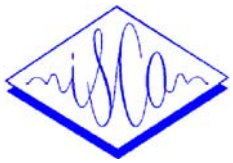

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Prosody and Foreign Accent Syndrome: a Comparison of Pre- and Post-stroke Speech

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Abstract

This paper describes the prosodic characteristics of a female Dutch native speaker with so-called Foreign Accent Syndrome. Although Foreign Accent Syndrome has often been regarded as a speech disorder which is characterized by substantial deviations in intonation patterns, the case of a Dutch-speaking patient is reported whose intonation patterns can be regarded as normal.

1. Introduction

Foreign Accent Syndrome (henceforth: FAS) is a motor speech planning disorder in which the speech characteristics of patients are such that they result in the perception of a foreign accent by listeners of the same speech community. It is the only speech disorder which is defined in terms of the listener's perception of the patient's speech.

The disorder was first described in considerable detail in [14] which reports the case of a native speaker of Czech who developed a Polish accent after a left-hemisphere stroke. The impression of the Polish accent was caused by stress placement on the penultimate syllable (rather than the first syllable in Czech), the loss of Czech vowel length distinctions, the palatalisation of fricatives and the nasalisation of certain vowels.

The best-known report is that of [12] which reported the case of a Norwegian woman who acquired a German accent as a result of severe head trauma. One of the most prominent characteristics of her speech was a significant deviation in pitch patterns: the Norwegian lexical tone distinction did no longer exist and sentence intonation was seriously impaired. To our knowledge, a total number of 32 cases have been reported since the earliest descriptions. It is not clear whether this limited number is a true reflection of the rarity of the condition or whether it has often gone unnoticed in clinical practice.

A comprehensive analysis of the literature reveals that prosodic errors have often been assumed to be an essential characteristic of FAS. The most important prosodic deviations relate to accent-placement, intonation, speech rhythm and juncture.

Accent

- Wrong placement of word accent [14]
- Wrong sentence accentuation [5], [7]
- Loss of the Norwegian tonal accent distinction [11], [12]
- The use of Swedish-like tonal accents in a native speaker of American English [13]

Intonation

- Substantially larger pitch excursions in intonation patterns [6], [12]
- Substantially smaller pitch excursions in intonation patterns: generally flatter intonation [7]
- The frequent use of rising pitch movements at phrase boundaries and end of sentence [4], [12], [15]
- Higher overall pitch [6]

Speech rate, rhythm and utterance duration

- Slow speech rate [1], [7]. [8]
- Unnecessary pauses [7], long pauses [8]
- Tendency towards syllable-timing where stress-timing is the norm [2], [4], [6]
- Staccato rhythm [11]

Juncture

- Failure to co-articulate words [12]
- Inadequate transitions between syllables in a stress group [1]

The aim of this paper is to present the neurological and prosodic speech characteristics of a Dutch-speaking patient with FAS.

2. Neurological characteristics

A 53-year-old right-handed female native speaker of Dutch acutely developed severe speech difficulties and severe paresis of the right hemicorpus. Neurological examination revealed verbal mutism (anarthria) with intact auditory-verbal comprehension, normal spelling, intact written comprehension and normal bucco-lingual praxis. A moderate right hemiparesis and central facial nerve palsy were found. Tendon reflexes were brisker at the right side of the body. The right plantar response was extensor. Sensory examination was normal. On confrontation no visual field defects or spatial neglect phenomena were noticed. Medical history was unremarkable. A computerized tomography scan of the brain on the fourth day of admission revealed an infarction in the left fronto-parietal region. A baseline Tc-99m-ECD SPECT scan of the brain in the lesion phase of the stroke (33 days postonset) showed a breach of the left frontal motor and parietal cortex. A secondary relative hypoperfusion was found in the thalamus and striatum of the left hemisphere. In addition to these supratentorial perfusion deficits a relative hypoperfusion of the right hemicerebellum was found,

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demonstrating the phenomenon of crossed cerebellar diaschisis. Two weeks post-stroke, brain magnetic resonance imaging displayed a cortical ischemic lesion in the territory of the left medial cerebral artery, involving the inferior frontal gyrus, the precentral gyrus, the anterior insular cortex, the postcentral gyrus and the supramarginal gyrus with discrete hemorrhagic conversion. A second but small ischemic lesion was visualized in the territory of the left anterior cerebral artery affecting the gyrus cinguli.

