of basic /o:/ in LL (apart from a small group of obviously exceptional loan words and a few instances of 'expressive lengthening' of [o]). In this case, her proposed rule of vowel shift would account for the facts, since the lowering of LL [u:] to [ow] in CC can clearly be treated as parallel to the lowering of [i:] to [ej]. If there are no /o:/'s, then the prediction that they would be raised to [u:] parallel to the raising of /e:/ to [i:] does no harm.

The first difficulty that we must note with this formulation is that not all LL [u:]'s correspond to '[ow]'[10] in CC: in fact, only those in absolute word initial position, or preceded immediately by a prefix, can show such a correspondence.[11] Thus, LL [u:řat] corresponds to CC [ouřat] 'office', and LL [ne=u:roda] corresponds to CC [ne=ouroda] 'bad harvest', but LL [mu:že] 'can (3sg.)' corresponds only to CC [mu:že], not to [mouže]. The reason for this is not hard to seek. LL, as well as CC, has the vowel sequence [ou]. In LL, however, this is limited to non-initial position.

On morphological grounds, initial [u:] can be identified with non-initial [ou] in LL. We must now ask, however, what the underlying forms are for a) non-initial [u:], and b) initial [u:], identified with the element which appears as [ou] elsewhere.

An indication is given by the effect of various morpholexical rules in Czech which affect the length of vowels. We have already noted that diminutives of nouns with basic long vowel often show a short vowel, and vice versa. Other relations between corresponding long and short vowels include the following: a) a number of masculine nouns show long vowels in the nominative singular and short vowels elsewhere (e.g. [du:m] 'house', [domu]); b) a number of feminines with long vowel show a short vowel in the genitive plural (e.g. [houba] 'mushroom', g.pl. [hub]); c) many verbs show long vowels in the infinitive and short vowels in other forms (e.g. [ru:st] 'to grow', present [rostu]; d) derived verb forms often show lengthening of the vowel in the stem from which they are derived (e.g. [vi=růstat] 'to grow up' from the stem of [rostu]); e) some collectives show lengthening of the stem vowel (e.g. [doubi:] 'young oak grove' from [dub] 'oak'); f) adjectives with irregular comparative forms often have short vowels in the comparative when this is used adjectivally, and long vowels in the comparative when this is used

adverbially (e.g. [drahi:] 'dear', [drašši:] 'de
[dra:že] 'more dearly'; [bli:ski:] 'near', [bli
'nearer', [bli:že] 'more nearly'). These proce
can be seen, involve both lengthening and short
and the vowels which are paired by them are (wi
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[e] with [e:]; [o] with [u:]; and [u] with [ou]
initial or [u:] (initial). This suggests that
initial) phonetic [u:] is in fact the long corr
dent of [o] at some stage, and that the vowel w
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long correspondent of [u] at the same stage.

If this analysis is correct, it would seem
we are right back where we started from. Thoug
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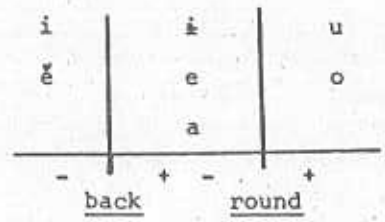
adverbially (e.g. [drahi:] 'dear', [drašši:] 'dearer', [dra:že] 'more dearly'; [bli:ski:] 'near', [bliššši:] 'nearer', [bli:že] 'more nearly'). These processes, as can be seen, involve both lengthening and shortening, and the vowels which are paired by them are (with 'short' vowel given first): [a] with [a:]; [i] with [i:]; (palatalizing) [e] with [i:]; (non-palatalizing) [e] with [e:]; [o] with [u:]; and [u] with [ou] (non-initial or [u:] (initial). This suggests that (non-initial) phonetic [u:] is in fact the long correspondent of [o] at some stage, and that the vowel which appears initially as [u:] and elsewhere as [ou] is the long correspondent of [u] at the same stage.

If this analysis is correct, it would seem that we are right back where we started from. Though we eliminated one proposed exchange rule in Czech (the LL→CC vowel shift proposed by Wolfe), we have arrived at a situation which seems to suggest another one; if [ou] comes from /u:/, and [u:] comes from /o:/, is this not exactly like the vowel shifts Wolfe discusses? It might be proposed that the necessary rules consist of a) interchanging /o:/ and /u:/; b) adding /w/ after derived /o:/, and then c) shortening /o:/ to /o/ before /w/. These latter steps would be parallel to the derivation of [ej] from /ě:/ in CC, and could be regarded as a process of LL which is simply generalized in CC.

