Phonetic and/or phonological errors and phonetic flexibility abilities : A case study of two non-fluent aphasic patients

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Introduction

In aphasia, an important question is the level of language processing at which speech errors occur. This study focused on errors than can arise at phonological or phonetic encoding. Phonetic paraphasias are generally considered as occurring in patients with non-fluent aphasia and consist in incorrect articulatory realization of phonemes due to motor planification impairment in the phonetic system. On the other hand, phonological paraphasias generally occur in patients with fluent aphasia and are defined as substitution, transposition, deletion or inversion of phonemes due to incorrect phoneme selection within the phonological system (Laine & Martin, 2006; but see Blumstein et al., 1980; Nespoulous et al., 2013). However, the distinction between phonological and phonetic paraphasias is generally based on perceptual analyses that could be influenced by the experimenter's perceptual system.

In this study, we assessed language difficulties of two French-speaking aphasic patients, TM (age = 62 years) and CL (age = 65 years). On a description task, both patients presented non-fluent aphasia, as indicated by great word finding difficulties and frequent pauses in inappropriate places in the sentences. On a picture naming task, both patients produced semantic paraphasias and substitutions of phonemes. TM presented impaired frequency and length effects and CL impaired length effect. These results led us to assume that both patients presented lexical selection and phonetic deficits.

In order to clearly attribute these errors affecting phonemes to phonetic difficulties, we used acoustic analyses. We focused on the analysis of voice onset time (VOT), a reliable cue of motor speech control that may be affected in patients with phonetic impairment. We assumed that patients with phonetic impairment would show a tendency to devoice voiced stop consonants and to produce VOT that fell between the voiced and voiceless categories. By contrast, in case of phonological impairment, patients' voicing errors would show no clearly-established preferential tendencies in phoneme substitutions (Blumstein et al., 1980; Nespoulous et al., 2013).

In a second time, we addressed the question whether patients were still capable of phonetic and articulatory flexibility (Delvaux et al., 2013, 2014) because this would be an interesting cue for speech therapy, frequently based on repetition paradigms.

Methods

Part 1

Patients' VOT durations were analyzed in a repetition task of 84 CVCV nonwords (the six stop consonants /p/, /t/, /k/ and /b/, /d/, /g/ combined with the three vowels /a/, /i/, /u/ presented in initial or intermediate position in the nonword). VOT was analyzed for each CV syllable by measuring the distance from the onset of the burst (associated with the release of the consonant) to the first periodic cycle of the following vowel (Lisker & Abramson, 1964).

Part 2

Patients' phonetic flexibility was assessed through an investigation of their capacity to acquire a phonetic variant that is not usual in their mother tongue, a $C_{[t]}V_{[a]}$ syllable with a long VOT (Cho & Ladefoged, 1999; paradigm from Delvaux et al., 2013, 2014). Experimental stimuli consisted in 5 $C_{[t]}V_{[a]}$ syllables of respectively 20-, 40-, 60-, 80-, and 100-ms VOT. The paradigm consisted first in an AX discrimination task and then in a repetition task, both including the 5 stimuli.

Results

Part 1

The results of our analyses indicated that CL showed a great tendency to devoice voiced stops (48% of the voiced stops) but the mean VOT values of the correctly produced voiced stops were within the norms (mean patient VOT = -98.72 ms, average VOT for French = -100 ms, Laeufer, 1996). The patient only voiced one voiceless stop and the VOT values for the correctly produced voiceless stops were also within the norms (mean patient VOT = 35.26 ms, average VOT for French = 35 ms, Laeufer, 1996). He also presented a lack of articulatory accuracy that led him to transform stops in fricatives. These analyses suggested that CL had phonetic impairment. TM's mean VOT for voiced stops were of -64 ms, which is shorter than the average values for these stops in French (-100 ms), indicating that TM may present difficulties to maintain the voicing before the onset of the burst of the consonant. By contrast, his mean VOT values for voiceless consonants (32.22 ms) were within the norms. These results suggest that the patient presented motor difficulties with the planification of speech +contrôle moteur sur consonnes : l ➔ J, consonnes non voisées peu explosées, parfois ressemblent à des voisées. However, TM also presented a tendency to voice voiceless stops (17% of the voiceless stops) and to substitute the consonants with a different consonant including a change of place of articulation (e.g., /t/ becomes [k]; 18.48% of voiced and voiceless stops). These observations also suggest the presence of phoneme selection difficulties for this patient.

Part 2

As indicated on Table 1, both CL and TM still show a capacity to acquire a non-usual phonetic variant and therefore still have a certain phonetic flexibility. Indeed, response VOT fairly matched stimulus VOT in the repetition task. Their performance did not differ from the control participants', matched in age with the patients, as indicated by the patients' Z-scores in Table 1. Only the patients' discrimination performances were low. These scores may be due to difficulties with instructions understanding.

Discussion

The results of the present study highlight the importance of conducting acoustic analyses in order to help distinguish between phonological and phonetic errors that both affect phonemes. Our data also show that non-fluent aphasic patients can present phonological difficulties as well, as already indicated by a few studies in the literature (Blumstein et al., 1980; Nespoulous et al., 2013; Ryalls et al., 1995).

The outcomes of the second part of this study indicate that, even with motor planification of speech difficulties, our patients are still able to adapt to non-familiar linguistic variants and therefore to keep a certain articulatory flexibility. Differences between patients will be discussed with regards to their different profile, as well as about possibilities of language rehabilitation for patients with their kind of pattern.

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Table 1

Mean VOT values (in ms) and percentages of correct responses for patients TM and LC in the articulatory flexibility paradigm in comparison with mean performances of healthy participants matched for age

	Patient TM	*Controls of 55-65 years*	*SD 55-65*	*Z-score for TM*	*Patient CL*	*Controls of 65-75 years*	*SD 65-75*	*Z-score for CL*
Discrimination (%)	0	66	48	-1.40	0	59	49	-1.26
Repetition								
20-ms VOT (ms)	61.00	45.00	26.00	0.59	12.38	53.40	29.55	2.38
40-ms VOT (ms)	47.00	53.00	23.00	-0.29	55.73	61.90	33.93	-0.18
60-ms VOT (ms)	53.00	55.00	24.00	-0.07	70.23	69.70	37.16	0.01
80-ms VOT (ms)	81.00	68.00	30.00	0.43	78.68	70.40	36.79	0.22
100-ms VOT (ms)	58.00	66.00	32.00	-0.24	71.98	73.70	39.70	-0.04