

THE PROSODIC STRUCTURING OF INFORMATION FLOW IN SPOKEN DISCOURSE

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ABSTRACT

This paper describes a study on the prosodic demarcation of larger-scale topical units in spontaneous discourse, in terms of various melodic variables and pause structure. The research reported upon centers on a specific kind of spontaneous language use, viz. so-called instruction monologues of three different Dutch speakers. These monologues are such that macro-units can easily be specified on the basis of criteria which are independent of supra-segmental information. It was found that, in order to indicate which stretches of discourse constitute meaningful units, the three speakers indeed exploit both melodic variables (boundary tones, variable height of *F₀*-maxima, overall downward tendency in pitch over the course of a topic) and pause structure (important points in the flow of information are marked with long pauses, the lengths of which depend on the deepness of the boundary). However, we also observed some speaker variation, in that not each of our informants appeared to use each of the prosodic demarcation devices to the same extent.

1. INTRODUCTION

This study tries to establish to what extent the topical structure of a spontaneous monologue is reflected in its prosodic make-up. The investigation stems from the general assumption that discourse is more than just the sum of isolated sentences. Indeed, in both spoken and written texts, one can often distinguish homogeneous sequences of sentences that somehow 'belong together'. As they together express one coherent information unit of a speaker or a writer, such groups of utterances can be said to form larger-scale discourse units (which we will label 'topics', cf. *infra*).

Language users have at their disposal various means with which they can bring out discourse structure. There is some evidence that particular morpho-syntactic devices exist to regulate information flow. Geluykens (1992a) argues, for instance, that the phenomenon of left-dislocation is an important syntactic mechanism to

introduce specific topics into the discourse. Many languages have specific particles that introduce or close a paragraph (cf. Schiffrin 1987). Also, the use of pronouns is frequently explained on the basis of the maintenance of coherence in a text (Geluykens 1989, *in press*).

In a written text, the different supra-sentential units can easily be visualized by orthographic means. Macro-units in spoken language, on their part, may have specific prosodic correlates. It has already been reported by e.g. Lehiste (1975) and Thorsen (1985) that read-aloud paragraphs possess a characteristic melodic supra-structure. Lehiste (1975) observes that a speaker can signal by temporal means whether a sentence is paragraph-final or not. Moreover, both researchers found strong indications that these prosodic properties are perceptually relevant: listeners appeared to use such suprasegmental information to decide correctly where in a paragraph an individually presented sentence had to be situated. The latter results, however, were obtained from analyses of read-aloud, small-sized paragraphs; it remains to be seen to what extent they are still applicable to spontaneous speech, which is, after all, a more common, less restricted spoken language use. Spontaneous language use generally involves only little pre-planning, which may have its repercussions on the prosodic properties of macro-units (see Levelt 1989 for a more thorough discussion).

2. SPEECH MATERIALS

However, the study of larger-scale units in spontaneous discourse faces some considerable methodological problems (Swerts & Collier, *in press*). One serious difficulty is to find an operational definition of a macro-unit: to avoid running into circularity, one is in need of a manageable criterion to specify such discourse units that is independent of the prosodic characteristics of the speech studied. As a solution, this study proposes to investigate a specific kind of descriptive language use, namely the instruction monologues that were used by Terken (1984) to test

specific hypotheses on the distribution of pitch accents (for the details of the total experimental design (subjects, recordings, elicitation procedure, materials), see Terken 1984). These monologues consisted of a series of instructions from a speaker to a listener to assemble the front view of a house from a set of ready-made pieces of cardboard (e.g. a roof, a front door, etc...); as such, it is clear that they have some internal organization, which reflects the different instructions. Moreover, on a purely linguistic level, they exhibited a clear topical structure, as will be shown below. An excerpt of such a monologue is presented below [accented syllables are underscored; English glosses are approximations rather than literal translations]:

- (1) 1. dan hebben we het zwarte vierkant
then we have the black square
2. daar gaan we nu een dak opzetten
now let's put a roof on it
- dat is het groene driehoek
that is the green triangle
- de grote groene driehoek
the large green triangle
- die zetten we er boven op
we place that on top of it
3. dan pakken we het woonkamerraam
then we take the living room window
- dat draaien we met de kleurzijde om
we turn its colored side up
- en leggen het links onderin
and lay it bottom left / leaving
- met wat ruimte eronder
some space underneath it
- zodat de lange kant evenwijdig ligt aan de
so that the long side is parallel to the
- onderkant van het huis
bottom of the house
4. dan pakken we de voor deur
then we take the front door
- en die zetten we een eindje rechts van het raam
and we put that a little to the right of the window
- met de korte zijde naar onder
with the short side down

We have already noted that the various instructions can be seen as meaningful units, as they consist of semantically coherent utterances dealing with the same building block of the house, i.e. with the same instruction. There is independent textual motivation for our structural analysis, however.

Instructions in the monologues generally are of the following form: a referent (e.g. het zwarte vierkant (the black square)) is introduced, which constitutes the core of the instruction, and on which some action has to be performed. These referents will be labelled discourse topics, following Geluykens (1992b), as they are both 'non-recoverable' and 'persistent'. First of all, they are highly irrecoverable: they concern information which cannot be retrieved, directly or via inferences, from the preceding discourse record (Geluykens 1988a). A good example is het woonkamerraam (the living room window) in the third instruction of (1) above. Secondly, they have a strong degree of persistence (after Givón 1983): they recur in various surface forms in the subsequent utterances that belong to the same instruction. This persistence (see Geluykens 1991, 1992b) can be either direct, through recurrence of the same referent in the subsequent discourse, often pronominalized (e.g. dat (that), het (it) in the same instruction above), or indirect, through mention of a semantically closely related referent (e.g. de kleurzijde (the colored side), de lange kant (the long end)). Such an analysis shows that there is an independent, 'information flow' (after Chafe 1987) motivation for indeed regarding the different instructions as separate topical units. On top of this, there are some other signals which indicate the structuring of the discourse by the speaker (e.g. the use of dan (then) at the start of each new instruction. All this provides us with an informational analysis which is independent from prosodic considerations.

From Terken's (1984) original eleven recorded monologues, three speakers (one male (HZ) and two females (SK, NE)) were selected for further analysis. This choice was determined by the fact that these speakers appeared to have the least problems with the experimental task and thus did not reveal much irrelevant stretches of speech. Moreover, they produced monologues of which the topical structure in terms of the relevant instructions was fairly easy to specify. These monologues were fed into the computer with a 10 kHz sampling frequency at 12 bits. The speech was LPC-analyzed and the fundamental frequency (Fo) was determined by means of a method of subharmonic summation (Hermes 1986).

In this study, two prosodic variables are investigated with regard to the supra-structure of the discourse: (i) the intonation or speech melody (melodic boundary markers, scaling of Fo-maxima and mean Fo of subsequent clauses) and (ii) the temporal structure, more specifically distribution and relative duration of pauses.

3. SPEECH MELODY

3.1. Boundary tones (table 1)

Brown et al. (1980), among others, have already argued that intonation is often exploited to signal topic-continuity or finality by the use of different melodic boundary tones. Their claim is that so-called 'low terminals' are regularly associated with the end of a topic, whereas 'not-low terminals' would serve to indicate that there is more to come on the same topic. It was checked whether some more evidence for these statements could be found in the three instruction monologues. At the end of each clause in the monologues, the course of F_0 was examined from the last accent till the beginning of the next clause; the latter was operationally defined as a syntactic entity containing a finite verb. A classification was made into low-ending contours and high-ending contours. The distribution of these is depicted in Table 1 (all tables can be found in the appendix).

