

IRREGULAR PERIODICITY AS A BOUNDARY CUE BETWEEN PHRASES

Christian Sappok
Seminar für Slavistik

Ruhr Universität Bochum, 4630 BOCHUM, BRD

ABSTRACT

The voiced portions of natural speech exhibit a tendency towards a certain amount of irregularity concerning the F0 values of successive periods. Is this due to the specific functioning of the voicing apparatus, or is it one of the features of the signal with a definite function of delimiting phrasing units? To gain evidence for one of these alternatives a test was constructed containing manipulated F0 declinations and gradual irregularity at the position of virtual boundaries. The results of perceptual experiments confirm the systematic status of both of the phenomena in the structure of the intonational contour.

It is a well known experience in the field of manipulation and synthesis of speech signals that a sequence of identical periods or a succession of periods with regularly changing parameters are perceived as unnatural. Already introducing a small amount of irregularity, called jitter in the case of F0-deviations, helps to make the signal sound more natural. A tendency "to vary randomly from the general intonational trend line" is characteristic to all instances of voiced speech (HILLER, LAVER and MACKENZIE 1984, 59 ff.)

There is some evidence for the hypothesis that irregularity is not only characteristic of natural utterances, but that it is more often found in specific parts of the connected speech chain than in other parts. CARDOZO and RITSMA (1968) found that irregularity is more readily perceived when it occurs in the center of a stationary signal; this observation leads to the conclusion that the phenomenon is more readily expected in the non-central parts of the signal. Leaving the field of artificial pulse trains aside, we would say that the phe-

nomenon is a substantial part of the speech signal, fulfilling a systematic function in the subdivision of the natural utterance into phrases; the problem of prosodic demarcation of certain constituents and its semantic functions have been systematically described by PEŠKOVSKIJ (1914).

There are two sorts of boundary signals in the phrased natural speech signal: the modified continuation of the parameters valid for the phrase central parts (F0-declination, decreasing intensity, lengthening; this last mentioned phenomenon has been described extensively by LEHISTE 1970 and KRIVNOVA 1983), or in the introduction of a specific signal as the pause which is without function in the central parts of the intonation contour.

Are these means alternative possibilities of realizing an abstract boundary mark between consecutive chains of the speech signal with the status of phrases? Or do they form a specific set of features characteristic for the non-central parts of the well-phrased utterance? If the former alternative is true, we would expect that gradually enforcing the change of prosodic parameters characteristic of a boundary would gradually reinforce the subdivided profile of the respective phrase. The latter alternative which gives these parameters the status of linguistic features with strictly delimited values, motivates the expectation that no such linear dependency exists between the strength of deviation between central and peripheral parameters on the one hand, and the interpretation of this deviation as distinctive on the other exists.

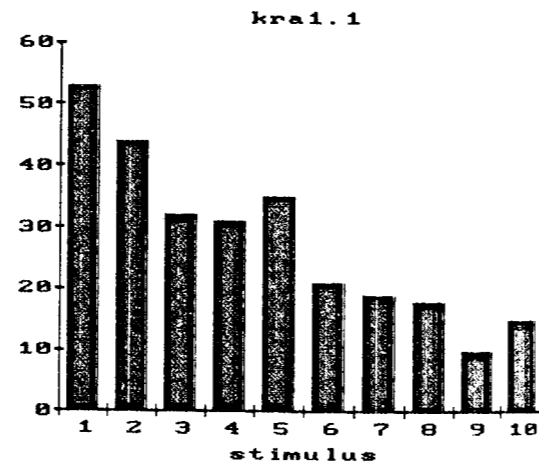
To investigate the possible solution of this alternative modelling of phrasing units, a series of tests was constructed on the basis of natural speech production and the controlled manipulation of pitch periods. No pitch transformations of periods were applied,

rather the periods of the original utterance were segmented and combined anew with the aim of imitating the internal phrasing boundary.

