# FLUCTUATING ACCENT IN FOREIGN ACCENT SYNDROME: A CASE STUDY

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## ABSTRACT

Foreign accent syndrome (FAS) is a rare acquired neurogenic speech disorder characterised by the emergence of an accented speech. The aim of this study is to describe the speech characteristics of LK, a FAS speaker who also shows fatigue and cognitive difficulties.

Perceptual as well as acoustic analyses show that LK's speech characteristics are comparable to those found in the literature, but also to those of speakers with apraxia of speech (AOS). The cognitive assessment shows that LK presents with deficit in inhibition control whereas other executive functions and short-term/working memory are unimpaired. Acoustic analyses show that speech characteristics enabling the detection of a foreign accent were intensified with tiredness. Moreover, agrammatism emerges in spontaneous speech with tiredness.

This speaker, unlike AOS ones, would be able to use compensatory mechanisms in order to maintain appropriate phonological contrasts. With tiredness, this ability declines and FAS characteristics exacerbate.

**Keywords**: Clinical phonetics; speech production; foreign accent syndrome; cognitive processes.

## 1. INTRODUCTION

Foreign accent syndrome (FAS) is a rare acquired neurogenic speech disorder characterised by the emergence of an accented speech [28]. Phonetic characteristics of FAS speech do not correspond to those of a true foreign speaker [10, 13], but fall within the possibilities of those of the world's languages [1]. Because listeners are in general more exposed to foreign or regional speech than to pathologic speech, pathological markers are construed as being characteristics of accented speech [7, 26]. FAS was also associated with agrammatism [8], which is a frequent symptom of Broca's aphasia, characterised by a deficit in sentence production (telegraphic speech, omission or substitution of function words as well as inflections or other grammatical morphemes).

Phonetic descriptions of FAS speech vary among studies. Consonant alterations include voicing errors, fortitions and less often lenitions [1, 10, 12, 17-18]. Vowel substitutions or distortions such as lax vowels becoming tense, low $F_1$ values, a restricted vowel space or higher vowel dispersion are observed [1, 6, 13]. Prosodic disturbances have also been reported in most studies: they affect linguistic prosody only, while emotional or affective prosody seem to be preserved [1, 12]. Prosodic changes may include: limited or larger than normal $f_0$ excursions [1, 13, 17], slow rate [13, 27], reduction of contrast between unstressed and stressed syllables reinforced by a non-reduction of unstressed vowels [1], rhythm modifications [12, 17-18] or inappropriate intonation contours [1].

FAS speech characteristics have been attributed by some authors to an excess of tension in the vocal tract or to an increase in the force of articulation [13, 23-24]. Other researchers argued that FAS is primarily a prosodic disturbance that has consequences on segmental characteristics of speech [1-2, 12]. Furthermore, other authors claimed that FAS is a mild form or subtype of apraxia of speech (AOS) [19, 22, 25, 27], because these two speech disorders share the same brain injury sites and similar symptoms (slow rate, phoneme substitutions, variability in production…).

According to the theoretical model proposed by Levelt [14-16], two phonetic encoding routes are involved in speech production: a direct route for high frequency syllables, stored in a mental syllabary, and an *indirect* route for low-frequency syllables or novel words. AOS speakers would present difficulties in accessing this direct route and therefore would resort to the *indirect* one, which has a heavier cognitive load [29]. By contrast, FAS speakers would use those compensatory mechanisms more efficiently than AOS speakers do. Therefore, their ability to use compensatory mechanisms in order to maintain appropriate phonological contrast would set them apart from other AOS speakers [25]. This proposition found support in an fMRI study that showed a compensatory reorganisation of motor speech and cognitive processing network in a single FAS patient [11].

The aim of this study is to characterise the speech of an FAS speaker presenting with associate cognitive deficits and an increase of her foreign accent with tiredness.

## 2. CASE REPORT

The speaker, LK, is a 53-year-old woman with a graduate degree. She is a native speaker of Quebec French who has always lived in the province of Quebec. She learned English at school and considers herself bilingual, although she has always used French in her everyday life. She suffered health changes in the last 15 years, including increased fatigue, weight loss, reduced concentration and mild anomia. These changes were followed by speech alterations, leading to FAS. No acute episode of loss of conscience was reported. Mild motor symptoms (reduced tonus and coordination in the left-side of the body) appeared 14 years ago and lasted about 3 to 4 months, but motor function returned to normal afterwards. Her general condition degraded during the first 5 years, which led to a diagnosis of primary progressive aphasia (PPA). Surprisingly, her condition then improved slightly and the diagnosis of PPA was removed. MRI and PET-scan did not show any conclusive results. General cognition, assessed with the MoCA test [20] three months before the present study, was normal (29/30). When we met LK, no definite medical diagnosis was made.