The day after admission speech started to recover. During the next days an oral-verbal output syndrome became apparent in which speech was slowly and hesitantly articulated. In addition, effortful articulatory struggles, particularly affecting consonant clusters, vowel and consonant lengthenings, decreased stress and a general flattening of voice volume disrupted prosody and melody. As a result, syllables tended to become isochronous and of equal prominence (scanning speech). Although the articulatory distortions affected speech rather inconsistently, most errors were close phonemic target substitutions. Articulatory groping and struggling giving rise to sequential errors, and mostly unsuccessful efforts to self-correction alternated at times with 'islands of error-free speech'. Errors significantly increased with word length and were not task dependent. No improvement was found when the patient recited, repeated or read aloud. Apart from the articulatory deviations the analysis of the patient's speech did not reveal any structural linguistic deficits. In addition, aphasic disturbances were formally excluded by means of standardized language tests. The patient herself as well as her direct acquaintances and hospital staff reported that her speech sounded odd as if she spoke with a French or German accent. A neurolinguistic diagnosis of FAS was made and intensive speech therapy was started.

The language tests were re-administered and extensive neuropsychological investigations were repeated in the postacute phase (one months postonset). The patient scored 30/30 on the Mini Mental State Examination. On the Wechsler Adult Intelligence Scale (WAIS), she obtained a verbal IQ of 125 and a performance IQ of 110. The Wechsler Memory Scale-Revised revealed a visual memory index above 138 and a verbal memory index of 125. On the delayed recall subtests an index of 140 was found. Formal assessment of handedness by means of the Edinburgh Inventory showed a laterality quotient of +100. Although no aphasic deficits were objectified inconsistent non-sequential substitutions of target phonemes and phonetic alterations such as prolongations and reductions of speech sounds were again present. Articulatory deviations were less prominent but interlocutors still perceived the patient's speech as distinctly foreign.

Three years after the stroke complete remission of FAS was found and mild apraxia of speech symptoms became apparent. Although articulation rate had markedly improved the patient still spoke slightly hesitantly as if she "wanted to stay in control of the production of sound patterns". Consonant clusters were sometimes articulated with increased effort resulting in vowel and consonant prolongations. However, stress patterns and voice volume had normalized. Scanning of speech had disappeared but articulatory groping and struggling still sporadically occurred. Analysis of a spontaneous conversational speech sample showed a return to normal speech rate. Repeat Tc-99m-ECD SPECT displayed unchanged absence of tracer uptake in the frontal motor area and parietal cortex of the left hemisphere. The secondary relative hypoperfusion of the left thalamus and striatum remained unchanged as well. However, at the level of the right cerebellum a marked improvement of tracer uptake was found.

3. Prosodic characteristics

The speech data presented in this paper consisted of two samples. The first sample was recorded a few weeks before the stroke and consisted of three short prayers read in church on the occasion of a wedding anniversary. The language register as well as the context were thus formal. Total duration of this sample was 11 sec 63 msec. The second speech sample consisted of 26 spontaneous speech utterances which were recorded during a short conversation (2 minutes) with the patient 11 days after the stroke. In this conversation the patient described the events following the insult.