A chain of particles such as Russian "da da da ..." and "nu, nu, nu ...", which allow for different intonational realizations and, according to these differences, more than one pragmatic interpretation, were produced by male native speakers, once as a single chain with reassuring function: "nu nu!" (= go ahead), once in an internally phrased form "nu nu! nu nu nu!", thus reduplicating the mentioned function. The resulting utterances were analyzed and manipulated in one of two ways:

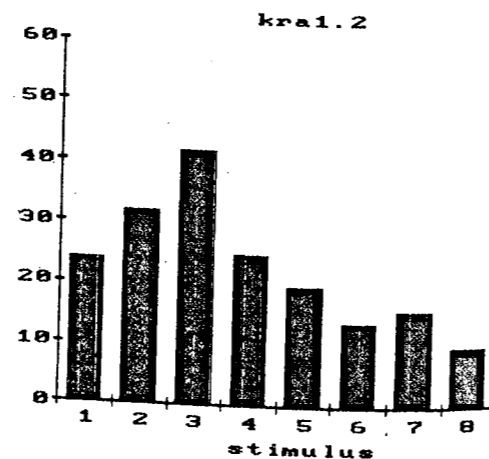
The first type of manipulations imitates at the final portion of the second "nu" of the internally non-phrased version the values of the internally phrased version, with increasing grade of intensity: F0 is gradually lowered or raised, and a lengthening was achieved by reduplicating periods. Alternatively, irregularity is implemented at exactly the same place of the virtual boundary and tested as to its subdividing effect.

In the chart kra1.1 the stimuli 2 to 5 contain a declination of F0 from the level of 208 Hz to 202, 200, 198 and 196 Hz respectively, in each case spread over the last ten periods of the second "nu" of internally non phrased series of five "nu"-syllables. The stimuli were presented in randomized order to native speakers (students of the Moscow State University, Institute of General, Comparative, Historical and Applied Linguistics, directed by Prof. L.V. Zlatoustova, to all of whom I wish to express my sincere gratitude), in a forced choice test, with the instruction to mark each of the perceived stimuli as either non phrased or internally phrased. The reactions to the stimuli with F0 declination show a marked shift in the interpretation, with a decreasing number of positive answers (= + internally phrased), but not in strict linear dependency. The same holds true within the group of stimuli 6 - 9, being identical as to the form of the F0 declination, but with an additional lengthening of 20 ms within the non - modified part of the last syllable. Note that even the unphrased original stimulus was not perceived as unphrased in 100 % of the reactions. In general, the use of natural speech production with the task of identifying communicative speech functions is much more complicated than

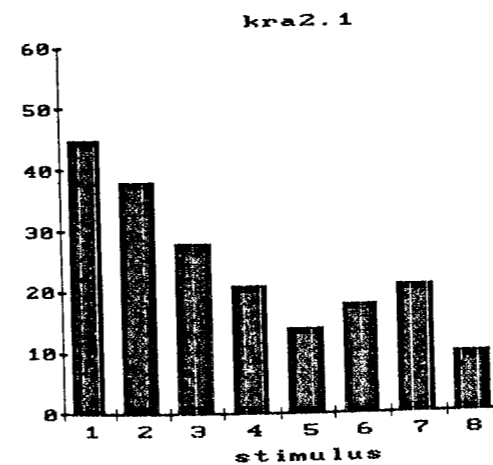


the use of meaningless pulse trains, or at least differ to a large degree; HESS 1983,79 reports suggestions that the difference limen for the audibility of F0 changes is higher in natural speech.

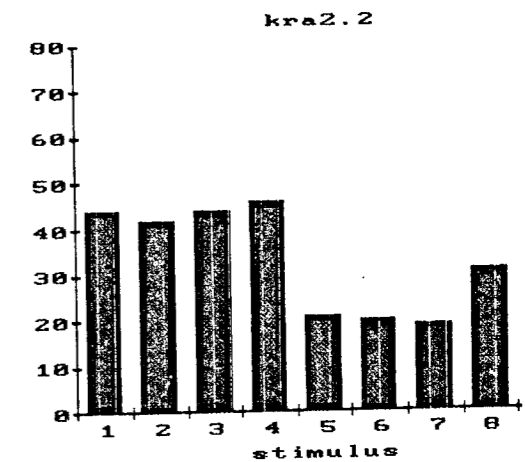
In the next series of manipulations (kra1.2, stimuli 1 to 4) we realized the same F0-declination, as in the former case, i.e. in kra 1.1, but in upward direction. The first and the last step of this manipulation leads to a considerable increment of positive reactions (i.e., plus internal-phrasing interpretations in 36 cases out of 60); the subdividing effect is weakend in the case of stimulus 2 and 3, a fact that is not easy to explain. Maybe the over-all contour of the unmanipulated natural signal has a slight internal contour within each of the syllables. This being the case, changing the F0-values in upward direction has a levelling effect with respect to this internal contour, thus reducing the uncertainty of interpretation. The addition of 20 ms, again, results in an increasing number of YES - interpretations.



