PHONOLOGICAL STRUCTURE AND THE ANALYSIS OF PHONEMIC PARAPHASIAS

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ABSTRACT

Errors in the realization of consonants and vowels by substitution, deletion, and epenthesis are typical of the speech of aphasic patients. The characterization of the structural pattern of such phonemic paraphasias requires appeal to a variety of levels of phonological representation. Critical to any analysis of phonemic paraphasias is consideration of the markedness of the underlying, lexical, and surface repre-sentations of segmental and syllabic structure.

INTRODUCTION

Phonemic paraphasias, errors involving the substitution, deletion, or addition of a vocalic or consonantal segment, are a general characteristic of the speech of aphasic patients. These errors have long been a focus of consideration in the characterization of aphasic speech [1, 2, 3]. Traditionally analyses have been based on two central assumptions: (a) segments are represented as a set of binary distinctive features, and (b) phonological representations are linear, i.e., are ordered strings of segmental repre-sentations. Though the exact content of the featural representations of segments has evolved since the pioneering work of Jakobson, Fant, and Halle [4], the first assumption is still maintained. However, as will be discussed below, the content of featural representations varies in specificity at different levels of phonological representation [5, 6, 7]. The second assumption has, in contrast, been abandoned in favor of multi-dimensional representations with hierarchical structure. Three levels of morpheme/word representation are postulated, an underlying level, a lexical level, and a surface level. The multidimensionality of phonological representations arises from the character-ization of strings on three "planes", the melodic, which provides featural repre-sentations of segments, the syllabic, and a skeleton linking the melodic and syllabic.

At the underlying level of representation (UR) strings are not syllabified and segments have the minimal featural repre-sentations necessary to uniquely individuate segments At the lexical level of representation (LR) strings are syllabified in accordance with the specific algorithm of a language. Featural matrices of segments are further specified at LR by redundancy rules. At the surface level of representation (SR) full featural matrices are assigned to each segment

The theory of markedness has played a role in phonology since Trubetzkoy [8] first introduced the concept in his analysis of segmental structure. For Trubetzkoy, a segment was more or less marked depending on its closeness to the neutral (breathing) configuration of the vocal tract. This notion has long since been supplanted by more abstract characterizations which appeal to the intuition that some segments and structures are more highly favored linguistically than others. The redundancy rules which specify the featural representations at LR can be viewed as markedness rules which assign unmarked values to features which are not specified in UR. Thus, the phoneme /t/ is not specified for voice at UR, since voicelessness is unmarked, while /d/ must be specified as [+voice] at UR. In addition to using markedness in the characterization of segments, markedness considerations also apply in the analysis of syllable structure [9].

Jakobson [10] was the first to argue that

phonological theory could be used to explain the pattern of phonemic paraphasias. He proposed that the pattern of phonemic paraphasias reflected a general tendency for unmarked values to replace the marked values of segments; Blumstein [1] likewise claimed that the substitution errors of aphasic patients involve replacement of marked segments with unmarked ones. In this and considerable subsequent work, it was generally assumed that the pattern of phonemic paraphasias was consistent across aphasic populations. Recent work (e.g., [11, 12, 13]) raises significant questions about this assumption. If the uniformity of the pattern of paraphasias across aphasiological types is in question, then that raises further questions about the claim that markedness considerations play a critical role in accounting for the pattern errors. In what follows, it will be argued that the current approach to phonology provides a means for distinguishing among classes of aphasics and supports, at least in part, the claim that phonemic paraphasias can be explained on the basis of markedness.

