

MIRROR-IMAGE RULES AND DISJUNCTIVE ORDERING

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The notational devices of generative phonology, such as the conventions of abbreviation by braces, parentheses, and Greek-letter variables, were originally justified by appeals to simplicity. It was argued that sets of rules related in the formal ways specified by these devices expressed greater generality than did arbitrary sets of rules of equal complexity. In his 1967 article "Some General Properties of Phonological Rules", however, Chomsky attempted to define another formal property that might be correlated with such formal resemblances among rules. He proposed that, in addition to expressing added generality, the notational devices of parentheses and Greek-letter variables also exhaustively defined a set of exceptions to the strict linear ordering of rules: rules abbreviable in one of these ways were claimed to operate *DISJUNCTIVELY*, in that the rules of such a set were to be mutually exclusive, with at most one member of the set applying at a given place in the derivation of a given form.

Such a special ordering property would be of tremendous interest in establishing the status of a given formal resemblance among rules, for it ought to have much more direct empirical consequences and make predictions that are more readily confirmable or disconfirmable than the always slippery arguments from simplicity. As such, it is important to inquire about the relation which any proposed notational relationship bears to the principle of disjunctive ordering. In the cases of the parentheses and Greek-letter variables conventions, there is not a great deal of hard evidence to go on. Most cases of rules involving these notations are in fact consistent either with disjunctive application or its opposite, *CONJUNCTIVE* ordering. Of the small residue of cases supporting disjunctive application, some are based on controversial interpretations of linguistic facts, and cannot be said to have unquestionable status. Still, such evidence as there is seems to favor disjunctive application, and no evidence exists favoring conjunctive ordering in these cases.

Recent papers by Bach (1968), Langacker (1969), and others have discussed so-called mirror-image rules. These are pairs of rules operating in environments that are exact inverses of one another: the most typical cases are described in traditional grammars with statements like "vowels are nasalized when adjacent to (i.e., either preceded or followed by) nasal consonants". A number of cases of this sort have

been presented in the literature, and it seems clear that such symmetrical environments can embody real generalizations. It is important to inquire, therefore, whether pairs of rules related as mirror-image processes are ordered disjunctively or conjunctively.

While not easy to find, cases with the formal structure necessary to decide this issue do seem to exist in natural languages. In the fairly frequent sort of lenitive process found in some Celtic languages, for instance, voiceless stops are replaced by voiced stops, and voiced stops are replaced by the corresponding spirants. In Old Breton, this process applied to stops between sonorants, provided at least one of the sonorants was a vowel. This is formulatable as a pair of mirror-image rules with the environments / [+son]—[+syll] and / [+syll]—[+son]. Now since vowels are also sonorants, a stop in intervocalic position fits both of these environments, and hence is a test case. When we observe that an intervocalic voiceless stop in Old Breton is replaced by a voiced stop, rather than being further lenited to a spirant, we can conclude that the environments must be disjunctive.

Further cases include the following: in Faroese, a glide is inserted between two non-consonantal segments provided one of them is [+high]. Between two [+high] vowels or glides, however, one glide and not two should be inserted, despite the fact that the insertion of one glide does not destroy the environment for the operation of the rule. The two parts of this rule, then, must be applied disjunctively. Elsewhere, in the ancient Italic dialect Oscan, the Latin rule of anaptyctic vowel insertion is found in a generalized form: not only is a vowel inserted between a non-dental obstruent and a following dental sonorant, but the rule can also apply to separate such an obstruent from a preceding dental sonorant as well. In a cluster such as *rkl*, however, where the obstruent is surrounded on both sides by sonorants, only the preceding anaptyctic vowel, and not both, could be inserted. A fourth case is found in Acoma, an American Indian language. Here, among other complex tonal phenomena, a process operates to remove a high tone from a vowel next to a glottalized sonorant. If two high-tone vowels flank such a resonant, however, only the first loses its tone.

Facts such as those just alluded to might well lead us to accept disjunctive ordering of mirror-image rules, for this evidence is more substantial than has yet been presented for any other notation. Unfortunately, the situation is not that clear. There are other instances of mirror-image rules of the required form that appear to argue for conjunctive ordering. Typical of these is Keller's assertion about Chontal that vowels adjacent to a glottalized segment become non-distinctively laryngealized, and that the laryngealization is more pronounced between two such segments. The laryngealization rule is clearly a mirror-image one, and the two subparts must evidently apply conjunctively, for their effect is additive. Similar cases abound in the rules of phonetic detail of many languages. Some Irish dialects are described as having non-distinctive nasalization of vowels next to nasals, with a more pronounced effect between two nasals. This situation is surely duplicated in many other languages. A similar sort of case is found in the description of the quality of reduced vowels in many languages:

in Old-Irish, for instance, a palatalized consonant exerted a raising and fronting effect, and a velarized consonant a raising and backing effect, on an adjacent unstressed vowel. These effects were additive, in that a reduced vowel between two palatalized consonants was described as higher and further front than one adjacent to only one such consonant. Similar effects can be found in the principles that determine the quality of vowels in the languages of the Northwestern Caucasus, where a small number of underlying vowels have a wide variety of phonetic realizations, depending on the surrounding consonantism. A slightly different sort of example is found in modern Breton. Here stressed mid vowels can have any one of three qualities, depending on the syllable's consonantism. A vowel harmony process also exists, by which another mid vowel, agreeing with the stressed vowel in backness and rounding and appearing in a syllable on either side of it, is made to agree with it in precise quality. This effect can extend to both sides at the same time, if appropriate vowels are found in all three syllables.