Since the proposed exchange process is not a morpho-lexical rule, we would be left with a counterexample to our proposed constraint on exchange rules.

It has been suggested to us by M. Halle that additional support could be found for this proposed rule exchanging back vowels. Let us reconsider the distinction between palatalizing and non-palatalizing front vowels. Recall that we proposed above that non-palatalizing [i, i:] be represented as /i̯, i̯:/. In the case of the mid vowels, however, it was the palatalizing vowel which was to be assigned a remote representation distinct (in some cases) from its surface shape; palatalizing [e] was to be represented as /je/. Suppose, however, that we treat the mid vowels in the same way as the high vowels: palatalizing [e] as front (written /e̯/), and non-palatalizing [e] as back (thus, assume that /e/ is a back vowel). There is good reason to believe that this solution accords with the historical facts (cf. Jakobson, 1929), and it need entail no complication of the grammar since the rule required to derive the phonetic value of /e/ is exactly the same as that required to yield [i, i:] from /i̯, i̯:/. The underlying vowel system of Czech (both CC and LL) would then consist of the following, with each vowel appearing both short and long:



Let us consider the consequences of t
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to /i̯:/ (which is then fronted to [i:]). I
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[di:lka] 'length', not *[d'i:lka], corresp
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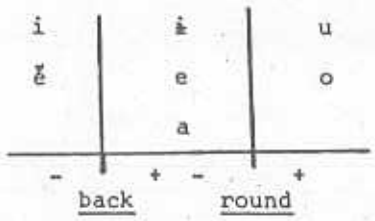

Let us consider the consequences of this analysis, first for CC. In this dialect, as we have argued above, basic /o:/ is raised to [u:] and basic /e:/ is raised to /i̯:/ (which is then fronted to [i:]). It must be /i̯:/, rather than /i:/, that /e:/ is raised to, because the resultant vowel is still non-palatalizing (cf. CC [di:lka] 'length', not *[d'i:lka], corresponding to LL [de:lka]). On the other hand, we could also propose that /u:/ and /i̯:/ are lowered to /o:/ and /e:/, respectively, before being diphthongized to [ou] and [ej]. Thus we would have parallel rules of raising and lowering applying to non-low long back vowels, constituting an exchange process even more extensive than appeared at first.

The first difficulty of this analysis, which treats the CC vowel shift as simply an extension of the switch of back rounded vowels present also in LL, is that there is no motivation for the use of [+back] vs. [-back] to distinguish non-palatalizing and palatalizing [e]. Phonetically, both are clearly [-back], and the rule of velar palatalization (distinct from the palatalization

process discussed thus far) applies before some non-palatalizing [e]'s (as well as before some [i]'s), as in [bože] 'Oh god!', vocative of [bu:h] 'god' from the stem /boh/. This suggests that even non-palatalizing [e] has been in some sense a front vowel for some time. The feature distinguishing palatalizing from non-palatalizing [e] for Jakobson was not frontness but diphthongization, with palatalizing [e] long and short represented as long and short /ie/. A representation of palatalizing [e] as /je/ has the virtue that this [j] actually appears on the surface (after labials and initially), and would thus have to be inserted if it were not present underlyingly. These arguments do not apply to the distinction between palatalizing and non-palatalizing [i], however, since [j] does not appear before palatalizing [i]. Thus, independent of the question of exchange rules, /e/ vs. /je/ and /ɨ/ vs. /i/ seem the most natural representations for the non-palatalizing/palatalizing contrast in the two vowels. In this case, however, the raising and lowering rules are no longer parallel: raising applies to the front vowel /e:/ and the back vowel /o:/, while lowering applies to the back vowels /ɨ:/ and /u:/, but must not be allowed to affect the front vowel /i:/. Thus, the raising and lowering processes have different conditions, and could

not be collapsed into a single sche
letter variables convention.

In fact, the same conclusion f
is assumed that non-palatalizing [e
is because lengthened palatalizing
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'faith', gen.pl. [vjer]; [pospi:šit
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different conditions, and could

not be collapsed into a single schema by the Greek-letter variables convention.

In fact, the same conclusion follows even if it is assumed that non-palatalizing [e] is [+back]. This is because lengthened palatalizing [e], which is [-back] on either analysis, is also raised to [i:]: cf. [vi:ra] 'faith', gen.pl. [vjer]; [pospi:šit'i] 'hurry', imper. [pospješ]. Raising thus applies to the front vowel /ě:/, as well as the back vowels /o:/ and /e:/ on this analysis of CC. Lowering, however, applies only to the back vowels /u:/ and /ɨ:/, and not to the front vowel /i:/. The conditions on the two rules are thus different, and they cannot be combined into a single schema by the convention of variables over feature values.