LK self-reported the following communication and cognitive difficulties: 1) fluctuating FAS (very mild to moderate-severe), more present with fatigue; 2) mild anomia; 3) reading difficulties due to attention deficit; 4) impaired executive functions (reduced attention, altered task organisation). Premorbid recordings of the patient's speech were not available.

## 3. METHOD

The subject was recorded twice, five months apart. The general characteristics of her spontaneous speech were evaluated on the first recording session. In order to confirm the variation of her accent with tiredness, a second recording session was organised. After a four-minute conversation, a text-reading task of the French version of *The North Wind and the Sun* was recorded. The text was presented once on a computer screen, one sentence at a time. These recordings were followed by a set of cognitive tests tapping short-term/working memory and executive functions: fluency tasks with semantic (most animal names in 120 seconds) and orthographic criterion (most words beginning with P in 120 seconds); free fluency task (most words in 150 seconds); Stroop test [9]; Trail making test [21]; Hayling test [4] (sentence completion with semantic-related and non-related words) with 15 extra items per condition; forward and backward digit span task (longest list of items that a person can repeat back in the presentation order or in the reverse order). After these tasks, the text reading and a short conversation were recorded again. Considering LK's cognitive complaints, we hypothesised that the administration of these tasks, demanding in terms of executive function and short-term/working memory, would likely cause an increase in her FAS.

Each recording session was carried out in a quiet room using a high-quality digital recorder. Prior to acoustic analysis, two listeners with at least five years of phonetic training were asked to identify all characteristics that made the speech sound foreign. Acoustic analyses (VOT and vowel formant analysis, $f_0$ range and contour, speaking rate) were performed using Praat software [3].

## 4. RESULTS

### 4.1 General speech characteristics

The two listeners observed the following general speech characteristics in the two recording sessions: lenition of consonants (especially [b] and [v]) and many vocalic reductions, suggesting a lack of tone in the vocal tract. Slightly slower speech rate, creaky voice and unusual prosodic patterns were also reported. Comparison between "before" and "after" the cognitive tests suggested that all those characteristics were more prominent with tiredness.

### 4.2 Acoustic results

Consonant productions were extracted from the text-reading task, taking the words starting with an occlusive consonant. The subject displayed normal ranges of VOT values, suggesting normal control of voiced/voiceless contrast (see Table 1). In normal speech, an increase of VOT values with consonant backness was observed [5]. Surprisingly, LK's VOT values were higher for labial consonants than for alveolar and velar. However, a slight lenition of labial consonants was observed by trained listeners.

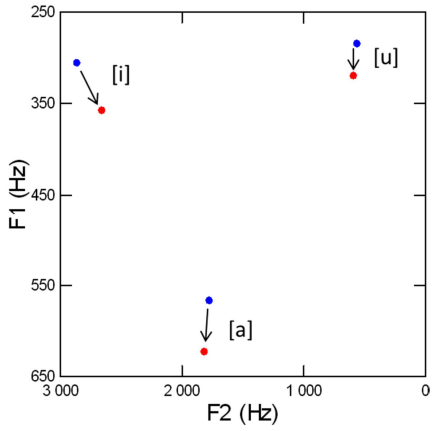
**Table 1**: VOT values (in ms) for each stop category in the first and second reading tasks

| | first reading task | | second reading task | |
|---|---|---|---|---|
| | voiceless | voiced | voiceless | voiced |
| labial | 73.7 | -63.1 | 61.2 | -71.5 |
| alveolar | 26.5 | -49.0 | 31.6 | -40.6 |
| velar | 42.9 | -36.5 | 42.6 | -31.3 |

VOT values were obtained by measuring the time between the apparition of the stop burst on the spectrogram and the following (or preceding) voicing. However, for some productions, no clear stop burst was visible, due to weak stop closure (leading to spirtantisation). These productions could therefore not be analysed and were excluded from the results. This phenomenon was present only on the corpus recorded after the cognitive tasks (0% before, 13% after). This observation suggests that a decrease in articulation strength occurred with fatigue.

