



Aphasia, phonological and phonetic voicing within the consonantal system: preservation of phonological oppositions and compensatory strategies



Jean-Luc Nespoulous^{a,*}, Lorraine Baqué^b, Alba Rosas^b, Anna Marczyk^b, Marta Estrada^b

^a Jacques-Lordot Laboratory, URI OCTOGONE, Université de Toulouse Le Mirail, Pavillon de la Recherche, 5, Allées Antonio-Machado, 31058 TOULOUSE Cedex 9, France

^b flexSem Laboratory, Autonomous University of Barcelona, Spain

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ABSTRACT

A great number of studies in aphasiology have reported devoicing of voiced consonants in patients who have particular difficulty with the phonetic processing of speech. Recently, other studies have made attempts to account for these difficulties not only in negative terms of 'deficit' but also, positively, as a palliative strategy which patients would resort to in order to compensate, at least partly, for their deficit.

The aim of this chapter is to contribute to the ongoing debate about devoicing phenomena in aphasia. We carried out a multiple-case study in which we acoustically analysed consonants distinguished by the voiced–voiceless contrast in order to determine, for each patient: (a) the nature of their deficit: whether it is phonological (pre-motor level of speech processing) or phonetic (motor level); and (b) the existence of possible palliative strategies. Results obtained from anarthria and Broca's aphasia speech output indicate that the subjects differ in a statistically significant way ($p < .05$) between the VOT values according to whether the target consonant is voiced or voiceless. This can be interpreted, in the patients under study, as a deficit at the level of planning and/or implementation of the voicing feature without impairment, at a deeper level of processing, of the phonological encoding. These results also show that the subjects resort to alternative acoustic cues such as (i) Voice Termination Time (VTT), (ii) total duration of the segment, (iii) number of noise bursts or (iv) duration of the preceding vowel to mark the phonological opposition of voicing, therefore suggesting that they are making use of palliative strategies to compensate for their deficit.

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1. Introduction

Since the beginnings of aphasiology research, numerous studies have reported on aphasic patients' difficulties with voicing control, which have let them formulate an initial classification according to which these difficulties have been interpreted as a result of phonetic deficit (non-fluent aphasia) or phonological deficit (fluent aphasia) (cf. for example, Alajouanine et al., 1939). This dichotomy is established not only from the results of the extremely large number of case studies (Lecours and Lhermitte, 1969; Poncet et al., 1972; Blumstein, 1973; Blumstein et al., 1977, 1980; Freeman et al., 1978;

* Corresponding author. Tel.: +33 5 63 93 29 38; fax: +33 5 61 50 49 18 (J.-L. Nespoulous).

E-mail addresses: nespoulo@univ-tlse2.fr (J.-L. Nespoulous), lorraine.baque@uab.cat (L. Baqué), alba.rosas@uab.es (A. Rosas), anna.marczyk@uab.es (A. Marczyk), marta.estrada@uab.es (M. Estrada).

Benson, 1979; Itoh et al., 1980, 1982; Goodglass and Kaplan, 1983; Monoi et al., 1983; Canter et al., 1985; Nespoulous et al., 1982, 1983, 1987; by a review, cf. Blumstein, 2001), which aimed to establish a correlation between the injury that occurred, the patients' psycholinguistic aptitudes and the treatment stages in language production, but also owing to the hypothesis according to which the frontal cortex would be responsible for planning and executing the motor gestures for speech, while retro-Rolandic injuries would lead to deficits in phonemic selection (premotor level, according to McNeilage, 1982).

In general, most of the studies cited above and performed with non-fluent aphasiacs attribute the difficulties observed with regard to voicing to a deficit in temporal control and in the coordination of two independent articulators (activation of glottal excitation and supra-glottal closure). Nonetheless, for these aphasia patients, timing control deficit, which takes voicing and nasality errors into account, does not seem to affect other phonic phenomena in the same way (Harmes et al., 1984; Ryalls, 1987; Baum et al., 1990).

Today, this dichotomy between high-level and low-level deficits is still found in different psycholinguistic models (either serial, like those by Garrett (1988) and Levelt (1989, 1999), interactive, like those by Dell (1986) and Dell et al. (1997), or independent, like those of Caramazza (1997)), which do not cast doubt on the fact that there is a phonological selection level at a different level involved in the programming and execution of articulatory gestures. Conversely, the division of aphasias into fluent and non-fluent, which has a one-to-one association with the division of phonetic vs. phonological troubles has indeed been called into question (Blumstein, 1973; Trost and Canter, 1974; Hatfield and Walton, 1975; Dunlop and Marquardt, 1977; Klich et al., 1979; Buckingham and Yule, 1987; Blumstein, 1990; Blumstein et al. 1980; Blumstein and Baum, 1987; by a review, cf. Vijayan and Gandour, 1995) primarily due to the coexistence, in a single type of aphasia, of phenomena likely to be the result of both phonetic and phonological troubles.

Lecours and Lhermitte (1969) agreed that phonemic selection difficulties would be manifested, among other signs, by the random nature of the errors, without markedness effect and without clearly-established preferential tendencies in substitutions. This is contrary to that which would characterise motor difficulties, where errors would be more stable, with a greater preferential trend towards simplification (devoicing) and more sensitive to syntagmatic effects, particularly intra-syllabic. However, methodological difficulties arise due to characterising voicing mistakes according to the phonetic/phonological dichotomy, particularly due to two phenomena:

- The existence of the phonemic false evaluation (Buckingham and Yule, 1987; Baum and Slatkowski, 1993), which could make it difficult to distinguish voiceless production from a voiced consonant resulting from an extreme phonetic distortion of the target phoneme or its replacement by the corresponding voiceless phoneme (Blumstein et al., 1980);
- The non one-to-one relationship between the type of underlying deficit and the resulting outer expressions observed, which could be added to the effects of adaptive behaviour and palliative strategies employed – consciously or not – by patients to deal with their handicap (Nespoulous, 1998; Nespoulous and Moreau, 1998; B  land and Paradis, 1998; Nespoulous and Virbel, 2004).

The purpose of our research, which fits into the framework of the COGNIFON Project (FFI2010-15320), is therefore to contribute to the long-standing debate on the difficulties of voicing control for left-hemisphere cerebral damaged patients. We have carried out multiple case studies, still in progress, on the acoustic characteristics of consonants in Spanish and Catalan, which differ due to the voicing feature, in order to determine for each patient (a) the nature of the underlying deficit (premotor or motor) and (b) the existence of possible palliative strategies. Two general hypotheses were made in this research project:

1. Phonic troubles of language pathologies are situated on a continuous axis ranging from a phonetic pole (peripheral) to a phonological pole (central), which would be congruent with the studies (cf. *supra*) that point to a larger proportion of phonetic errors in anarthria and non-fluent aphasias, and phonemic errors in fluent aphasias, although the existence of the inverse type of errors cannot be excluded. The relationship between the different pathologies and the underlying deficit would be:



2. From a methodological viewpoint, both perceptive and acoustic analyses of patients' productions compared to 'normative' values are insufficient to take into account the subjects' phonic structuring. A third axis, based on the comparison of intra-speaker productions, is essential for identifying the underlying deficits and the appearance of possible palliative strategies (Baqu  , 2004; Marczyk, 2009; Marczyk et al., 2009; Rosas, 2009; Rosas et al., 2011).

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