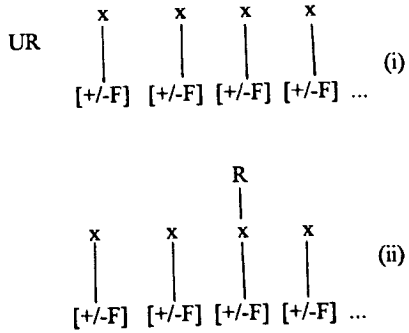
THE APHASIAS

Aphasias, acquired impairments of linguistic capacity, arise typically from damage to the left cerebral hemisphere. There are a variety of distinct symptom complexes in aphasia. In the literature on phonemic paraphasias, three types of aphasia figure most prominently: Broca's aphasia, conduction aphasia, and Wernicke's aphasia. Broca's aphasia and conduction aphasia are nonfluent aphasias, patients exhibiting relatively spared comprehension and word-finding difficulties. These two types of aphasia are distinguished on the basis of limited and/or agrammatic speech output in Broca's aphasia frequently accompanied by arthric disorders, as opposed to an absence of arthric disorders and production of numerous phonemic paraphasias in conduction aphasia. Wernicke's aphasia is characterized as a fluent aphasia. Speech typically contains semantic paraphasias, phonemic paraphasias, and neologisms. Each of these types of aphasia will be considered separately, and it will be proposed that the phonemic paraphasias of conduction aphasia involve UR and LR, with markedness considerations playing a significant role, while the segmental paraphasias of Broca's patients involve SR and motor planning and the errors of Wernicke's aphasics involve retrieval of URs.

Conduction Aphasia

Beland et al. [11] have provided the most detailed analysis of phonemic paraphasias in conduction aphasia. In an extensive single case study of a French speaking patient, they offer a detailed taxonomy of the pattern of simple paraphasic errors, e.g., substitutions, deletions, and additions of single segments, in the context of current phonological theory.

At UR, as was noted above, represen-tations consist of underspecified segmental representations on the melodic plane and a skeleton; syllable structure is assigned in the derivation of LR (Figure 1). The first step in syllable formation is the identification of the rime (R), the vocalic nucleus of the syllable. Next, in this simplified presentation, comes "sigma formation" which establishes a syllable on each rime. Every position to the left of the rime which the syllabification alogorithm provides for is attached to sigma creating an onset. Finally, through coda formation unattached segments to the right of the rime are attached to it.



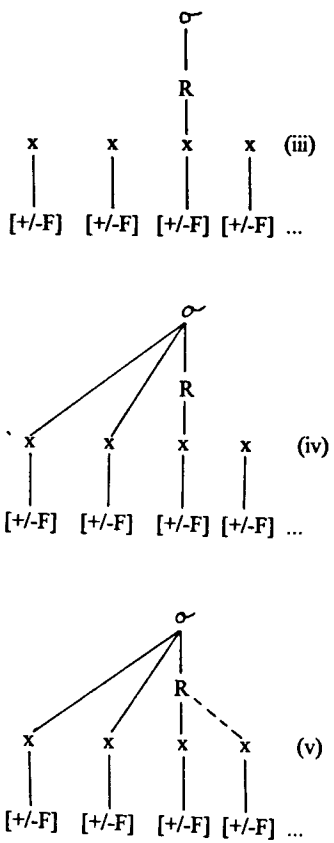


Figure 1. Assignment of syllable structure.

Syllable structure plays an important role in the description of phonemic paraphasias in conduction aphasics. Vocalic omissions can occur where there are adjacent rimes (naive, /na$iv/> [niv]). As adjacent rimes are marked, omission of one vowel reduces markedness. The markedness of adjacent rimes is also reduced by consonant epenthesis (ahuri, /aYRi/ > [alYRi]). Such epenthetic consonants are liquids, glides, or copies of another segment in the string. Syllable structure markedness is also reduced by vowel epenthesis in internal closed syllables (chemise, /ʃmiz/ > [ʃœ$miz], final closed syllables (fleur,/floer/ > [floe$roe], and in complex word onsets (strie, /stri/ > [sœ$tri]). Both vocalic and consonantal deletions occur at the extreme positions in words (kilo, /kilo/ > [kil] but never /kilo/ > [klo]; talc /talk/ > [tal]). Omissions at the extremes are insensitive to syllable structure, hence should be attributed to UR processes, whereas the other errors just described reflect difficulties in syllabification, that is the mapping from UR to LR.