These findings seem to confirm the earlier claims by Brown et al (1980). There is indeed a correspondence between the topical structure of the discourse and the use of low versus high boundary tones. The majority of the low-ending contours are located at the end of the final clauses of the various instructions: their function seems to be to signal that an informational unit has been rounded off. Most of the non-low contours occur within instructions: they signal that there is still more to come on the same topic. However, our data also reveal some exceptions to this general tendency. From the class of low boundaries that do not coincide with the end of an instruction, some can still be argued to be dependent on the topical structure of the discourse (especially in the monologue of speaker SK). That is, they occur at points where the information conveyed is sufficient enough to enable a listener to successfully execute the instruction of the speaker. However, in a sort of afterthought, the subsequent clause provides some details that are redundant from a purely informational point of view or that are so obvious or deducible from the previous discourse that they are strictly speaking not necessary to be communicated. Of course, this non-essential information may facilitate the communication between speaker and hearer, as it confirms what has been said in earlier utterances. In (2), which is instruction 3 of speaker SK, an example is presented an illustration of what is meant ($H\%$ symbolizes a high boundary tone, $L\%$ a low boundary tone):

- 2) dan pakken we de voordeur ($H\%$)
then we take the front door

en die zetten we rechts in het zwarte vierkant ($H\%$)
and we put that right in the black square

rechtsonder ($H\%$) zodat de smalle kant van de
voordeur
bottom right so that the small side of the front
door

tegen de onderkant van het zwarte vierkant
aanzit ($H\%$)
sits on the bottom side of the black square

en een klein stukje een centimeter of twee
and a little bit about two centimeters

vanaf de rechterzijkant van het zwarte
vierkant ($L\%$)
from the right side of the black square

dus de onderkant van de voordeur loopt gelijk
so the bottom side of the front door runs parallel

met de onderkant van het zwarte vierkant
to the bottom side of the black square

van de voorgevel ($L\%$)
of the front view

In (2), it can be observed that the first occurring low boundary is located at a position where the instruction is informationally complete. The subsequent utterance only paraphrases what has already been said in the previous part of the instruction. In the three monologues, 5 instances were found of low boundary tones that occurred at the end of an informationally (quasi-)complete unit, that did not coincide with the end of the total instruction.

3.2. F_0 maxima (table 2)

Another melodic variable is the location of the F_0 maxima in accent-lending pitch movements (F_0 maximum being defined as the end of a rise or the beginning of a fall). There were some difficult cases, namely the abrupt pitch rises that occurred relatively late in one-syllable words and that seemed to consist of an accent-lending and a non-accent-lending part. It was difficult to locate the exact transition point between these two parts, as they present themselves as one fluent, complete F_0 movement. Therefore, the F_0 maximum of the entire movement is taken as a measure point. These 'exaggerated' values are italicized in Table 2. Other F_0 maxima are also depicted in Table 2.

Terken (1984) has already observed in these speech materials that noun phrases introducing a new topic into the discourse were always accented. This finding was

interpreted to mean that by accentuation the speaker gives an indication of the degree of availability of the information conveyed. As the referents introduced are always irrecoverable, they always get an accent. Moreover, these new items constitute the topics of the subsequent discourse and are therefore made prominent in order to signal that the referent must be given preferential status in the listener's discourse model. The data on Fo maxima seem to give further support to these ideas as these accents also appear to differ qualitatively from other accents in the discourse: the accents on the referent-introducing noun phrases are very conspicuous since they are located very high in the speaker's register: such very prominent accents may function as 'warning signals' from the speaker to the listener that a new topical unit has been started. However, the latter interpretation only seems to hold for two of the three speakers. Indeed, NE does not consistently provide the topic-introducing noun phrase with the highest Fo maximum as do HZ and SK.

It has to be noted here that the Fo maxima on referent-introductions (Table 2) are not always easy to identify, as some introductions are accompanied by elaborative material, making the introducing phrase quite long (e.g. the second instruction in (1) above: het groene driehoek, de grote groene driehoek). This may account for some of the discrepancies between referent-introductions proper and Fo maxima in Table 2, the Fo falling on the elaborative material.

3.3. mean Fo of subsequent clauses (table 3)

The measurement of the boundary tones and the Fo maxima were relatively local. In addition, some more global calculations of the fundamental frequency were also performed. The mean Fo was determined over the range of one clause (see section 3.1 for an operational definition of clauses). If there was a large pause (i.e. longer than 1000 ms), the clause was split up into two separate units. The measured means of Fo of subsequent clauses are shown in Figure 1.