These examples, which require conjunctive application just as rigidly as the first class required disjunctive order, might cause us to give up and say that disjunctive order is not definable in terms of a formal resemblance between the rules. In the case of mirror-image rules, at least, it seems that the disjunctiveness is an ad hoc fact about particular rules. It seems to me, however, that there is a more interesting generalization to be extracted from these examples. The cases supporting disjunctive order differ systematically from those supporting conjunctive order in that the former all involve rules that alter the categorical value (\pm) of some feature while the rules of the conjunctive sets all affect only the numerically specified value (on some arbitrary quasi-continuous scale) of some feature whose categorical value is not thereby distinctively affected. We might suggest on this basis, then, that disjunctive order is a property associated only with rules affecting categorical values (and related formally by notations like the mirror-image convention), while other rules apply conjunctively regardless of their notational status. This leads us to inquire about the status of parentheses rules that affect only numeric values. I know of no criterial cases, but I suspect that the investigation of phenomena such as down-step in terrace tone languages will provide interesting information in this connection.

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REFERENCES

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DISCUSSION

GAGE (Washington)

All the cases I think of that fit the conditions you describe for conjunctive specification of some property actually involve some time variation in the glottalization, nasalization, fronting, or whatever else, at least adjacent to a single triggering adjacent segment, so that something more sophisticated than a single numerical value of a feature assigned to a segment would in the long run be required. (One might consider the differences among Russian vowels occurring before, after, and between palatalized consonants — however it is to be specified — as showing the sorts of effects that are typical in real pronunciation.)

ANDERSON

Mr. Gage's point is well taken, and certainly needs to be taken account of. What is going on presumably bears some resemblance to the sort of suprasegmental phenomena that are best described on a realtime, rather than segmental basis. I believe Prof. Halle intends to touch on these issues in his presentation Thursday [see pp. 179-205 of this volume for Halle's presentation].

LEIDNER (Brookline, Mass.)

In regard to your Old Breton rule: I cannot see why $p \rightarrow b$ and $b \rightarrow v$ are lumped into one rule, since they involve different feature changes, *viz.*, voice and continuant changes respectively.

ANDERSON

It is certainly true that no present feature system takes these two processes to be the same. It is also clear, I think, that this is in some sense an error: both are instances of 'weakening' processes, in traditional terms, and this fact ought to be somehow reflected in a linguistic description. The best we can do at present is the use of notational conventions such as that of angled brackets; this allows us to write the two types of change as one schema, but does not express the fact that the sub-parts of this schema are more intimately related (as 'weakening' processes) than some other arbitrary pair, such as changes in voicing and coronality taking place in the same environment.

FROMKIN (Los Angeles)

There are languages with phonological mirror-rules which are conjunctively ordered which do not require the assignment of scalar values; *i.e.*, only plus or minus needs to be assigned. Often nasalization is such a rule. Thus $V \rightarrow [+nasal]/[+nasal]$ results in:

/dum/ → [dũm] and /pã+a/ → [pãã].

Mirror-image rules which conflate conjunctively ordered (or randomly ordered) rules need not specify a degree of nasalization but merely class membership.

ANDERSON

Prof. Fromkin's point is certainly well taken, but seems to me to indicate more about how hard it is to find clear-cut cases of the disjunctive status of a particular kind of rules than it does about the answer I proposed. It is of course the case that a vast number of processes abbreviable in any of the ways that have been discussed in the literature are CONSISTENT with either disjunctive or conjunctive formulation, depending on minor alternatives of formulation. The problem is to isolate some cases that are only consistent with one alternative, and to characterize this range of cases in some principled way. When this is done, we hypothesize that the resulting characterization can be extended to give a decision in the previously undecidable cases. This letting-the-theory-decide is of course a procedure that we could hope to have confirmed by some other kind of evidence, but just now I don't have any idea what that other evidence would be. The particular case mentioned by Prof. Fromkin could be formulated as the (disjunctive) rule $V \rightarrow [+nasal] \% - [+nasal]$, or as the (vacuously conjunctive) schema $V \rightarrow [+nasal] \% - [+nasal]$ (where % is the notation for mirror-image processes).

BUTLER (Berkeley, Calif.)

I would like to mention merely that, analogous to O. Breton, the Romance languages show a 'weakening' of intervocalic obstruents, but that here it might be argued that, say, in the history of Spanish, either two passes of a disjunctive rule

$$\left(\begin{array}{l} pp \rightarrow p \\ p \rightarrow b = \text{the old Spanish stage} \\ b \rightarrow v \end{array} \right)$$

or a change of disjunctive to conjunctive rule (*i.e.*, O. Sp. $b \rightarrow$ Mod. Sp. v) must be assumed.

ANDERSON

It is certainly true that these processes recur over and over in the same language sometimes. In such cases it would be necessary to look rather closely at the facts to determine whether simple relexicalization of a (historically) intermediate form was involved, or a change from disjunctiveness to conjunctiveness (a type of change which one would like to exclude as impossible, if disjunctive order is to be formally predicted).