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PROSODIC FEATURES IN CONDUCTION APHASIA

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Abstract

Prosodic features (tonal and temporal) of the speech of two conduction aphasics were studied. Patients were compared to each other and to three normal speakers. All read a standard diagnostic text (Swedish version of The North Wind and the Sun). Compared to the normals, the patients paused more often, spoke more slowly and in shorter units (both as defined by pauses and as defined by intonation) and showed no evidence of medial shortening/final lengthening effects. Quantitatively, pausing was more deviant than differences in intonational patterning. Compared to each other, the patients differed with respect to pause frequency and sensitivity to syntactic structure as reflected in intonation patterns. It is suggested that prosodic features may be of value in differentially diagnosing patients within an aphasic syndrome, because prosodic differences may reflect different underlying defects.

Introduction

Several studies have shown that prosodic characteristics such as tempo and intonation are sufficient for broadly differentiating the main aphasic syndromes (Howes & Geschwind, 1964; Benson, 1967; Kerschensteiner et al., 1972; Wagenaar et al., 1975). Moreover, it is the patients classified as fluent according to prosodic characteristics who produce phonological and lexical jargon. Both of these facts highlight the importance of prosody for clinical diagnostic and therapeutic purposes, as well as for the theory of language production.

The study reported on here is based on the speech of two conduction aphasics. With respect to prosody, conduction aphasics are considered to lie somewhere between the extremes of prosodically normal, fluent (Wernicke's) aphasia and the non-fluent, dysprosodic speech of Broca's aphasics. Conduction aphasia typically involves segmental substitution and sequencing errors (called literal paraphasia) and/or a short-term verbal memory defect. It is identified clinically by the patient's inability to repeat despite good lexical comprehension (cf.Benson et al,1973;Shallice & Warrington,1977). The patients were chosen because they appeared to be good representatives of the two subtypes of conduction aphasia; Patient 1 had a predominance of segmental errors, and Patient 2 showed evidence of a short-term memory deficit, in addition to an initial segmental disorder.

The aim of the study was to see if prosodic characteristics could be useful in distinguishing patients within a major syndrome, and whether different prosodic features (i.e., tonal vs. temporal) are differentially affected in this type of aphasia.

Subjects[1]

Patient 1 (P1) was a 62-yr-old ambidextrous former bricklayer from southern Sweden, admitted in October 1972 with right hemiparesis and aphasia after a sudden fall. Three weeks after admission the patient was able to walk and use his right hand. His speech was extremely paraphasic, and he was not able to repeat even single words without gross distortions. Naming of objects was grossly paraphasic, but he was able to adequately demonstrate their use by means of gestures. There was some perseveration. The patient could point to named objects, and he could obey verbal commands to stick out his tongue, put his finger on his nose, whistle, and point to his ear, but with long latencies. Comprehension of normal conversation appeared to be fully intact, and tests of ability to identify non-verbal sounds showed no impairment. After five months of therapy there was some improvement in ability to read aloud single words, but spontaneous speech and repetition were still grossly paraphasic.

Patient 2 (P2) was a 62-yr-old former custodian from southern Sweden, with a history of hypertension. In March 1976 he was admitted for a few hours with a suspected transient ischemia with no paralysis, Babinski or headache. The following day he was readmitted, because relatives reported that he couldn't talk. On readmission he produced fluent jargon without much information content. There was no paralysis or dysarthria. He could not stick out his tongue on command, but could imitate the gesture. On initial speech examination, the patient's speech was paraphasic (both literal and verbal paraphasia) and he could not repeat any but the shortest words, and these only after many presentations by the therapist. He could not point to named pictures or follow written instructions, but he could match written words to pictures. Naming was paraphasic, writing to dictation extremely paragraphic. Paraphasias in speech decreased during the next few months and reading aloud was almost error-free, but even after a year of therapy the patient could neither repeat nor write phrases of more than two words. Spontaneous writing was paragraphic, but the patient was able to edit his writing so that the final production contained few errors. Comprehension was normal, apart from a word deafness, which persisted throughout 1 1/2 years of therapy.