Now consider the facts of LL. Here the raising rule still affects long palatalizing /ě:/ (based on the same forms as cited above for CC), and it also affects long /o:/, raising it to [u:]. It does <u>not</u>, however, affect long non-palatalizing /e:/, and this becomes simply [e:]. The lowering rule in LL affects neither the front vowel /i:/ nor the back vowel /ɨ:/, but only the back rounded vowel /u:/, and then only when /u:/ is in non-initial position. Here too, then, the conditions on raising and lowering are quite distinct, and they cannot be combined into a single schema by the convention of variables over feature values.

Both LL and CC, then, have rules of raising and of lowering, but in neither case can the rules be combined by the convention which Chomsky suggested defined the class of rules which are applied simultaneously. The problem he originally noted, however, seems to arise on either analysis. Both LL and CC have a rule which, among other things, raises /o:/ to [u:]. If they also have a rule which lowers /u:/ to /o:/, then whichever order the two are applied in, the distinction between underlying /u:/ and /o:/ will be neutralized. We would have a set of processes which properly include an exchange, but which are not abbreviable by the appropriate convention even if simultaneous ordering is allowed for the class of cases described by Chomsky.

The key to this dilemma lies in the phonetic value of the diphthong ou. Wolfe transcribes this as [ow]; that is, as a sequence of vowel plus glide consonant, and it is this representation that makes the derivation /u:/ > /o:/ > /o:w/ > [ow] plausible. In fact, however, the diphthong ou is unlike the sequences of vowel plus (tauto-syllabic) glide that appear elsewhere in the language ([uj, ej, oj, aj, i:j, a:j, u:j]). Phonetically, the element [j] in these sequences is definitely short and non-syllabic, and the sequence is phonetically and distributionally parallel to other vowel plus consonant sequences. The diphthong ou, however, "is

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Czech o sound which gradually blends with
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pronounced like ow in English mow, prolonged considerably. This diphthong is much prolonged, and is the longest Czech vowel sound. It begins with a clear Czech o sound which gradually blends with Czech u, and ends with a clear Czech u sound;" (Harkins, 1953:9). This is not a sequence [ow] of vowel plus consonant, but rather a sequence [ou] of two vowel sounds. It is definitely a unit, however: Czech does not allow vowel sequences, and generally breaks up those that arise over boundaries by the insertion of glottal stop. The ou sequence is structurally a single unit, on a par with the phonetic long vowels, as has been emphasized by Mathesius (1929) and Jakobson (1968). As we have suggested above, its underlying source is /u:/.

As is well known, long vowels in many languages are best treated as (tautosyllabic) sequences of identical short vowel elements (called moras). Since there do not appear to be any other properties that are consistently associated with this bimoric treatment, it is probably the case that long vowels are always at least potentially ambiguous between single units and sequences.[12] In these terms, the underlying elements /o:/ and /u:/ in Czech are also analyzable as /oo/ and /uu/; and it is clear from the phonetic facts that the rule applying to non-initial /uu/ to give ou simply alters the quality of the first element

of the sequence. The sequence /oo/, on the other hand, is converted to [uu], a change which can be described in terms of either the single-segment or the sequence analysis of long vowels. Given the fact that any non-initial vowel in Czech will be preceded by a non-syllabic element, these changes could be formulated as (1):

(1) a. $\begin{bmatrix}+\text{syll}\\+\text{round}\end{bmatrix}$ --→ [-high]/[-syll]___ $\begin{bmatrix}+\text{syll}\\+\text{round}\\+\text{high}\end{bmatrix}$

b. $\begin{bmatrix}+\text{syll}\\+\text{round}\end{bmatrix}$ --→ [+high]/ ___ $\begin{bmatrix}+\text{syll}\\-\text{high}\end{bmatrix}$

c. $\begin{bmatrix}+\text{syll}\\+\text{round}\end{bmatrix}$ ___ [+high]/ $\begin{bmatrix}+\text{syll}\\+\text{high}\end{bmatrix}$ ___

Rule (1a) converts non-initial /uu/ to /ou/, as required; rule (1b) converts /oo/ to /uo/, which is then converted to /uu/ by (1c). The splitting of the raising of /oo/ into the two rules (1b) and (1c) may appear peculiar, but it is in accord with the historical facts, since Modern Czech [u:] from /o:/ was phonetically [uo] until about the 16th century. Evidence for the separation of (1b) and (1c) synchronically comes from the fact that (1c) can be generalized naturally to account for the raising of long palatalizing [e:] to [i:]. If we assume that the lengthening and shortening rules give representations in which long palatalizing [e:] is represented as /ie/, while short palatalizing [e] is represented as /je/, then (1c) need only be replaced by (2) to raise /ie/ to /ii/ as well as /uo/ to /uu/:

(2) [+syll] --- [+high]/

The raising and lowering proces
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According to Jakobson, the
the LL ones in part in that non
joined palatalizing long [e:] i
This would result if underlying
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___ [+high]/ $\begin{bmatrix}+\text{syll}\\+\text{high}\end{bmatrix}$ ___

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The raising and lowering processes in LL, then, can be represented by the rules (1a), (1b), and (2).

