

TEMPORAL VARIABLES FOLLOWING UNILATERAL LEFT OR RIGHT HEMISPHERE LESION

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ABSTRACT

This paper presents the results of an instrumental analysis of five temporal variables in the spontaneous speech output of eighteen subjects with unilateral cerebral lesion. Subjects with left hemisphere lesion are shown to have a lower value for RTATL, articulatory rate, speech rate and a higher number of pauses than subjects with right hemisphere lesion.

1. INTRODUCTION

The majority of previous investigations of this topic (see [1] for a brief review) use a phonetically imprecise definition of temporal variables to describe speech output produce by brain damaged patients. Speech rate, for example, is described as the number of words per minute rather than on the basis of an articulatory measure such as syllables per second. Other temporal variables such as articulatory rate, or number, duration and distribution of pauses are generally not taken into account. Among recent studies of

temporal variables in brain-damaged subjects, Deloche, Jean-Louis et Seron [2] studied speech rate, speech percentage and pauses in five Francophone subjects with left hemisphere lesion. Their results indicate that these subjects produce a similar articulatory rate and a similar number of pauses as compared to control subjects. On the other hand brain-damaged subjects produce a greater average pause duration than control subjects.

Klatt [4] studied the relationship between pause frequency and grammatical category in Anglophone aphasics in a reading task. He observed that Verbs were associated with the highest frequency of occurrence of pauses followed by Nouns and then by Adjectives.

The purpose of this study is to compare two groups of subjects with unilateral brain lesion in order to determine whether temporal variables provide for differentiation of these groups according to hemispheric lateralization of lesion. The following temporal variables are examined in this study:

- a) RTATL; (see [3] and [4]);
- b) articulatory rate;
- c) speech rate;
- d) the total number of pauses;

e) average pause duration.

2. SUBJECT POPULATION

The patients for this study were eighteen right-handed Francophone adults. Each subject suffered from a confirmed, focal, unilateral cerebral lesion. Eleven patients had suffered cerebrovascular accidents and seven a cerebral tumor. All were in stable neurological condition at the time of interview.

In terms of lesion localization, subjects A-I (Group A) suffered unilateral right hemisphere lesion and subjects J-R (Group B) suffered unilateral left hemisphere lesion. These two groups can be further sub-divided into three further groups according to intra-hemispheric lesion localization:

A, B, C, J, K, and L, had frontal lobe lesion; D, E, F, M, N and O, had parietal lobe lesion and G, H, I, P, Q and R had temporal lobe lesion.

Subjects with right hemisphere lesion varied in age from 34 to 56 years old with an average age of 44. Subjects with left hemisphere lesion varied in age from 23 to 71 years old with an average age of 52.3.

None of the subjects had a family history of left-handedness and all were strongly right-handed. All subjects were unilingual Francophones, born, raised and still residing in the greater Paris metropolitan area. They had completed at least primary school education and spoke with a relatively standardized Parisian French pronunciation.

3. SPEECH SAMPLE

The speech sample submitted to instrumental analysis was drawn from the spontaneous speech section of the clinical aphasia examination battery in use at the time at the Salpêtrière and St. Anne Hospitals. This section occurs at the very beginning of the battery, thereby minimizing the effect of fatigue. The patients were replying to questions about their illness, their profession, etc.

For each subject, a speech sample of approximately 300 syllables was analyzed. This speech sample was submitted to two parallel instrumental phonetic analyses of Frequency, Intensity and Duration attributes. The first analysis was carried out with a Pitch Machines digital real-time fundamental frequency analyzer and the second with an RT-1000 digital real-time colour spectrograph.

4. INSTRUMENTAL ANALYSIS

The results given in Figure 1 show that subjects with unilateral left hemisphere lesion show a much lower overall value for RTATL when compared to subjects with right hemisphere lesion.