Neither patient was able to produce serial speech (counting, days of the week, months) without error or perseveration. Both had some high frequency hearing loss, and both reported that they had never spent much time writing.

Three normal speakers were recorded for comparison. GH, a retired baker, age 73, had some hearing impairment and used a hearing aid. ID was a housewife, age 71. GB was a trained phonetician, age 31. All were from the same

regional dialect area.

Materials

All subjects read a Swedish version of The North Wind and the Sun. The patients were recorded during aphasia examinations: P1, 3 weeks after admission (P1:1), five months later (P1:2) and after about 16 months (P1:3); and P2, 12 days after admission (P2:1) and about 10 weeks later (P2:2). (some spontaneous speech was recorded for P1 at P1:2 and P1:3, and for P2 some time after P2:2).

The normal speakers were told to read as naturally as possible. GH and ID were not familiar with the text and were not given any opportunity for practice. GB was specifically instructed to read slowly, and he was very familiar with the text.

Duplex oscillograms with separate intensity and pitch curves were made for each reading. Segmentation was done manually, and the durations of silent pauses were measured. Prosodic phrases (roughly corresponding to tone units) were identified according to the relative pitch of stressed syllables (identified auditorily) and terminal junctures, using the pitch curves. Finally, durations of the four occurences of the words kappa/kappan (or their paraphasic substitutions) were measured, to allow an estimation of final lengthening/medial shortening effects.

Results

1. Segmental errors and self-corrections

Despite a superficial similarity, the two patients differed from one another in terms of the number and types of target-related errors they made. On the first readings, both P1 and P2 were paraphasic. P1's paraphasia did not improve over the three readings, and more than half of the target words he read were incorrect, sometimes distorted beyond recognition. P2 differed on his first reading in that he produced fewer errors than P1, in terms of incorrect targets, but many more repeated attempts (for 17% of the target words) for both correct and incorrect productions. By the second reading, however, (10 weeks later) P2 had only two target errors. Although the errors were quantitatively comparable to the normals, they were still recognizably pathological (så hårt att någonsin kunde, kappan onôm sig).

Table 1. Incorrect targets and repetitions as % total words in text.

	Patient 1			Patient 2		Normals		
	P1:1	P1:2	P1:3	P2:1	P2:2	GH	ID	GB
% incorrect	63	53	58	28	2	1	6	1
% repetitions/ self-corrections	4	0	0	17	0	1	1	0

2. Intonation

The major difference in sentence intonation between patients and normals was that the patients divided their utterances into more prosodic phrases than the normals. That is, sequences of stressed-word peaks which could be connected by a single downward-sloping topline in normal sentences were often composed of separate sequences, each with its own topline, in the aphasic sentences. Such f_0 resetting is seen both in patients and normals, but more frequently in the patients, as we would expect if the patients process speech in smaller, syntactically defined chunks.

However, when the patients were compared to each other, two differences emerged. The first is related to the difference in error types. The overall prosodic effect of P2's first production was more abnormal than that of any other reading, including P1's, because of the frequency of repetitions and self-corrections (and more frequent pausing, see below). As in normal speech, his repeated corrections are marked by a higher pitch than the words they replace.

The second difference concerns the stress level of function words. The only sentence stress abnormality for P2 (first reading), apart from the prosodically normal but too frequent stressed repetitions, is a focal stress on gång, shown in Fig. 1 below. P2's second reading was indistinguishable from the normal readings, with respect to sentence intonation. (Fig. 1 is normalized for duration; P2's first try was almost twice as long as the second.)

Fig. 1 also shows that there was a large register difference between P2's first and second readings. This is most probably due to a stress reaction, not uncommon in the initial period after a cerebro-vascular insult (Wilkins, 1963). This initial stress reaction may have contributed to P1's extremely high pause frequency in the first reading, as well.)