According to Jakobson, the CC dialects differ from the LL ones in part in that non-palatalizing long [e:] joined palatalizing long [e:] in undergoing raising. This would result if underlying /ee/ were to undergo diphthongization to /ie/, and then subsequently undergo rule (2). This diphthongization of /ee/ to /ie/ is, of course, an extension of the already necessary diphthongization of /oo/ to /uo/ by (1b). In CC, then, we should replace (1b) by (3):

(3) $\begin{bmatrix}+\text{syll}\\-\text{low}\end{bmatrix}$ --→ [+high]/ ___ $\begin{bmatrix}+\text{syll}\\-\text{high}\end{bmatrix}$

The other difference between CC and LL (in the relevant domain) is that in CC /i̱i̱/ becomes [e:]. This could be accomplished in the following way: we already need a rule to front /i̱, i̱i̱/ to /i, ii/, which we could write as (4) below:

(4) $\begin{bmatrix}-\text{round}\\-\text{low}\end{bmatrix}$ --→ [-back]

Rule (4) applies in both LL and CC. Accordingly, if we were to diphthongize /i̱i̱/ by lowering its first element, this sequence would then be converted by rule (4) to /ei/. The required diphthongization of /i̱i̱/ is simply a generalization of (1a), which diphthongized /uu/ to

[ou], and we should accordingly replace (1a) by rule (5) below for CC:

(5) $\begin{bmatrix}+\text{syll}\\+\text{back}\end{bmatrix}$ --> [-high]/ ___ $\begin{bmatrix}+\text{syll}\\+\text{back}\\+\text{high}\end{bmatrix}$

The sequence /ei/ will then be converted to [ej] by an independently necessary rule which desyllabifies /i/ after an unlike vowel. Thus, the vowel quality rules for CC are (5), (3), and (2), and the differences between LL and CC consist in the generalization of two LL rules ((1a) and (1b)) in CC.

The important aspect of the above analysis for our purposes is that there is no longer an exchange process in either dialect. Though (1a) and (1b), or (5) and (3), perform a lowering of high vowel moras and a raising of mid vowel moras, the rules involved are dissimilation processes, and the environment in which raising takes place is distinct from that for lowering. The problem raised by Chomsky does not therefore arise in this case, and a sequential ordering of the rules is perfectly possible.

The essential basis of the analysis given here is that we assume diphthongization and raising/lowering to be inextricably connected. The long vowel /o:/, for example, does not change directly to [u:], but is rather raised first in its first mora. A precedent for such a diphthongization process is not hard to find; consider,

for example, the well known rul
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$$\text{--> [-high]/} \quad \text{—} \begin{bmatrix} +\text{syll} \\ +\text{back} \\ +\text{high} \end{bmatrix}$$

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for example, the well known rule in Finnish by which underlying /ee/, /oo/, and /ȣȣ/ become /ie/, /uo/, and /ʉʉ/, respectively. That diphthongization and vowel shift are connected in this way is supported by the following fact: there are words like [se:na] 'scene', and [bo:r] 'boron' which do not undergo either vowel shift or diphthongization in CC (or LL). There is not, however, any form like LL [si:sa] whose CC correspondent is [se:sa], with vowel shift but not diphthongization, or a form /so:sa/ which (in either dialect) could fail to change to [su:sa] but could undergo diphthongization to [sousa]. If the raising and lowering rules are regarded as applying to long vowels as units, followed by a diphthongization of the remaining long mid vowels, there is no reason why a form could not be an exception to just one of these processes. On the analysis given here, however, there is no way for /siisa/ to become /seesa/ (with 'vowel shift' but not 'diphthongization'), since the only rule which could apply to this form is the diphthongization rule (5). Similarly, there is no way for /soosa/ to diphthongize to /sousa/: the only possible source for [ou] is by diphthongization from /uu/, not from /oo/. The analysis given here explains the pattern of exceptions, therefore. A form in LL can be exceptional with respect to

(1b), and thus not undergo vowel shift (these are the foreign loans with long [o:], universally considered exceptional), but there are apparently no exceptions to (1a) or to (2). In CC, a form can be exceptional with respect to (3), and thus preserve [e:] or [o:]. There may also be some exceptions to (5), which would preserve long [i:] from /ɨɨ/ rather than giving [ej] (though here it is difficult to tell whether we are dealing with exceptions to a CC rule, or rather with LL forms in a sentence which also contains CC forms, a sort of mixture mentioned above). Again, there are no exceptions to (2). The important point is that a form is exceptional, if at all, with respect to exactly one rule, and there are no exception features linked in a "both or none" relationship, as would be required by the alternative analysis.

