DECODING PARALINGUISTIC SIGNALS: EFFECT OF SEMANTIC AND PROSODIC CUES ON APHASICS' COMPREHENSION

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A matching task between sentences voiced with joyful, angry, or sad intonation and pictures of facial expressions representing the same emotions is proposed to 27 aphasics and 20 normal subjects. Semantic contents are either meaningless, neutral, or affectively loaded. In the affective-meaning condition, content is redundant with prosody or conflicting with it. Results are 1. a greater number of nonprosodic choices in the aphasic group; 2. an identical influence of the congruence/conflict variable on aphasics and control subjects; 3. an identical influence of the semantic content of the conflict sentences on both groups. Aphasic impairment is interpreted as purely quantitative, since affective semantic content influences the decoding of the sentences.

Introduction

Auditive comprehension of linguistic material requires coordination of several processes at different levels: phonological, syntactical, and semantico-pragmatic (Clark and Clark, 1977). Some of the semantic processes are related to the linguistic value of the message; others depend on paralinguistic cues (intonation, stress, tempo, etc.). The sensitivity of aphasic patients to paralinguistic cues has been studied by different authors and it appears that comprehension deficits may leave intact some paralinguistic processings (for reviews, see Boller et al., 1977; Assal et al., 1979). The paralinguistic cues are particularly important in the decoding of affective meaning which, according to Mehrabian (1972), is principally conveyed by nonverbal means. Aphasics' capacity for decoding emotional intonation has been assessed by only two experiments which pay special attention to right–hemisphere–lesioned patients and which do not include normal control subjects. In the first experiment, Heilman et al. (1975) showed better auditive discrimination in six aphasics (five anomic aphasias and one conduction aphasia) than in six right-hemisphere-lesioned patients during a

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recognition test of sentences voiced with four different tones: anger, sadness, joy, and indifference. In the second, Schlanger et al. (1976) compared 40 aphasics and 20 right-hemisphere-lesioned patients in a similar test. These authors found a deficit in some severe aphasics but, as a group, aphasic patients are in no way inferior to the right-hemisphere-lesioned patients. In both experiments, authors have eliminated possible interference of verbal contents by using either neutral sentences (Heilman et al., 1975) or neutral and meaningless sentences (Schlanger et al., 1976). In normal subjects, however, different studies show that the emotional evaluation of a sentence depends on several interacting factors, such as semantic content, intonation, and facial expression, as evidenced by Mehrabian (1972). When a conflict exists in sentences between the intonation and the semantic content, greater value is given to intonation, but this effect may be modified if the subject is asked to pay attention to content only (Mehrabian and Wiener, 1967). It also depends on the age (Bugental et al., 1970) and on the nature of the conflict (magnitude of the discrepancy and type of conflicting emotions; see De Paulo et al., 1978, 1979). Thus, decoding affective meaning is not a simple process. On the contrary, the prominence of prosody could also depend on the linguistic content of the message. It thus seems interesting to examine further the ability of aphasic patients to decode sentences that present congruence or conflict between intonation and affective verbal content.

For this purpose, we have conducted an experiment which requires as in the Schlanger et al. (1976) paradigm, a matching of sentences voiced under different intonations, with emotional facial pictures. To neutral and meaningless sentences, we add sentences with marked affective content, whether congruent or not with the intonation. In this way, we are able to analyze in more detail the influence of aphasia on decoding of intonation and on the relative weight of intonation and semantic content in the interaction between these two factors. It is mainly hypothesized that this interaction may be modified by the presence of semantic difficulties in the aphasia semiology.

Method

Subjects

The experimental group included 27 aphasic subjects (20 men and 7 women), ages ranging between 30 and 70 yr with a mean of 54.77 yr. There were 14 cases of Wernicke aphasia, nine of Broca aphasia, and four of global aphasia. The etiology was vascular in 25 cases, tumoral and traumatic in the two remaining ones. The control group included 20 normal individuals (16 men and 4 women), ages ranging from 27 to 67 yr, with a mean of 50.35 yr. All the aphasic patients took our standard examination test for aphasia. This test included some subtests of Lhermitte and Ducarne (1965) and of Goodglass and Kaplan (1972). Our

criteria for establishing a specific syndrome were the same as those of Goodglass and Kaplan (1972). Semantic disorders were evaluated by the presence of semantic paraphasias in the oral naming subtest and/or in the spontaneous speech of the patient. To appraise the degree of aphasia we used the "Aphasia severity rating scale" of Goodglass and Kaplan (1972), and classified the patients as follows: those with scores of 0, 1, and 2 were rated as "light," and those with scores of 3, 4, and 5 as "serious."