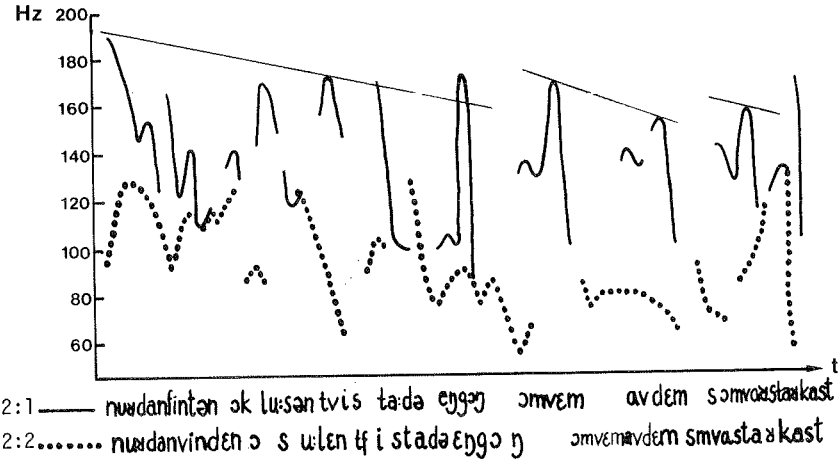

Fig. 1. Comparison of P2's first and second readings of sentence 1. Normalized durations.

In contrast to P2, P1 frequently begins prosodic phrases with stressed function words. Fig. 2 shows P1's production of sentence 2, compared to a normal reader (GH). Although both sentences contain two prosodic phrases, divided at the same juncture, in the normal reading the initial preposition i is unstressed, whereas for P1 it has a high pitch level. The same is true for P1's phrase-initial relative pronoun som in sentence 3, for men ('but'), the comparative adverb desto, and och ('and') in sentence 4, and och in sentence 5, in all three of his readings. The only phrase-initial function word which is not stressed is att (solen) 'that (the sun)' in sentence 5. Apparently it is the word's position in the prosodic phrase, rather than its lexico-syntactic status, which determines whether it will have a high pitch level or not: Virtually all of P1's prosodic phrases begin at a high f_0 level, but function words within prosodic phrases are appropriately destressed.

3. Rate

Both patients read at an abnormally slow rate, not only as measured in words per minute, which is affected by pausing,[2] but also as measured by syllables per second, excluding pause time. Even at the second recording P2's rate is slower than that of the normal reader (GB) instructed to read slowly.

Fig. 2. Comparison of normal (GH) and aphasic (Patient 1) production of sentence 2; phrase-initial function word stressed in Patient 1's production.

