THERAPEUTIC TRAINING OF AN RHD PATIENT WITH PROSODIC DISTURBANCES OF A LINGUISTIC AND AFFECTIVE NATURE

Deborah Günzburger, Research Institute of Language & Speech, Utrecht University, the Netherlands, Laura Roelants & Mariska v. Schothorst

ABSTRACT

The core of this paper is a case study of a right hemisphere disorder (RHD) patient whose improvement in the production of affective prosody is described in the light of a) general issues of differential lateralization of the affective and linguistic aspects of language and b) a specific therapeutic training that involved visual feedback as part of his treatment.

INTRODUCTION

For more than a century (Broca, 1865, Wernicke, 1977, originally published in 1874) it has been known that brain injuries in the left hemisphere can cause impairment in various linguistic skills and consequently the claim has been made that language is a lateralized function of the left hemisphere; the role of the right hemisphere in language has, for a long time, been considered rudimentary. However, over the last two decades it has become increasingly evident that the right hemisphere also has an active role in language processing, in particular in the domain of affective prosody.

The right hemisphere superiority for emotional prosody has been meticulously scrutinized by Ross, Edmondson, Seibert & Chan, 1992, by testing Taiwanese speaking subjects who had incurred infarctions of the right frontoparietal region as documented by tomographic brain scans. The patients were able to use F0 modulations for the production of lexical tones, but showed impairment in their ability to use tone latitude for affective expression. These data are in line with the postulated differential lateralization of linguistic and emotional prosodic aspects in the human brain.

In non-tone languages, of course, non-lexical affective signalling in speech is mainly realized by pitch variation in the form of intonation, with various other factors also having a possible contributing role. Since the **acoustical** properties of linguistic and emotional prosody are identical (e.g. Lieberman, 1967) the issue of different localization in the brain is particularly interesting but also extremely complex.

Various data of RHD patients indicate the importance of the exact lesion site (Shapiro & Danly, 1985): patients with right anterior brain damage had less pitch variation in their speech and a more restricted intonational range as compared with normal speakers. Patients with right central brain damage displayed a similar pattern with, in addition, a lower mean F0 level. This observation applies to the emotional and the propositional domain. Patients with right posterior damage had a higher F0 level and more pitch variation than either right anterior -, right central -, left posterior brain damage patients or normal control subjects.

In addition, Behrens (1988) has proposed the so called functional lateralization, a model that applies also to non-tone languages. This model assumes that the right hemisphere is superior for the processing of emotional prosody but not for linguistic prosody. In Behrens' (1968) study, RHD patients' ability to convey purely linguistic stress appeared preserved, whereas use of emotional prosodic cues was severely impaired. It should be noted that the combinational influence of lesion site and functional lateralization adds to the complexity of the issue.

To gain some insight into this subject matter, and stimulated by the clinical background of one of the authors, an experiment was carried out with a clearly therapeutic goal in mind. This experiment, a case study, will now be described in comprehensive terms; for details see also Roelants & van Schothorst, 1993.

METHOD

The subject was a 39 years old male RHD patient. His brain damage was due to a right frontal subdural hematoma. Neurological diagnosis also showed spastic hemiparesis. Patient's speech was monotonous with irregularities in loudness and rhythm. His perception of prosodic cues seemed reduced. Since his visual perception was intact, treatment with a visual feedback method was chosen. We used the so called "Speech Viewer" developed by IBM, which produces an on-line visual display of pitch and loudness variations. To the best of our knowledge there is no description of prosodic training with visual feedback for RHD patients, whereas such programmes have been widely used and are well documented for the deaf and hearing impaired. The visualization of prosodic cues can:

- enhance patient's general motivation for the training programme,
- facilitate the learning process as an additional sensory input modality and
- stimulate a possibly reduced "self monitoring" function.

The influence of visual feedback on the self monitoring task in connection with RHD patients is discussed in greater detail in Roelants and Van Schothorst, 1993 and does not fit within the scope of the present paper.

The above mentioned functional lateralization model assumes a right hemispheric superiority for emotional prosody processing and a left hemispheric superiority for linguistic prosody processing. Therefore the training programme we constructed was focused on a well structured increase of emotional pitch variation. As a first therapeutical attempt it was decided to train the least damaged, left hemispherically controlled, most linguistically significant aspects of prosody.