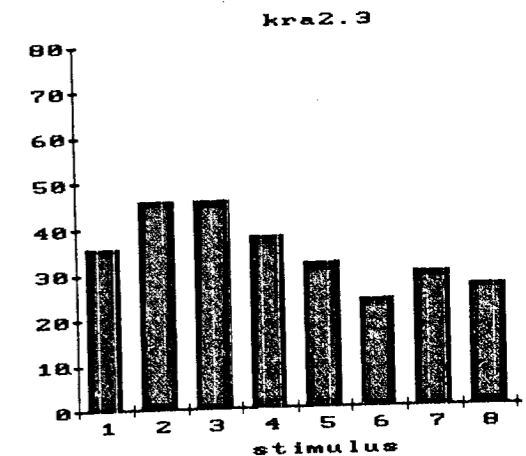
To what extent are these results comparable to similar manipulations in the field of irregularity, provided that the location and the graduation of the manipulated stimulus parts remain the same? To answer this question, deviating periods were inserted in the chain of 208 Hz periods in randomized order, beginning with 204 Hz and increasing this deviation by 2-Hz steps. The reactions show an increasing tendency towards the phrased interpretation, reinforced by an additional lengthening of 20 ms, this time without a regular shift, cp. kra2.1.



This kind of manipulation was repeated in kra2.2, this time with a upward deviation throughout, but with an identical randomized sequence. This type of irregularity shows a marked rise in the positive reactions as to the presence of an internal boundary, which again is reinforced to a remarkable degree in combination with lengthening; but in this case without any clear differentiation within the sequence of different degrees of deviation. This can be interpreted as evidence for the fact that jitter is interpreted as a boundary signal irrespective of the distance between the deviant periods from the surrounding level.



In the series kra2.3 the periods near the virtual boundary were combined in the following manner: Up- and downward deviations alternate in randomized succession, the distance between the highest and the lowest deviation corresponding in stimulus 1 to 4 to the unilateral deviation of the respective sequence in kra2.1 and kra2.1. There is a difference between the responses to the unlengthened stimuli and the lengthened (compare the responses to stimuli 5 to 8), but again no marked influence caused the prominence of the deviation. If we take it for granted that this type of irregularity comes closest to the jitter of natural speech production, we can conclude that the function of irregularity in the process of boundary marking is relatively independent of reinforcing influences of other boundary signals.



The tentative conclusions on the basis of these results may be formulated as follows:

1. The stimuli under consideration correspond to simple, yet natural utterances, revealing a clearly marked pragmatic function, with the possibility of reduplication of contour and function, the latter case showing an internal phrase boundary.

2. The decision of interpretation in unclear cases, being the result of minimal manipulations, is influenced to the same degree by F₀ - declination and by irregularity of subsequent pitch periods. This effect is in both cases reinforced by additional lengthening of the already manipulated syllable.

3. In the case of irregularity there is a remarkable absence of interdependence between the degree of deviation and the bias of interpretation within one and the same type of boundary signalling.

Mainly this last observation gives evidence for the hypothesis that jitter does indeed have a fixed place in the system of boundary signals in natural speech. It reveals its function in position near the phrase boundary and interacts in a systematic way with the other boundary cues. Further experiments have to show whether this is a characteristic function only in positions adjacent to the boundary, or whether also fullfledged lexical items on the periphery of intonation contours, bearing phrase accent ("frazovoe udarenie" according to NIKOLAEVA 1982), but not phrasal stress ("akcentnoe vydelenie" according to NIKOLAEVA *ibid.*), can be marked by irregularity.

Literature:

CARDOZO B.L., RITSMA R.J. (1968): On the Perception of Imperfect Periodicity. *IEEE Transactions* 16 (2), 159-164.

HESS W. (1983): Pitch Determination of the Speech Signals. Algorithms and Devices. Berlin et al.

HILLER S., LAVER J., MACKENZIE J. (1984): Durational Aspects of Long-Term Measurements of Fundamental Frequency Perturbations in Connected Speech. *Work in Progress* Nr. 17, Dept. of Linguistics, Edinburgh University.

KRIVNOVA O.F. (1983): Dinamika tempa v sintagme. *Fonetika-83. Materialy k X. mezhdunarodnomu kongressu fonetičeskich nauk (avgust 1983 god, Utrecht, Niderlandy)*, 102-114.

LEHISTE I. (1970): *Suprasegmentals*. Cambridge, Mass.

NIKOLAEVA T.M. (1982): *Semantika akcentnogo vydelenija*. Moskva.

PEŠKOVSKIJ A.M. (1914): *Russkij sintaksis v naučnom osveščeníi*. Moskva.