It can be seen that the larger-scale informational units of speakers SK and HZ appear to exhibit a global phonetic characteristic: the instructions are provided with a superordinate melodic structure. In their data, the Fo is, on the average, relatively high at the beginning of a unit, and it then slowly decreases over the course of the instruction; at the beginning of a new topical entity, the Fo is again shifted up. The macro-units of speaker NE, however, do not have this general prosodic feature.

At this point, it is not clear yet how the global decrease in the mean Fo (that is, in the data of HZ and SK)

must be interpreted. Though exact measurements are not yet performed, it is our impression that it is the composite result of two mechanisms present: a general decline in Fo register and a global decrease in the excursion size of the movements. In any case, it suggests that relatively global correlates can be observed in spontaneous discourse (a claim which has been questioned a few times in the literature), provided that the speaker is enabled to pre-plan much of his speaking unit. Of course, this does not mean that this finding also holds for conversational, non-monitored speaking style.

4. PAUSE STRUCTURE

A second major prosodic dimension which speakers may manipulate to structure their information flow is the temporal one, more particularly the use of pauses in discourse. (Pauses are operationally defined as periods of silence, equal to or longer than 100 ms; they were measured directly on the digitized speech waveform.)

4.1. Distribution

A first look at the distribution of the pauses in the three monologues brings to light that many of them occur at the end of a clause or a phrase. However, it would be a mistake to conclude from this that pausal structure can be explained purely in syntactic terms. Apart from the fact that some of the pauses are present at relatively shallow structural breaks (e.g., in between an article and a noun), it is also the case that not all clause boundaries are marked by a period of silence. This is clearly exemplified by (3) and (4) below, where major clause boundaries do not coincide with the presence of a pause, respectively after daar gaan we nu een dak opzetten in (3) and dan heb ik nog een groen frotje over in (4):

- (3) dan hebben we het zwarte vierkant (0.33)
then we have the black square
- daar gaan we nu een dak opzetten (no pause)
on that we are going to put a roof now
- dat is het groene driehoek (0.17)
that is the green triangle
- (4) dan heb ik nog een klein groen frotje over (no pause)
then I have another small green thingie left
- dat zal wel een bloempotje zijn (0.43)
that will probably be a flowerpot

dat zetten we bij het voorraam onder (7.18)
that we put by the front window below

The likelihood of occurrence of a clause-final pause appears to be very high at two important discourse locations. Firstly, pauses are present at all transitions between instructions, i.e. between all topical units. Secondly, pauses consistently occur right after the topic-introducing phrase or clause. These two locations constitute crucial information flow positions, as will be shown below.

4.2. Duration (table 4; see appendix)

The picture becomes even more interesting if one looks at the respective lengths of the pauses in various discourse locations, i.e. (i) in between instructions, (ii) after the clause or phrase introducing a new referent and (iii) at other positions. Results can be found in Table 3.

This table shows that, in these three monologues, pause duration is dependent on the topical structure of the discourse: the longest silence intervals are found in between instructions; within a topical unit, the pauses in post-referent-introducing position are consistently longer than in other locations. Though the three speakers differ considerably in their absolute pause lengths, they all share this same pattern of varying pause duration as a function of discourse location.

Having established that there is a strong correlation between pause structure and the topical organization of the discourse, it remains to be explained what cognitive or communicative factors might account for this regularity. In the following, a few tentative solutions will be presented that need further experimental verification. First of all, one can argue that pausal structure is a result of cognitive processing by the speaker. In this view, the silence intervals in between instructions could reflect the planning carried out by the speaker before s/he embarks on the next instruction. Similarly, the pause after the referent-introduction could be caused by the speaker's planning as regards how to develop the newly introduced topic in the subsequent discourse. The subsequent utterances within the same topical unit would then require less processing, and pauses are consequently shorter. However, since the experimental task seems to be a very simple one, which does not need considerable mental effort, the cognitive explanation does not appear to be very likely as the sole factor governing pause length.