RTATL is lowest for subjects J (39.55%) and L (37.73%) (left frontal lesion). Other patients with left hemisphere lesion produce a RTATL value of between 60% and 80% which is still significantly lower than that obtained for subjects with right hemisphere lesion. There is then a strong correspondence between interhemispheric lesion lateralization and RTATL.

	RTATL	Articulatory Rate	Speech rate
A	81.12%	4.22	208.20
B	70.19%	5.95	250.80
C	60.90%	6.18	234.00
D	83.09%	6.02	304.20
E	90.75%	5.86	315.60
F	75.81%	4.24	191.40
G	88.87%	3.84	201.60
H	87.37%	3.88	203.40
I	78.82%	5.62	262.20
Avg	79.65%	5.09	241.26
Std. dev.	9.05	0.95	43.01
J	39.55%	3.59	77.40
K	61.41%	2.99	102.60
L	37.73%	4.20	82.80
M	68.86%	4.63	183.00
N	64.31%	4.07	135.00
O	60.76%	3.72	124.20
P	77.47%	4.46	196.80
Q	81.89%	3.74	163.80
R	67.19%	4.36	184.20
Avg	62.13%	3.97	138.86
Std. dev.	14.17	0.48	42.74

Figure 1. RTATL, articulatory rate and speech rate

T-Test Group A / Group B

RTATL
 $t = 3.124$ (16 d.f.) $p = 0.0065$

Articulatory rate
 $t = 3.157$ (16 d.f.) $p = 0.0061$

Speech rate
 $t = 5.066$ (16 d.f.) $p = 0.0001$

	Number of pauses	Average pause duration
A	14.00	101.57cs
B	23.00	81.41cs
C	34.00	75.77cs
D	16.00	56.44cs
E	7.00	62.00cs
F	27.00	75.11cs
G	11.00	77.54cs
H	17.00	62.82cs
I	27.00	48.62cs
Avg	19.55	71.25cs
Std. dev.	8.24	14.85
J	98.00	139.09cs
K	100.00	48.43cs
L	139.00	98.38cs
M	47.00	64.80cs
N	63.00	76.02cs
O	71.00	69.41cs
P	38.00	46.76cs
Q	50.00	41.72cs
R	56.00	56.12cs
Avg	73.55	71.19cs
Std. dev.	30.78	29.11

Figure 2. Number of pauses and average pause duration

T-Test Group A / Group B

Number of pauses
 $t = -5.084$ (16 d.f.) $p = 0.0001$

Average pause duration
 $t = 0.550$ (16 d.f.) $p = 0.995$

Articulatory rate was calculated separately for each accentual group rather than for the whole speech signal sample.

The data in Figure 1 show that subjects with unilateral left hemisphere lesion also produce a significantly lower articulatory rate than subjects with right hemisphere lesion.

The other data given in Figure 1 indicate that subjects with unilateral left hemisphere lesion once more produce a much lower value for this variable as compared with subjects with right hemisphere lesion.

Direct statistical comparison of the averages indicates the existence of a very highly significant difference between the two groups of subjects

Pauses were defined as any period of silence in the speech signal, with the exception of consonantal occlusions.

The results given in Figure 2 show that patients with left hemisphere lesion produce an extremely high number of pauses. In particular, those with left frontal lesion produce many more pauses than all the other subjects: J (98), K (100) and L (139). Direct comparison of the averages shows that there is a highly significant difference between the two groups.

On the other hand, and in sharp contrast to the four other variables studied here, average pause duration does not distinguish the two sets of subjects.

5. CONCLUSION

The various results presented here indicate that subjects with left

hemisphere lesion produce speech output which is slower and punctuated by a greater number of pauses than subjects with right hemisphere lesion. The most dramatic differences between the two groups are to be found in speech rate and the number of pauses. This finding is significantly different from that reported in [2]. The data presented here indicate that it is the relative discontinuity of the speech output which is the major differentiating factor between these two sets of subjects.

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