Procedure

This experiment partly replicated the Schlanger et al. (1976) technique. The patient was asked to listen to a sentence voiced with a special intonation and then had to point out the corresponding emotional expression amongst three photographs representing joy, anger, and sadness. The 27 sentences had six syllables each, and no word had more than two syllables. Three kinds of sentences were used: nine with a neutral meaning (N.M.), i.e., *Paris est au Sud-Est* ('Paris is South-East'); nine without meaning (W.M.), made up of nonwords constructed with the phonemes of the French language, i.e. *le bardu est limbo*; and nine with marked affective meaning (A.M.), i.e. *j'ai gagné le gros lot* ('I won the price'). These sentences were divided into three joyous ones, three sad ones, and three angry ones. In order to establish the affective meaning of the N.M. and the A.M. sentences independently of any prosodic elements, 120 normal subjects were asked to silently read 60 sentences and to decide whether they sounded joyous, angry, sad, or neutral. According to the result of their judgements, we selected 18 sentences (nine N.M. plus nine A.M.) for the experience. They were the sentences for which there was an agreement of at least 90% during silent reading. The 27 sentences were then recorded and uttered according to three different emotional prosodies, in such a way that one-third of the W.M. sentences and one-third of the N.M. sentences were pronounced with each of the three emotions. The A.M. sentences were dealt with in a different manner according to the semantic content of the sentence. In one-third ("redundance sentences") prosody agrees with content; the other two-thirds ("conflict sentences") were uttered with an inadequate prosody (i.e., *mon petit chat est mort* ['my little cat is dead'] which has a sad semantic content, was uttered with a joyous prosody). In order to obtain the maximal intonation/semantic conflict, the most unexpected prosody was chosen, i.e., the one that had never been chosen during silent reading by the 120 normal subjects. The 27 sentences of the test were presented on a tape-recorder in random order, but with the W.M. sentences grouped at the end of the test to avoid focusing of attention on the prosody. The instructions were nonverbal and consisted in a pretest in which three sentences with consistent prosody and semantic content were presented. After hearing the first sentence of the pretest, the examiner pointed out the relevant photograph

without letting the subject know whether his choice was determined by the semantic content or by the prosody. The patient then reacted to the two remaining sentences of the pretest. Then the experiment itself started with a 20-sec interval between sentences. Each sentence was preceded by a warning sound. The sentences were spoken out by a young theatre actress, who also stood for the three photographs. Any wrong choice was considered as an error. For the conflict sentences, the nature of the choice was also noted as prosodic or semantic.

Results

Table 1 represents the percentages of responses corresponding to the intended prosody, in each condition, for aphasic and normal subjects. Some differences appear, and the statistical significance of these results will be assessed in three ways: to answer questions concerning global results, affective meaning sentences, and conflict sentences.

Global Analysis

A first series of questions concern 1) the global effect of aphasia on decoding prosody, and 2) the global effect of semantic content (however congruent or discrepant it is) on reaction to intonation. In this analysis, score 0 is given to any prosodic choice (choice of the picture corresponding to the emotion expressed by intonation), and 1 in the other cases. Nonprosodic choices (score 1) are either "error" (in the N.M. and W.M. conditions) or choices of the picture corresponding to the semantic content only (conflict sentences condition); in the congruent

TABLE 1

Percentage of Responses Agreeing with Prosody for Aphasic and Normal Subjects According to the Semantic Content of the Sentences (n = Number of Stimuli per Condition; N = Number of Subjects per Group.)

	Aphasics (N=27)	Normals (N=20)
Neutral sentences (n = 9)	59%	88%
Affective meaning (n = 9)	58%	80%
conflict (n = 6)	48%	70%
Redundance (n = 3)	79%	100%
Meaningless sentences (n = 9)	60%	86%
Total (n = 27)	59%	84%

condition, prosodic and semantic choices are assimilated. Total individual scores (0−27) are submitted to 2 (aphasia vs. control group) × 3 (semantic content) analysis of variance. A significant effect ($F = 15.87$; df 1,145; $p \leq 0.01$) is obtained with the first criterion: aphasic patients produce less prosodic choices than control subjects, and their prosodic choices are given in equal proportion whatever the semantic character of the sentences. No other effect is observed.

To assess the extent to which the aphasic difficulty in processing prosody is related to linguistic impairment, we calculated a correlation coefficient between verbal comprehension scores and experimental scores. Aphasic subjects are ranked according to the number of nonprosodic choices in the N.M. and the W.M. sentences condition (18 stimuli). The A.M. condition is deleted in this analysis to avoid an influence of the semantic decoding *per se* in the calculated coefficient; verbal comprehension is tested by responses to seven oral orders (auditive comprehension) and to seven identical written orders (reading comprehension). Spearman's coefficient between experimental scores and auditive comprehension is +0.46 ($p \leq 0.03$) and +0.28 ($p \leq 0.10$) for reading comprehension. We note thus a relationship between verbal and nonverbal deficits, plus a sense modality influence, since correlation with auditive comprehension is greater than with reading comprehension.