An alternative hypothesis (which is not mutually exclusive with the previous one) concerns the communicative goals of the speaker, and his need to be cooperative towards the hearer. By manipulating pause length, one could argue, the speaker is trying to make it easier for his interlocutor to process discourse structure. In

such a way, he is not only marking which major chunks of the discourse (the instructions) belong together, but is also drawing attention to the newly introduced referents by making them prosodically more salient, and hence more easily identifiable as new discourse topics. This outcome is very compatible with the finding that two out of three speakers generally provided the topic-introducing NPs with the highest Fo maxima (see section 2).

This latter view (and, especially, the discussion about the pauses in post-referent-introduction position) is also compatible with a third, more interactional explanation. Although the speech materials under investigation consist of monologues, the test setting really was a communicative one: speakers had to give instructions to hearers who were physically present. There is thus an interactive dimension to this discourse, despite the fact that no verbal or visual feedback was possible, as is the case in real conversational data (see Terken 1984 for the experimental design). In Geluykens (1991, 1992b), it is argued that referents in conversation are introduced in a collaborative manner, through a three-stage interaction between a speaker and a hearer. These stages are, respectively, introduction by the speaker of a new referent, acknowledgement by the hearer of this new referent, and establishment of the new referent by the speaker, by developing it as a discourse topic (see (5)).

- (5) C: Prof. Worth asked me to get some books for him
B: oh yes yes
C: I've just arranged for those to be sent over by taxi

(simplified from Geluykens 1991)

Acknowledgement, it is claimed, can be either verbal, as in (5), (usually through a short acceptance signal such as yeah, mhm, and the like), or implicit, without an overt linguistic signal. In the latter case, the speaker pauses to give the hearer the opportunity to take in the new referent cognitively, but also to enable him to reject the new referent if s/he should feel that way inclined. Given the normal politeness principles operative in conversation (see Brown & Levinson, 1987), such rejection is not very likely. In the vast majority of the corpus-data analyzed in Geluykens (1991, 1992b), it was found that referent-introductions were followed by an overt acknowledgement signal, but also often by a pause.

The long post-referent-introduction pauses in our data could therefore be argued to reflect this interactive dimension, giving the hearer the chance to process the new referent, but also, theoretically, giving him the opportunity to intervene if necessary, either to request more information or to short-circuit the referent. In other words, some of these pauses would thus be quasi-conversational and

essentially interactive. As it is impossible to verify this unequivocally in the data, such a statement needs further experimental support.

5. GENERAL DISCUSSION AND CONCLUSION

This study has shown that speakers may enrich spontaneous discourse through prosodic structure in a variety of ways. It was found that the topical make-up of three monologues could be clarified by speech melody (use of various melodic boundary markers, the scaling of F_0 maxima in accented words, the average F_0 calculated over a clause) and by the variable duration of pauses. However, another important observation was that there was some speaker-variation, since not every speaker exploits each of the above prosodic structuring devices. Obviously, prosody is just one of a variety of means (lexical, syntactic, perhaps even non-linguistic, such as visual) to indicate the structure of the discourse. Therefore, as there could be some trade-off between these various mechanisms, some liberty in the use of melodic and temporal signals may be allowed without dramatic consequences for the understanding of the spoken text. Further experimentation is obviously necessary here.

This work has to be extended in two directions. First of all, it needs to be explored whether a speaker's prosodic structuring is also important from a listener's point of view. The assumed prosodic structuring devices can only be communicatively relevant if they are in some way meaningful to a listener. To gain more insight into this problem, we are currently conducting a series of perception experiments, both with filtered versions of the monologues studied here (Swerts, Gelykens & Terken, in press) and with utterances in which speech melody was systematically manipulated (Swerts, Bouwhuis & Collier 1992).