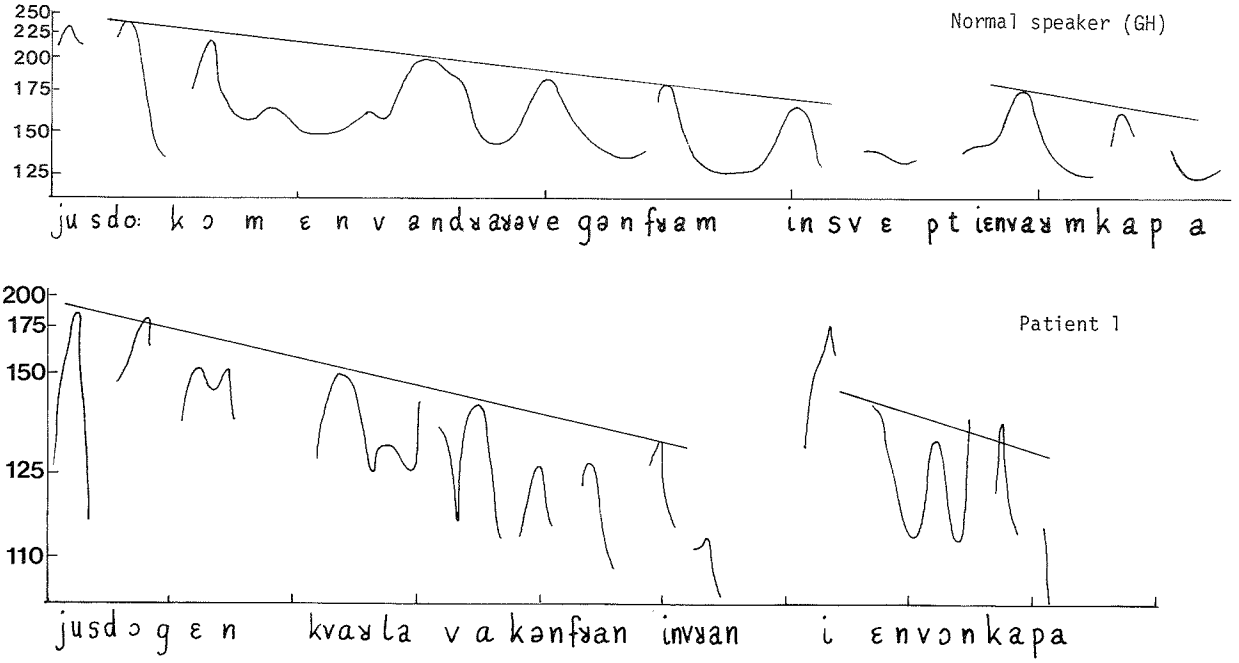

Table 2. Speaking rate in words per minute and syllables per second.

	Patient 1			Patient 2		Normals		
	P1:1	P1:2	P1:3	P1:1	P1:2	GH	ID	GB
wpm	70	65	70	43	91	114	120	104
syll/sec	2.47	2.23	2.12	2.01	2.92	4.09	4.17	3.10

4. Pausing

Not only do the aphasics break sentences up into shorter, intonationally defined prosodic phrases than the normals, but also, as expected, they pause more often between and within phrases. Table 3 shows the number of prosodic phrases, defined as a resetting of the stressed peak topline, compared to the number of word sequences bounded by pauses for each sentence and subject.

Table 3. Prosodic phrases/interpause sequences.

	Patient 1			Patient 2		Normals		
	P1:1	P1:2	P1:3	P2:1	P2:2	GH	ID	GB
Sent. 1	3/5	3/7	3/4	3/8	3/2	2/2	3/1	2/1
Sent. 2	5/6	2/6	2/5	4/9	2/2	2/1	2/2	2/2
Sent. 3	4/10	2/10	2/8	3/10	2/2	2/2	3/2	2/2
Sent. 4	7/14	5/16	5/16	10/30	3/10	3/5	3/4	3/4
Sent. 5	4/14	5/13	6/11	9/18	4/9	4/4	4/4	4/3

(excluding pauses under 100 msec duration)

Table 3 shows that pausing is quantitatively much more deviant than intonationally defined phrasing. In the paraphasic productions (excluding P2's "recovered" reading) 98.5% of the interpause sequences contain less than five words, and more than half include only two words or less. Only 12% of the normal interpause sequences are as short as four words. P2's performance, both with respect to prosodic phrases and number of pauses, improved dramatically. Although 70% of his interpause sequences still contain less than five words, the short sequences are almost all in the long, syntactically complex sentences 4 and 5. In contrast, P1's pauses are about equally distributed over all the sentences, regardless of length or complexity.

For both patients and normals, mean pause durations at major syntactic boundaries (sentence and clause) are greater than anywhere else.

5. Final lengthening/medial shortening

In normal speech, the relatively shorter duration of a pre-final as opposed to a clause-final word can be taken as evidence of temporal subordination of the words to a higher-level articulatory plan. If this is the correct explanation for medial shortening, it seems that the patients lack the ability to structure their productions in large enough units to produce the effect, since there is no evidence of medial shortening for the words measured; for them, final words were often shorter than the medial ones.

Table 4 shows mean durations for the three pre-final occurrences of the words kappa/kappan. (All but one (i.e., tɔpəld) of the ten paraphasic substitutions had the same syllable structure as the target words, and kappa was never shorter than both final occurrences of kappan in the normal readings). Final lengthening/medial shortening was evident for all three normals.

Table 4. Durations of clause-final and pre-final kappa/kappan, sec.

	Patient 1			Patient 2		Normals		
	P1:1	P1:2	P1:3	P2:1	P2:2	GH	ID	GB
Final (mean of 3)	.73	.80	.83	.82	.70	.60	.65	.64
Pre-final	.84	.80	.98	1.04	.88	.41	.48	.47

None of the normal pre-final words, and all of the aphasics' were followed by pauses. They ranged in duration from .08 - .4 sec.