In addition to omissions and deletions, substitutions are also encountered. At UR, where segments are not fully specified, only two types of errors are possible: some feature(s) may be "lost", or the specification on a feature might be "changed". There is no mechanism which allows for there to be any addition of features. Word-internal consonant omissions are found in the structure VC$CV where it is always the first consonant which is omitted, yielding V:$CV (admis, /ad$mi/ > [a:$mi]). Analysis of such errors involves the loss of the melodic plane associated with the first consonant which leaves an empty skeletal position that is automatically associated with the preceding vowel by the syllabification algorithm giving rise to compensatory lengthening. Given an incomplete melodic representation, there are three options available: (a) at extreme skeletal positions, the segment may be lost, (b) the un(der)specified slot is specified through the redundancy rules (diet, /djɛt/ > [tjɛt]; niaise, /njɛz/ > [njɛs]), or (c) has its full speci-fication realized through a process of copying (valse, /vals/ > [valv]). The former two processes must be associated with UR, while the latter process can be accounted for at LR. There is, in fact, a considerable range of errors which are to be accounted for at LR. For example, various consonant deletions, which also serve in the reduction of syllable structure markedness, can only be interpreted with respect to syllabified strings. In onset sequences obstruent + liquid (+glide), the onset may be simplified by the deletion of the

liquid, a deletion which enhance the sonority contrast between the onset and nucleus (droit, /drwa/ > [dwa]). By the same token, codas may also be simplified by consonantal omission; the most sonorous segment in the sequence is deleted which enhances sonority contrast (film, /film/ > [fim]).

Analyses such as that proposed by Beland et al. [11] illustrate the richness of phonological theory and its ability to provide a structure for accounting for a disparate range of errors. At the same time, the theory precludes, in principle, certain classes of conceivable errors. Markedness theory provides further constraints on the range of errors. Thus, for example, vocalic additions never create adjacent rimes, and errors in specification of the melodic plane at UR feed the redundancy rules which assign unmarked specifications to features. The analysis of the error corpus strongly suggests that in conduction aphasia the phonological compromise involves UR and LR. This attribution of the errors of conduction aphasics to a premotoric "phonemic" level is supported by Nespoulous et al. [12].

Broca's Aphasia

The most striking feature of speech in Broca's aphasia is the relative paucity of output. Agrammatism, the tendency to omit function words and various inflectional morphemes, is the most frequently noted realization of this deficit; however, there are also Broca's aphasics who speak in short relatively well-formed phrases and/or sentences. Like other aphasic patients, Broca's aphasics do make phonemic paraphasias, though these are not as ubiquitous as in the speech of conduction aphasics. Consequently, there has not been extensive research focused specifically on the pattern of phonemic paraphasias in this population. However, a consistent view emerges from a review of the literature (e.g.,[2, 3, 12, 14): The phonemic paraphasias of Broca's aphasics reflect simplifications at the levels of SR and motor planning and control.

The phonemic paraphasias of Broca's aphasics typically involve a change of a single feature in segmental realization [14]. Given this, the "misreading" of feature specifications must occur after segments have been fully specified. A prominent aspect of the consonant substitutions of these patients is a tendency to replace a voiced segment with its voiceless counterpart. MacNeilage [2] has argued that this devoicing is a simplification which is a function of the slow rate of speech of Broca's aphasics. Indeed, the devoicing is, at least in part, a reflection of the perceiver rather than the speaker: Phonetic analysis indicates that segments are only partially devoiced [14]. That the segmental disorder of Broca's aphasia is to be analyzed at the level of motor planning and the temporal control of speech production is further supported by the finding that voice onset time can be disturbed in Broca's aphasia [15, 16].

Nespoulous et al. [12] provide a contrastive analysis of the phonemic paraphasias of conduction and Broca's aphasics. They observe, for example, that in conduction aphasia errors in segmental realization are frequently contextually conditioned, but this is not a prominent feature of such errors in the speech of Broca's aphasics. Their data not only replicate the earlier finding regarding the tendency to substitute voiceless consonants for voiced ones, but also indicate a tendency for errors with voiceless consonants to involve a change in place of articulation (e.g., /k/ > [t]; /k/ > [t]). This general finding is also reflected in the data from a variety of studies which is analyzed by Beland and Favreau [17]. Such errors, like shifts in voicing, are readily accounted for at SR

Wernicke's Aphasia

The phonemic paraphasias of Broca's and conduction aphasics illustrate distinctive impairments in phonology, the latter involving the underlying and lexical representations of morphemes/words and the former the surface representation and mechanisms of motor

planning and control. If words have an abstract phonological representation, UR, which must be retrieved, then a third source of possible error is in the retrieval of UR's or in the loss of URs. Wernicke's aphasia, with its characteristic neologisms, is a candidate for such a disorder. Kohn and her colleagues [13, 18] argue for just such a position. Following previous authors, Kohn et al. [13] recognize two types of neologisms: (a) those which are "target-based" and (b) those which have no apparent lexical motivation.