3.1. Speech tempo

The patient's speech articulation rate was quantified as the number of syllables per second and speech rate in terms of words per minute. For the pre-stroke speech sample, articulation rate was 11.37 syllables per second and speech rate amounted to 153 words per minute. A comparison to average articulation rates for Dutch sponaneous speech reported in [3] (between 4.8 and 5.3 syllables per second), reveals that the patient's pre-stroke speech delivery rate is almost twice as fast as normal. It is not clear how to account for this fast speech and articulation rate, but it seems reasonable to assume that it may have something to do with the higher stress levels associated with formal speaking/reading situations.

In the post-stroke speech sample, articulation rate was 1.9 syllables per second and speech rate was 68.4 words per minute. These values are significantly lower than the values for the patient's pre-stroke speech as well as the average values for normal Dutch in [3]. This finding is consistent with other cases in the literature. [7] reported excessive pausing at phrase boundaries and 'unnecessary" pausing elsewhere in utterances and [10] describes a FAS patient with generally slower, halting speech. [11], however, reports a perfectly normal speech tempo.

In addition to this slow speech rate, speech delivery of the patient sounded very much syllable-timed and isochronous, rather than the stress-timed nature of normal Dutch. In addition, the patient's speech sounded quite staccato. This is also consistent with the findings of [9] who describes the following characteristics: "(…) a tendency towards "syllable timing", away from the normal "stress timed" pattern of English (…) A staccato speech rhythm is often reported, together with the impression of a tense articulatory setting" [9] A similar staccato rhythm is also reported in [11].

3.2. Segment duration

A comparison was made of the durational characteristics of the vowels and consonants in the pre- and post-stroke speech sample. For this purpose the durations of all speech segments in the two speech samples were measured in the signal-processing program PRAAT on the basis of a speech wave form with time-aligned broadband spectrogram. The durations were analysed statistically with a two-way analysis of variance with the factors 'sound' (consonant vs. vowel) and 'condition' (pre- vs. post-stroke). The ANOVA was significant

($F(3,381=43.4727)$, $p < 0.0001$) with a significant effect of 'condition' only: the effect of 'sound' and the interaction between 'condition' and 'sound' were not significant. The effect of condition is such that both vowels and consonants are on average 64% longer in the post-stroke speech sample: in pre-stroke speech, vowels and consonants have a duration of 82 and 89 ms respectively; these durations were 128 and 137 ms for the post-stroke vowels and consonants. This significantly longer duration of vowels and consonants in post-stroke speech can be in part accounted for by the big discrepancy in speech rate between pre- and post-stroke speech. It should be noted that this observation is different from [6]: in their patient, vowel durations were substantially shortened in post-stroke speech, while consonant durations were lengthened.

3.3. Pitch

The intonation contours in the pre- and post-stroke speech sample were analyzed by means of a stylization procedure [16]: on the basis of visual pitch information and auditory information the actual pitch contours are replaced by a stylized contour. In experimental practice, the procedure of stylisation involves the replacement of the actually observed pitch contours by set of straight lines which are perceptually equivalent to the original contours. This procedure does not only filter out microprosodic effects, but also provides an insight into the internal structure of pitch contours in terms of their constituting pitch movements.

This stylisation procedure was applied to the data twice by the same researcher on two different occasions. Independently of this stylisation procedure, the second researcher transcribed the intonation contours solely on the basis of his perception and labelled the pitch movements in terms of the labelling system developed by [16]. He labelled the intonation contours on two separate occasions.

At the end of the analysis procedure, the information in all the transcriptions was compared and it was found that there was disagreement in the transcription in 25% of the cases. These cases were analysed again by both researchers and it was attempted to arrive at a consensus transcription. This turned out to be possible in all cases.

The analysis of the patient's pre-stroke speech revealed several intonation contours. The first one is the so-called pointed-hat contour 1&A. In this contour, a sentence accent is realized by means of an accent-lending rise (1) which is immediately followed by an accent-lending fall (A) on the same syllable. This type of intonation pattern occurred once in (7%) the pre-stroke speech sample and it is associated with a syllable that normally carries word stress.