Discussion

The data presented here confirm the clinical impression that conduction aphasia may have little effect on sentence intonation. Although more than half of Patient 1's target words contained segmental errors, pause durations and sentence intonation respected syntactic structure in all but the most complex sentences.

The overall prosodic effect of Patient 2's first (paraphasic) reading is more abnormal than that of Patient 1. This is clearly due to the frequent

repetitions and self-corrections which, in combination with the paraphasic errors, make the listener's task more difficult, since they require a suspension of interpretation until the patient finds the requisite word or accepts a paraphasic substitute for it. These repetitions and revisions add new prosodic phrases to the sentence, and the listener must recognize them as amendments and then backtrack to a previous phrase in order to follow. In normal speech, deviations from sentence intonation and rhythm can be used as markers of a change in the sentence plan, since false starts and self-corrections are relatively rare. Patient 2's revisions are so frequent, however, that such prosodic marking has tendencey to lose its signal value.

Paradoxically, Patient 1's lack of prosodically disruptive revisions is probably a symptom of a more severe aphasic impairment than that of Patient 2, as it suggests that Patient 1 was less able to attend to and correct his paraphasic errors.

Pause behavior also suggests that Patient 1's linguistic deficit was the more severe. The length of interpause sequences in Patient 1's and Patient 2's (first) readings did not appear to be affected by syntactic complexity, presumably because neither was able to scan large enough units. But when Patient 2 improved segmentally and prosodically, he paused less often in the syntactically simpler sentences than in the long complex ones. This suggests that pause frequencey may be useful as an indication of degree of syntactic impairment.

Both patients respected sentence boundaries, as shown by intonation and pause duration. However, Patient 1's stressing of phrase-initial function words, which were appropriately unstressed even in Patient 2's initial reading, implies that he was more impaired thant Patient 2 even from the onset. This difference in particular may mean that conduction aphasics with literal paraphasia as the most prominent symptom are more impaired syntactically than patients with a predominant short-term verbal memory defect. (Cf. Shallice & Warrington, 1977; Caramazza & Zurif, 1976.)

Finally, since Patient 2 showed difficulties with complex syntactic structure, as reflected in pause frequency in his second reading, and since neither patient showed any medial shortening/final lengthening effects, it is likely that some degree of syntactic impairment affected speech pro-

duction for both patients, even though intonation was fully normal in Patient 2.

Because of the limitations of the material and the restriction to two patients, the results presented here can only be considered suggestive. What they suggest, however, is that more detailed study of the finer detail of prosodic structure may be helpful in diagnosing linguistic impairment in aphasia, perhaps especially for patients who do not clearly fall into either of the fluent or non-fluent categories.

FOOTNOTES

1. I would like to thank Doc. Peter Kitzing and the staff of the Department of Phoniatrics, Malmö General Hospital, for making the tapes of the patients available to me, and speech therapists Catharina Anderson and Boris Larnert for taking time to discuss them. Of course the responsibility for the descriptions given here is mine.
2. Most studies of "normal" reading rates have used young, highly educated speakers and different texts. Johnson reported normal reading rates of from 105-219 wpm, and Darley from 129-222 (both cited in Williams et al., 1974). Grosjean & Collins call a mean of 201 wpm normal.Burns & Canter found a mean of 104.6 wpm for five conduction aphasics, compared to mean 155.2 wpm for five Wernicke's aphasics. Canter (1963) found a mean syllable duration of .16 sec. (=3.7 syll/sec.) for 17 Parkinson patients and also for 17 normal controls. In that experiment, normal reading rate ranged from 140-219 wpm.

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APPENDIX

The North Wind and the Sun (Nordanvinden och solen)

Nordanvinden och solen tvistade en gång om vem av dem som var starkast. Just då kom en vandrare vägen fram insvept i en varm kappa. De kom då överens om att den var starkast, som först kunde få vandraren att ta av sig kappan. Först blåste nordanvinden så hårt han någonsin kunde, men ju hårdare han blåste, desto tätare svepte vandraren kappan om sig, och till sist gav nordanvinden upp försöket. Då lät solen sina strålar skina, och genast tog vandraren av sig kappan, och så var nordanvinden tvungen att medge, att solen var den starkaste av de två.