Secondly, the current paper has only been concerned with monologues. Therefore, it remains to be seen to what extent these findings can be extrapolated to discourse situations which are more interactional, in the sense that hearer-feedback is made possible. Both corpus-based (Gelykens 1992a, 1992b, in press) and experimental (Clark & Wilkes-Gibbs 1986) research suggests that there is a very outspoken collaborative dimension in the way new discourse topics are introduced in dialogue situations. It seems logical to assume that this collaborative dimension will also be reflected prosodically, in the way information is structured both on a melodic and a temporal level. It would be interesting to put this hypothesis to the test in conditions which are somewhat controlled and yet permit spontaneous, unplanned interaction. It is our intention (Gelykens & Swerts 1992) to further explore functions of prosody in (spontaneous) discourse, both from

the point of view of interaction (in relation to the turn-taking mechanism) and of information flow regulation.

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Table 1. Distribution of low and not-low boundary tones as a function of discourse position

| | SK End of Instr. | | HZ End of Instr. | | NE End of Instr. | |
|---------|---------------------|----|---------------------|----|---------------------|----|
| | yes | no | yes | no | yes | no |
| Low | 12 | 5 | 9 | 7 | 9 | 3 |
| Not low | 1 | 38 | 3 | 18 | 3 | 12 |

Table 3. Mean pause durations (in sec.) at various discourse locations

| | SK | HZ | NE | Overall |
|--------------------|------|------|------|---------|
| inter-topic pauses | 2.89 | 1.82 | 7.59 | 4.10 |
| within topics | | | | |
| - ref-intro pauses | 2.21 | 1.03 | 2.38 | 1.87 |
| - other pauses | 0.92 | 0.70 | 0.67 | 0.76 |

Table 2. Successive Fo-maxima (expressed in Hz) within instructions: □ represent the value of the major accent in the topic-introducing phrase, boldtype represents the highest Fo-maximum within an instruction. The italicized numbers represent the 'exaggerated' measurements (further explanations in the text).

| Inst. | Successive Fo-maxima within instructions |
|---------|---|
| SK 1 | 303 303 250 238 J2J |
| 2 | 313 256 238 256 263 256 213 |
| 3 | 286 J2J <i>J0J</i> 278 233 256 286 270 263 213 238 204 263 222 217 204 222 200 |
| 4 | 303 250 <i>J0J</i> 256 294 250 244 244 294 263 233 227 263 294 217 227 233 |
| 5 | 270 400 238 286 250 233 244 278 227 222 244 227 270 238 250 227 270 192 |
| 6 | 400 233 204 233 250 213 J2J 233 196 |
| 7 | 244 278 270 222 263 222 256 294 263 217 244 204 |
| 8 | 278 263 270 286 222 286 233 294 213 217 208 182 |
| 9 | 286 222 J3J 244 244 286 238 263 244 250 233 244 196 |
| 10 | 244 J45 244 238 233 238 244 222 222 217 175 |
| 11 | 227 J57 233 213 208 |
| 12 | J85 286 238 244 263 233 J57 256 233 233 217 |
| 13 | J57 233 244 222 233 208 213 185 |

| | |
|---------|---|
| NE 1 | 370 345 313 |
| 2 | 323 370 345 313 323 313 |
| 3 | 333 313 278 303 313 323 303 286 |
| 4 | 313 303 323 323 345 313 294 323 323 303 256 |
| 5 | 294 303 286 303 303 303 278 J70 313 278 244 |
| 6 | 313 286 222 222 286 303 303 286 286 250 |
| 7 | 286 278 256 303 278 323 303 303 286 286 J3J 250 |
| 8 | 286 294 263 256 270 270 |
| 9 | 270 270 294 313 278 263 |
| 10 | 256 263 278 303 294 238 |

| | |
|---------|---|
| HZ 1 | 143 172 217 |
| 2 | 192 192 189 175 189 149 120 |
| 3 | 196 139 164 256 137 152 J0J 137 167 145 167 141 137 103 |
| 4 | 222 139 141 147 119 132 112 |
| 5 | 179 167 139 204 164 106 |
| 6 | 189 179 147 120 |
| 7 | 120 152 137 104 154 133 111 95 120 108 |
| 8 | 182 154 143 |
| 9 | 145 147 159 123 122 112 |
| 10 | 154 175 164 200 128 116 145 127 |
| 11 | 167 159 122 133 109 |
| 12 | 179 200 139 115 118 |