Vowel formants were extracted from five [i], [a] and [u] of the text reading task. As shown in Figure 1, $F_1$ values were slightly higher in the second text-reading task, suggesting once again a more lax vocal tract. A greater variability in formant values was also observed, especially in $F_1$, in the second reading task.

**Figure 1**: Mean formant frequencies in the text-reading task for [i], [a] and [u] before (blue) and after (red) cognitive tasks




Suprasegmental analyses (speech rate, $f_0$ range and contours) were based on the recordings of the text-reading task.

**Table 2**: Mean fundamental frequency, pitch range, speaking rate and articulatory rate before and after the cognitive tasks

| | before | after |
|---|---|---|
| $f_0$ | 224 | 201 |
| range (semitones) | 18 | 24 |
| speaking rate (syll./s) | 4.6 | 4.0 |
| articulatory rate (syll./s) | 5.1 | 4.5 |

Mean $f_0$ is slightly lower in the very last recording session; pitch range did not seem to be affected with tiredness. As in [27], two rates were measured: speaking rate and articulatory rate. Speaking rate includes silent pauses (except for those between sentences) whereas articulatory rate does not. Results are expressed in syllables per second. As shown in Table 2, speech rate slows down between the beginning and the end of the recording session.

### 4.3 Cognitive tests results

As shown in Table 3, LK's performance was normal in fluency tasks as well as in the Trail making test, two tests exploring mental flexibility. She did not present any problems in short-term/working memory tests (digit span) either. However, LK showed difficulty in the two tests exploring inhibition abilities. Her performance was outside the normal range for the 'word' and 'interference' conditions of the Stroop test. She also encountered problems in the second part of the Hayling test, in which she was asked to generate a word that did not correctly complete the sentence and was not connected to the sentence in any way. In this experimental task (i.e. 15 sentences added to the standardised version), she showed problems suppressing or inhibiting automatic responses and produced 8 of this type of errors.

**Table 3**: LK's performance in cognitive tests

| | **LK** | **Norms: mean (SD) or range** |
|---|---|---|
| Fluency tasks | | |
| - Semantic criteria | 34 | 26.9 (7.8) |
| - Orthographic criteria | 29 | 19.9 (6.9) |
| - Free fluency | 66 | 56.5 (18.5) |
| Trail Making Test- part A (s) | 12 | 17-65 |
| Trail Making Test- part B (s) | 34 | 42-122 |
| Stroop Test - word (s) | 58* | 32.2-51.6 |
| Stroop Test - color (s) | 40 | 41.2-79.2 |
| Stroop Test - interference (s) | 160* | 57.5-146.6 |
| Hayling test (inhib cond.) | | |
| - 1st 15 items (nb of errors) | 2 | 2.43 (2.25) |
| - next 15 items (nb errors) | 4 | - |
| Digit span forward | 8* | WNR |
| Digit span backward | 6 | WNR |

* Indicates a score below the norms or outside the normal range. WNR: within the normal range.

Whereas spontaneous speech was normal at the beginning of the assessment session, the patient presented with mild agrammatism after the administration of cognitive tests. There were no phonemic or verbal paraphasias but speech was sometimes telegraphic with omissions/substitutions of function words, morphological errors and

impoverished syntactic structure (e.g., “le début **de le** mois de mars” instead of “le début **du** mois de mars” the beginning of March). None of these errors were self-corrected.

## 5. DISCUSSION AND CONCLUSION

The main goal of this study was to characterise the speech of LK, a FAS speaker presenting with a fluctuating foreign accent, tiredness and cognitive difficulties. Perceptual and acoustic analyses show that LK shares the same FAS characteristics as in other studies (articulatory and prosodic distortions, slow rate). These results are also consistent with the hypothesis that FAS is a subset of AOS. The speech characteristics enabling the detection of a foreign accent were exacerbated with tiredness, being more prominent after a cognitive effort. These observations are compatible with the assumption that, unlike AOS speakers, FAS speakers can successfully use compensatory mechanisms. Indeed, although the accent was always present in her speech, control seemed more affected when she was tired. In LK, agrammatism also appeared following cognitive effort. Although never proposed before, the hypothesis of compensatory mechanisms for deficits in syntactic processes, undermined with tiredness and/or executive deficits, could also be posed. Further studies are therefore required to confirm our results and our interpretation related to the functional origin of FAS and associated manifestations.

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