Influences of other variables on aphasic subjects performance have been tested in separate F-tests, but neither sex and socioeconomic level, nor kind of aphasia (Broca, Wernicke, and global aphasia), time since onset (below and above 3 mo), severity, presence/absence of semantic paraphasias play a significant role.

Affective Meaning Sentences

The lack of effects of the semantic content observed in the first analysis of variance (ANOVA) should be submitted to a detailed analysis because in sentences with affective meanings two inverted effects could cancel each other, especially if subjects react differently to redundant and to conflict sentences. A second analysis is then made of the "affective meaning" condition only. Variable A refers to aphasic vs. control, variable B to congruent vs. conflict sentences. A significant effect of the two main factors appears (aphasia: $F = 9.54$; df 1,45; $p \leq 0.01$; congruent vs. redundant sentences: $F = 47{,}11$; df 1,45; $p \leq 0.01$), the interaction does not reach a significant level. The observed differences are thus more quantitative than qualitative and both groups are influenced by the semantic content in that they make more nonprosodic choices when confronted with conflict sentences.

In order to examine the possible influence of linguistic disorders on the responses to A.M. sentences, new analyses are performed. First, a new 2 × 2 ANOVA: presence or absence of semantic paraphasias (in the oral naming subtest and in the spontaneous speech) is variable A and congruence vs. conflict

between prosody and content is variable B. As in the preceding analysis, variable B is significant ($F = 31.94$; $df = 1,21$; $p \leq 0.01$). Neither variable A nor A × B interaction have significant influence. A second analysis examines the influence of the verbal comprehension variable. In this 2 × 2 ANOVA, variable A refers to presence or absence of oral comprehension disorders (scores ≥ 6 vs. scores ≤ 5), and variable B to congruence vs. conflict between prosody and content. As in the preceding analyses, variable B is significant ($F = 33.68$; $df = 1,23$; $p \leq 0.01$) and variable A exerts also a significant influence ($F = 9.91$; $df = 1,23$; $p \leq 0.01$). There is no interaction effect. Subjects with good oral comprehension make less nonprosodic choices, but the absence of interaction effect indicates that both groups are influenced by the congruence/conflict variable.

The results of these three analyses are not simple to interpret: association between difficulty in processing prosody and linguistic disturbance is of a complex nature. On one hand, we have noted a consistent influence of the variable congruence vs. conflict. All the subjects (normal and aphasic subjects; aphasics with and without semantic paraphasias and oral comprehension deficit) are thus sensible to the semantic experimental manipulation. It is suggested that affectively loaded semantic contents affect the decoding process of a sentence. On the other hand, subjects with low oral comprehension scores made more nonprosodic choices, and linguistic and paralinguistic processes in sentence decoding are thus associated.

Emotional Evaluation in Conflict Sentences

Reactions to A.M. sentences may be based on semantics as well as on prosody. Proportions of each kind of choice per conflict sentences are given in Table 2.

The results indicate that content influenced the choices of normal and aphasic subjects in the same manner but aphasic subjects made more errors. It is thus interesting to examine whether these errors occur in equal proportion whatever the nature of the conflict. This is not the case, since the distribution of errors is the following: 20.6% when conflict exists between sad and angry emotion; 29.3% and 50% for conflicts between joy and anger and joy and sadness, respectively. Thus the conflict between joyful and sad emotions seems to be more disturbing for aphasics (normal subjects also made two errors in this conflict on a total score of three errors!).

Furthermore, we examine whether the bias observed by Schlanger et al. (1977) against the "happy response" is confirmed. Table 3 gives the number of emotional choices for each emotion represented by prosody and by content in the six conflict sentences. An *chi*-square analysis was not significant for either content or prosodic choices. Thus, there exists no such bias in our observation.

TABLE 2
For Affective Meaning Sentences—Percentage of Responses Agreeing with Prosody or Content in Conflict Sentences, for Aphasic and Normal Subjects (Six Stimuli)

	Aphasics	Normals
Choices agreeing with prosody	48%	70%
Choices agreeing with content	32%	28%
Errors	20%	2%
Totals	100%	100%

TABLE 3
Total Number of Prosodic and Content Choices made by Aphasic Patients According to the Relevant Emotion

Aphasics $N=27$	Joy	Sad	Angry	Total
Total of prosodic selections [a]	26	21	30	77
Total of semantic selections [b]	16	17	18	51

[a] Chi-square (df = 2); 1.58 NS.
[b] Chi-square (df = 2); 0.12 NS.