Mean Fo (expressed in Hz)

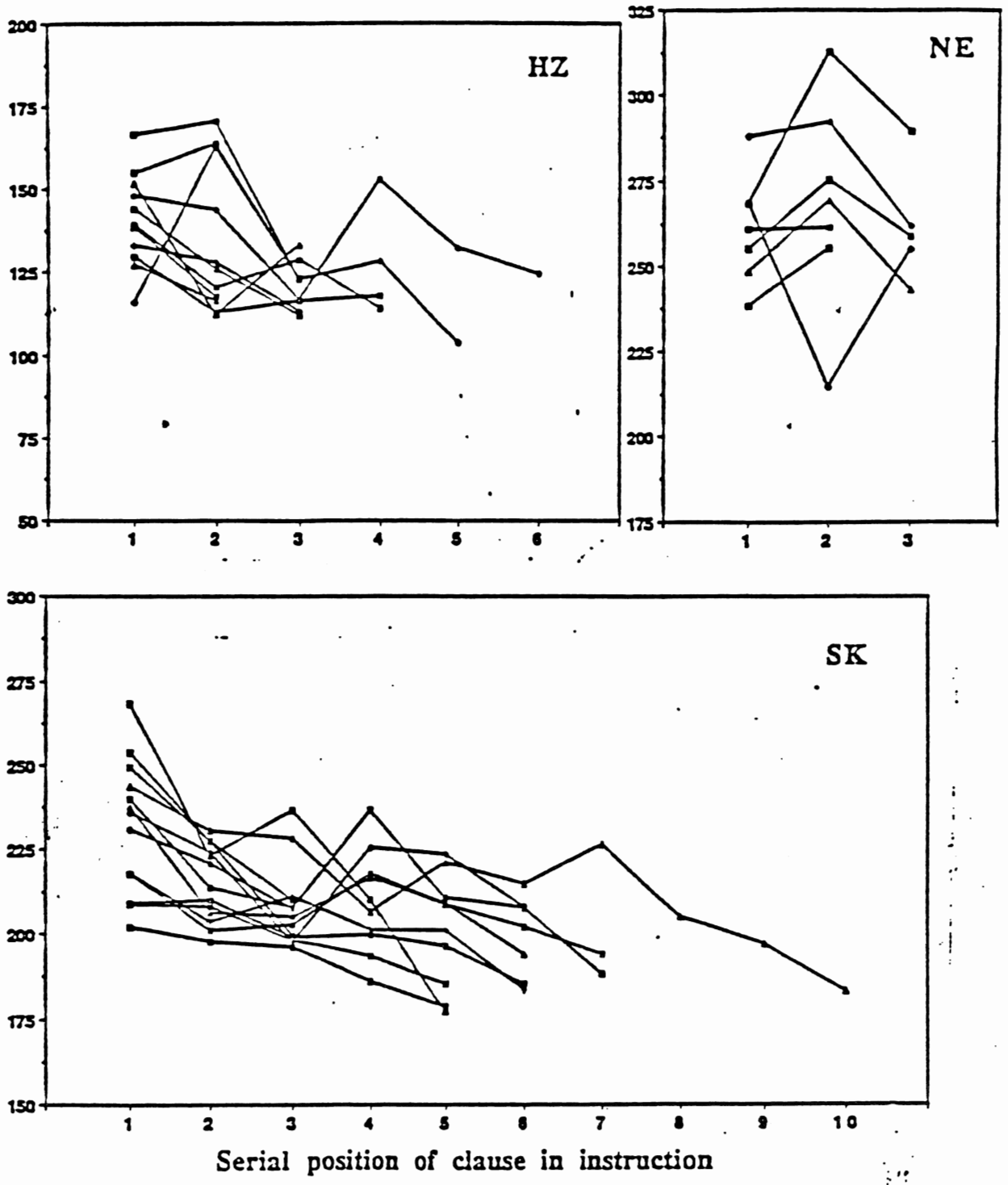


Figure 1. Mean Fo of successive clauses of the instructions. Identical symbols connected through lines represent the means within the same instruction