A variant of this basic intonation contour in Dutch is the 1-0-A contour, in which the prominence-lending rising and falling pitch movements are associated with different accented syllables: the two movements are connected by a stretch of high declination. The distribution of this contour is not free: it is restricted to the two last accented syllables in utterances. In the patient's pre-stroke speech, this contour occurred 4 times (28.57%). In 6 other instances (42.85%), the 1-0-A contour was followed by a continuation rise (2).

The last contour that was observed was the 1-B pattern. In this contour, a sentence accent is realized by means of a prominence-lending rise (1). Subsequently, the pitch stays high and is reset to a lower level at a syntactic boundary. This is the standard 'continuation' contour in Dutch which signals that the speaker has not finished his speaking turn yet. This contour occurred 4 times (28.57%) in the patient's pre-stroke speech.

The frequency of occurrence of the contours in the patient's pre-stroke speech is difficult to generalize, but it can be noticed that there are similarities to the occurrence of contours in quantitative data for normal Dutch spontaneous and read speech [3]. In [3] the 1A contour occurs most frequently with an average of 32.97%. The 1B contour occurs substantially less often with an average of 19.50%.

In the patient's post-stroke speech, a total number of 50 pitch contours were observed which were all of the type 1A (11%), 1B (64.8%) or 1E (3.70%). In the latter contour the first accent of an utterance is realized a prominence-lending rise (1) and the last accent is realised as a prominence-lending fall (A). The intervening accents are marked by a half fall (E) which creates the impression of a terraced contour. A comparison to the patient's pre-stroke speech as well as the quantitative data in [3] clearly indicate that the 64.8 % for the 1B-contour in this patient is exceptionally high, while an 11% occurrence of 1A is extremely low. The occurrence of 1E with 3.70% is somewhat lower than in [3], but this is probably not significant.

Further analysis also shows that the 1B pitch contours are not always used to mark major syntactic breaks, but that words within a bigger syntactic unit may be realized with this pitch contour. This may suggest that the patient uses this contour actively as a device to compensate for her slow speech rate and her halting type of speech: as a result of this she may often feel to be in danger of losing her speaking turn and she may have tried to avoid this by using this continuation contour to signal prosodically that her speaking turn has not finished yet. Although this is essentially not wrong, it adds to the hesitant character of her speech output.

Finally, it should be mentioned that all the accent-lending pitch movements in the pitch contours are located correctly, i.e. on the syllables of words that normally carry word stress. No misplacements of accents were observed. In addition, the patient's pitch contours subserve the general more fundamental requirement of the Dutch intonational system that a falling pitch movement always has to be preceded by a rising pitch movement. Unlike some other languages, two falls can never occur in sequences.

On the basis of this analysis, it can be argued that the production of pitch contours of this patient is entirely intact. Not only does the patient use well-formed Dutch intonation contours, but there are also indications that she completes the intended pitch contours irrespective of long pauses, hesitations and segmental articulation difficulties. On a number of occasions, the patient had to repeat a syllable a few times before finally achieving the correct pronunciation (articulatory groping). On each of these repetitions, the correct accent-lending rise was already present and this was followed by a well-formed completion of the contour once the segmental pronunciation hurdle had been taken. As a result, there is a clear impression of continuity in sentence intonation. These observations are consistent with [10].

4. Discussion and conclusion

From the prosodic analysis presented in this paper it can be seen that the main prosodic impairment of the patient has to do with segment duration (both vowels and consonants are longer than in the post-stroke speech sample) and speech

tempo (speech rate of the post-stroke speech is very low, hesitant and isochronic). The intonation patterns, however, are quite normal, except for the fact that the continuation contour was much more frequent that what could be expected on the basis of Dutch reference data. It was hypothesized that the frequency of this contour had to do with active efforts of the patient not to lose her speaking turn. Although it has often been assumed that deviant intonation patterns constitute an essential characteristic of FAS, the data presented here strongly indicate that FAS is not necessarily a "dysprosody of speech".

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