Discussion

In this experiment aphasics have been shown to be inferior to normals in their responses to emotional sentences. Our results complete thus those of Heilman et al. (1975) and of Schlanger et al. (1976) comparing aphasics and right-hemisphere-lesioned subjects. The observed impairment is, however, purely quantitative. First, aphasics are influenced by the semantic content of sentences in their choices of pictures as normals are, i.e. less prosodic choices are made in the case of conflict sentences. Second, we have not observed a general bias towards a given facial expression in the aphasic population. Results of Schlanger et al. (1976) concerning a bias against the "happy" response are thus not confirmed. An interesting fact is that aphasic patients made more errors when confronted with a conflict between two emotions (joy and sadness) which, according to some authors, are the poles of the main dimensions of the affective field. All these facts are in favor of the preservation of the connotative structure

in aphasic patients. The problem is to identify the nature of the observed deficit in aphasia. None of the general variables examined (age, sex, socioeconomic level, kind of aphasia, time since onset, and severity) exert a particular influence. Concerning the role of the severity factor, our results are not consistent with those of Schlanger et al. (1976). Let us note, however, that criteria of severity differ. Schlanger et al. (1976) rate aphasics on a "Verbal Communication functioning Continuum" whereas we use the "Aphasia severity rating scale" of Goodglass and Kaplan (1972). As linguistic disorders are examined, results are different according to the expressive or receptive character of the disorder. The presence of semantic paraphasias exerts no influence in the decoding of A.M. sentences, unlike the presence of oral comprehension disorders which influences the amount of prosodic choices; this effect is the same for conflict and congruence sentences.

Finally, it appears that a single hypothesis is not sufficient to account for our results. It is not enough to oppose linguistic and paralinguistic decoding, or verbal and nonverbal decoding, to assess the comprehension deficit. Results suggest that the role played by the verbal component of the task may be different according to mostly denotative or connotative character of the semantic content. The comparison between the "neutral meaning" and the "affective meaning" conditions (see Table 1) indicates that both normal and aphasic subjects are influenced by the semantic variable. Thus, it is shown in our experiment that affectively loaded contents affect the processing of sentences.

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References

Assal, G., Buttet, J., and Zander, E. (1979). Prosodic aspects in the reception of language. In Lebrun, Y., and Hoops, R. (eds.), *Problems of Aphasia*. Lisse: Swets and Zeitlinger, pp. 125–139.

Boller, F., Kim. Y., and Mack, J.L. (1977). Auditory comprehension in aphasia. In Whitaker, H., and Whitaker, H.A. (eds.), *Studies in Neurolinguistics*, vol. 3. New York: Academic Press, pp. 1–63.

Bugental, D.E., Kaswan, J.W., and Love, L.R. (1970). Perception of contradictory meanings conveyed by verbal and non verbal channels. *J. Pers. Soc. Psychol.* **16**:647–655.

Clark, H.H., and Clark, E.V. (1977). *Psychology and Language*. New York: Harcourt Brace Jovanovich.

De Paulo, B.M., Rosenthal, R., Eisenstat, R.A. Rogers, P.L., and Finkelstein, S. (1978). Decoding discrepant nonverbal cues. *J. Pers. Soc. Psychol.* **36**:313–323.

De Paulo, B.M., Rosenthal, R., Finkelstein, S., and Eisenstat, R. (1979). The developmental priority of the evaluative dimension in perception of nonverbal cues. *Environmental Psychol. Nonverb. Behav.* **3**:164–171.

Goodglass, H., and Kaplan, E. (1972). *The Assessment of Aphasia and Related Disorders*. Philadelphia: Lea & Febiger.

Heilman, K.M., Scholes, S.R., and Watson, R.T. (1975). Auditory affective agnosia, disturbed comprehension of affective speech. *J. Neurol. Neurosurg. Psychiat.* **38**:69–72.

Lhermitte, F., and Ducarne, B. (1965). *Test pour l'Examen de l'Aphasie*. Paris: Editest.

Mehrabian, A. (1972). *Non-verbal Communication*. New York: Aldine–Atherton.

Mehrabian, A., and Wiener, M. (1967). Decoding of inconsistent communications. *J. Pers. Soc. Psychol.* **6**:109–114.

Schlanger, B.B., Schlanger, P., and Gertsman, L.J. (1976). The perception of emotionally toned sentences by right hemisphere-damaged and aphasic subjects. *Brain Lang.* **3**:396–403.