Expectations were that

1. all trained prosodic aspects would improve with a maximum increase in improvement due to emotional prosodic training, moderate improvement due to sentence intonation training and relatively little improvement due to prosodic training based on contrastive accent (see also our section on speech material).
2. a positive transfer would take place from speech produced during training sessions to utterances produced in more natural conditions.

Speech produced by the patient before, during and after training sessions was perceptually evaluated by a panel of listeners in terms of naturalness and related to some acoustic features.

The speech material of the training programme consisted of the following parts (conditions):

1. contrastive lexical accent: a certain sentence was given and answers to ensuing questions were elicited, e.g. "father was at the office yesterday"; "who was at the office yesterday?"; "where was father yesterday?"
2. sentential intonation: training of interrogative, declarative and imperative sentences.
3. emotional tone: expression of a given emotion based on situational information. E.g: after months of having been looking for work, you are selected for the desired job. Extremely happy, you tell your best friend: "......!"

These prosodic conditions were each trained three times a week for two consecutive weeks. Purely imitational exercises were followed by pseudospontaneous role play between patient and therapist. All training was enhanced by on-line visual feedback using the modules 'pitch' and 'loudness' of the 'Speech Viewer'.

Before and after training transfer of the prosodic aspects was tested by means of

4. reading aloud a text with a high occurrence of direct speech and

5. a dialogue between patient and therapist.

PERCEPTUAL EVALUATION

Before, during and after training, recordings were made of nine sentences per condition for the purpose of perceptual evaluation. In order to evaluate the so called transfer, additional recordings were made of two times nine sentences before and after training (see also Table I).

For the actual listening test sentence pairs were prepared. A pair consisted of two sentences in any combination of recordings (before, during, after) within a condition. Pairs were presented in pseudo-randomized order to a panel of 32 speech-therapy students who were instructed to pay special attention to prosodic cues when judging the sentences as to naturalness. Comparison scores were given on the second sentence of each pair on a 5-point scale.

Raw data were subsequently processed and analysed by means of the Scheffé (1952) method. Ensuing results are expressed in so called preference values (range: 0 - 2) and showed an improvement in all three prosodic conditions and the two transfer conditions. Table I indicates whether improvement is significant. Data are pooled over 32 listeners.

Table I: scheme of perceptual evaluation with indication of significance (= significant on p≤.05)*

condition	1st.rec.	2nd.rec.	sign.	pref.val.
contr.accent	before	after	*	.4
	before	during	*	.36
	during	after	-	.04
sent.inton.	before	after	*	.43
	before	during	-	.13
	during	after	*	.3
emotion.tone	before	after	*	1.1
	before	during	*	.83
	during	after	*	.28
reading	before	after	*	.54
dialogue	before	after	*	.2

When trying to relate these perceptual findings to some acoustic characteristics the following observations can be made:

1. Improvement in judgments in the contrastive accent condition can be related to the fact that in the course of the training programme the lexical item in question is realized with higher F0, greater amplitude and longer duration.

2. Higher naturalness judgments in the sentence intonation condition are due to a better command of a number of prosodic rules: sentence terminal F0 decrease instead of increase for declarative sentences, increase in amplitude for imperative sentences and overall decrease of speech monotony.

3. Inspection of data on the emotional tone condition indicates a bipartition of emotions into 'restrained' emotions like shy, anxious or disappointed and 'effusive' emotions like happy, angry or surprised. Whereas before training there was little or no distinction between the two types of emotions, this was clearly different after training: effusive emotions were characterised by a relatively high average F0, greater amount of F0 variation and higher average amplitude value; for restrained emotions, measurements indicated a relatively low average F0, less F0 variation and lower amplitude values.

CONCLUSION

As was expected and can be seen in Table I, greatest improvement took place in the emotional tone condition. Overall degree of improvement of sentence intonation and contrastive

accent is of a similar magnitude, the latter reaching its maximum value at an earlier stage in the training programme than the former. It is probable, therefore, that follow-up training of sentence intonation and emotional tone would further enhance positive results of the present programme.

We can state that training emotion in prosody with a visual feedback method turned out effective in the case of our RHD patient. Since it concerns an N=1 study, further research with more subjects and a matched group of nonneurological speakers is needed. It should be kept in mind, however, that this kind of study cannot provide an answer to the more fundamental question as formulated by Bates (1994, personal communication): We do not know with any certainty whether localized language deficits due to brain injury can be improved as a result of domain specific (partial) recovery or that it is successful reorganization of regional specialization (stimulated by appropriate therapy) that is responsible for the observed improvement.

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