Apparently, therefore, the facts concerning the long back vowels in Czech do not provide motivation for an exchange rule after all. In fact, all putative examples of segmental exchange rules (leaving the English vowel shift out of account) turn out either to involve morpholexical processes or to be based on faulty or incomplete analyses. This fact suggests that we should impose the restriction on such processes that was suggested above: namely, limiting them to the

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Footnotes

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Footnotes

* This work was supported in part (Anderson) by a postdoctoral fellowship from the American Council of Learned Societies, and in part (Browne) not. We are grateful to Morris Halle, who does not agree with us, for his comments on an earlier version.

1. The relation between the Czech literary language and the modern spoken dialects has been the topic of much discussion in the literature. Kučera (1955) provides an account of the phonological facts which is in some respects more complete. For a discussion with considerably more information on syntactic matters, cf. Havránek (1929).

2. Not quite all LL [e:]'s are raised to [i:] in CC. For example, [ve:no] (hypocoristic of [va:clav] 'Wenceslaus') has [e:] in both LL and CC.

3. Variant of usual form with [-i:mi] used when modifying certain words (old duals): e.g. [hluxi:ma ušima] 'with deaf ears'.

4. The unpalatalized/palatalized pairs referred to are t/t', d/d', n/ň, k/c, h/ž, x/š, r/ř. The glide j appears before palatalizing e after the labials p, b, f, and v.

5. There are a few instances of the sequence [je] which must not be reduced although they follow a non-labial consonant. It is not clear whether these forms show that the representation /je/ is untenable for palatalizing e, or whether the j-deletion rule must be restricted.

6. For the vowel quality alternation in this pair, see the discussion below.

7. The productivity of this process is sufficiently limited to raise questions about its operation in the form suggested here. In a sample of dictionaries and native speaker interviews, no masculine or neuter nouns were found which shorten the vowel in forming the diminutive. In these forms, long vowels stay long, while short vowels lengthen in the great majority of words. The feminines are more interesting from our point of view. Of these, the results were as follows:

Long stem, short diminutive:	19 (+3 questionable or doublets)
Long stem, long diminutive:	39 (+7)
Short stem, short diminutive:	42 (+11)
Short stem, long diminutive:	8 (+3)

Thus, of the long stems less than a third alternate, while about one sixth of the short stems do. It should also be noted that, while the old Slavic vocabulary is distributed among all four classes, recently acquired words like škola, scéna are exclusively in the non-alternating class. The status of this regularity is thus problematic.

8. Wang (1967) has claimed that exchange rules are extremely common in tone sandhi rules in Chinese languages. He does not present much of the data on which this conclusion is based, and his sources are not generally accessible to us. Accepting his analyses, however, we restrict our claim here to the domain of processes affecting segmental features (however these are to be delimited). Since it is clear that tone sandhi rules have formal properties that are in many ways distinct from those of other phonological processes, this limitation does not affect the substance of our claim.

9. It is interesting to note that, in the case of the one other example which has been argued to support an exchange rule in the literature (Bever's (1967) description of Menomini), a recent paper by Goddard (1972) has shown that the phenomenon in question is in fact morpholexical rather than phonological. Goddard's conclusion is entirely independent of ours, but supports the proposal made here.

10. We refer here to the diphthong written ou in Czech orthography, and ow by Wolfe (1970). The phonetic character of this diphthong will be discussed immediately below.

11. Initial ou in CC is being lost i
language word by word. Ouroda for LL [u:r
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speakers.

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11. Initial ou in CC is being lost in the modern language word by word. Ouroda for LL [u:roda] is still current, but ouřat for LL [u:řat] is stylistically marked, and ne-ouroda is impossible for at least some speakers.

12. Within generative phonology, see for example the discussion of Kenstowicz (1970). In Anderson (1973) it is argued that the "schizophrenic" character of long vowels may be so extensive that the same rule may refer to them in one part of its SD as units, and in another part as sequences.

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