Target-based errors reflect some access to the phonological lexicon. Some target based errors involve simple phonemic paraphasias. In cases where there is a substitution (e.g., bride > blide), Kohn et al. [13] argue that the UR melodic specification of [r] is "lost" and the patient reconstructs the string by analogy to other lexical entries. However, as we have already seen such errors can also be explained on the basis of the application of redundancy rules to an underspecified melodic representation. As the appeal to an analogical repair process involving lexical search is not independently motivated, an analysis utilizing standard phonological theory is preferable.

A second class of errors discussed involves the addition of a syllable; for example, one subject realized "umbrella" as [ʌmrɪpɛlə]. In such an example, there is an apparent relation to the correct lexical entry, but it is impossible to determine a clear source for the error. Descriptively, the error would appear to involve metathesis of /b/ and /r/, devoicing of /b/, and vowel epenthesis, or deletion of the skeletal position of /b/, addition of a consonant (perhaps with labiality copied from /m/), and vowel epenthesis, or deletion of the skeletal position of /r/, etc.. Kohn et al. [13] suggest that a case such as this can be accounted for because "[s]yllables can be 'randomly' added when the process of phonological reconstruction overcompensates for missing information." Again appeal is made to an otherwise unmotivated mechanism of reconstruction. An alternative approach would rely on basic phonological processes and markedness. First, it is assumed, that the shift of /b/ to /p/ arises from a loss of specification of the feature [voice]. This phenomenon has already been recognized in the analysis of phonemic paraphasias in conduction aphasia. Metathesis such as seen in this case can be viewed as a consequence of the breakdown in normal skeletal-melodic linkages in UR. The consequence of the metathesis is the sequence VmrpV which cannot be grammatically syllabified in English - *Vmr$pV, *Vm$rpV. The minimally marked locus for an epenthetic vowel which is consistent with English syllable structure is after the /r/, yielding VmrVpV. That is, once the stop and the /r/ are metathesized, it follows automatically that there will be an epenthetic vowel in a specific location given the syllable structure algorithm and markedness theory. Other target-based errors in their corpus are amenable to similar accounts which assume a disruption of representations at UR or of efficient retrieval of UR representations which are then "repaired" by normal phonological processes. In order to determine the adequacy of such a UR based approach to target-based neologisms, it would be necessary to carry out an analysis of comparable detail to that of Beland et al. [11].

In contrast to the target-based errors are the true neologisms, errors in naming, reading, or discourse which bear no decipherable relation to targets. Kohn et al. [13] provide several such examples, e.g., pig > [batɛntuvɛtu], elephant > /kʌlʌnsʌr/. They argue that cases such as these should be accounted for in terms of a loss of URs and not simply a deficit in the full retrieval of URs. The latter possibility is rejected since, under their theory, it would entail access to analogical reconstruction and the product of such reconstruction should be, at least in some degree, relatable to the target. However, if, as is suggested here, there is no mechanism of analogical reconstruction, then there is no basis for deciding between a retrieval impairment and a loss of URs. Neither hypothesis, it should be clear,

provides a clear basis for explaining neologisms in the context of normal phonological processes. Thus, it would appear that neologisms may well involve more than extreme distortions of phonological representations.

CONCLUSION

It has been argued here, following the tradition laid down by Jakobson [10], that the phonemic paraphasias of aphasic patients can be accounted for in terms of phonological theory. Departing from earlier analyses which were based on the assumption that phonemic paraphasias do not differ across different aphasic syndromes, recent work has provided evidence that the phonemic paraphasias of different types of aphasics are different in character. An overview of recent studies which have looked at the paraphasias of different aphasic populations has illustrated how modern phonological theory can contribute to our understanding of phonological and phonetic disruptions consequent to brain damage. There has, however, not been sufficiently detailed work on a broad enough class of cases to provide convincing evidence that the distinctions among aphasic populations suggested here generalize across patients within syndromes.

ACKNOWLEDGEMENT

This work has been supported in part by NIH-NIDCD grant no. DC02166.

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