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Tonal and temporal manifestations of successively higher emphasis in two communicative contexts

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The study concerns f_0 and duration in focused words when repeated with successively more emphasis in a dialogue interaction and in a reading-aloud situation. Results show greater adjustments in the dialogue context and generally greater adjustments of duration as compared to f_0. The findings are seen in the light of different demands of the two communicative situations as well as different production constraints on f_0 and duration.

1. Introduction

The research reported on is undertaken within the Swedish GROG project "Boundaries and groupings – the structuring of speech in different communicative situations" (Carlson et al., 2002)[1]. An extended version of the present paper will appear in Strangert (2003).

Focal accent is the highest level of prominence in the Swedish intonation model (Bruce, 1977). It is signalled primarily by a rise in f_0, although recent studies point to strong effects also of other parameters, in particular, duration (Heldner, 2001). A focused word, further, may be more or less emphasized; within the phonologic category of focus a continuous variation of emphasis can be assumed (Bruce, 1998). The means used to increase emphasis are tonal as well as temporal. Carlson et al. (1975) observed temporal and tonal adjustments to successively higher levels of emphasis, and Ericson & Lehiste (1995), reported on longer word durations in emphasized words. To emphasize, and for contrastive purposes, speakers also tend to insert pauses (Strangert, 1991; Selkirk 2002). Thus, speakers apparently adjust the prosodic means to the degree of emphasis required.

The interaction dimension is central here. Borrowing from the H&H theory (Lindblom, 1990) communication depends on the speaker *and* the listener. Thus, when a communication goes wrong, it is up to the speaker to adapt to the situation. The means used to do so include emphasis and not the least repetitions (Swerts et. al., 1998). Such repetitions often contain inserted pauses between words (Bell & Gustafsson, 1999).

The current work aims at describing prosodic adjustments to increased emphasis. Two situations are studied, a semi-spontaneous interaction between a speaker and a listener, and a reading-aloud situation. The demands on the speaker, most reasonably, will be greater with a listener present. On the basis of previous work, pause insertions as well as adjustments of f_0 and duration can be expected. However, as a Swedish focused word already has a high f_0 peak, and given the range over which a person's f_0 can vary, additional increases of f_0 should be restricted. Duration, and in particular pause insertions, should be less constrained. Therefore, the means for achieving higher emphasis are expected to be primarily temporal.

[1] The project is supported by a grant from the Swedish Research Council.

2. Method

12 native Swedish speakers participated in the study, 6 in the interaction and 6 in the reading experiment. All were students of about the same age, and all except one were women.

All speakers produced the same phrase, *Ellen säljer fällen* /ɛlːen sɛljer fɛlːen/ 'Ellen is selling the rug'. Focus on each of the three words in turn was elicited by different questions posed by the experimenter. For each of the three phrases, four tokens were produced with successively increasing emphasis on the focused word. 6 of the subjects uttered the phrases in a semi-spontaneous dialogue with the experimenter pretending to misunderstand the focused word and repeatedly asking for clarification (cf. Ericson & Lehiste, 1995). Emphasis was increased in three steps from a low (reference) level. The four levels will be referred to as e0-e3 (for *Ellen*), s0-s3 (for *säljer*) and f0-f3 (for *fällen*). The other 6 speakers just read the phrases (focused word underlined) trying to increase emphasis in three steps.

The recordings were made using high quality equipment and were digitised at 16 kHz. f_0 peaks (in Hz) and duration of the focused word (in ms) were measured using ESPS/waves+. The f_0 and duration data were used for calculating changes from lower to higher emphasis levels (0-3) with changes expressed in % with the lowest level (0) as the reference. In cases of a pause (= silent interval) before or after the focused word, pause duration was measured.

3. Results

Figure 1 shows the mean changes in f_0 peak value and word duration for each of the three words separately across the four levels of emphasis in the two communicative situations.

The adjustments in f_0 appear as positive or negative changes relative to the reference level for each word. In the reading experiment, increased emphasis in general led to increased mean f_0 peaks of about 5-15%. However, as indicated by the spread in the data, not all of the speakers increased f_0 maximum step by step. There is also a difference between the words, *säljer* being the least affected by emphasis. In the dialogue experiment, the mean changes never exceed 10% and the changes furthermore are positive in some cases and negative in others. This is true for *Ellen* as well as *säljer*. Only in the last word, *fällen*, the changes are generally positive.

Word duration increases successively from low to high levels of emphasis in the reading as well as in the dialogue experiment. However the adjustments are greater in the dialogue experiment. While the maximal increase is about 60-70% in the dialogue situation, the corresponding figure for the reading is about 40%. The means indicate an increase step by step as emphasis is increased. Though this is the general trend, the spread in the data indicate, and a more detailed analysis shows, that increases of duration do not occur at each step for each speaker. The trend of a stepwise increase is however similar for all the three words, although the last word, *fällen*, is the least affected with smaller durational changes.

Table 1 shows the occurrence of pauses, their distribution relative to the focused word and pause durations pooled for the six speakers. As can be seen, pauses occurred frequently after focused *Ellen* and also before *säljer* but less frequently after *säljer* and before *fällen*. That is, most of the pauses (20 of the totally 30 pauses in the dialogue and 12 of the 13 pauses in the reading) occurred between the first (noun) and second word (verb). Also, the majority of pauses appeared at the higher (2, 3) levels of emphasis. Pause duration, furthermore, seems not to be affected by the level of emphasis; there is no general trend of increased pause duration as a function of emphasis. Thus, the pattern is very much the same in the dialogue and the reading, except for the apparent difference in the frequency of pausing.

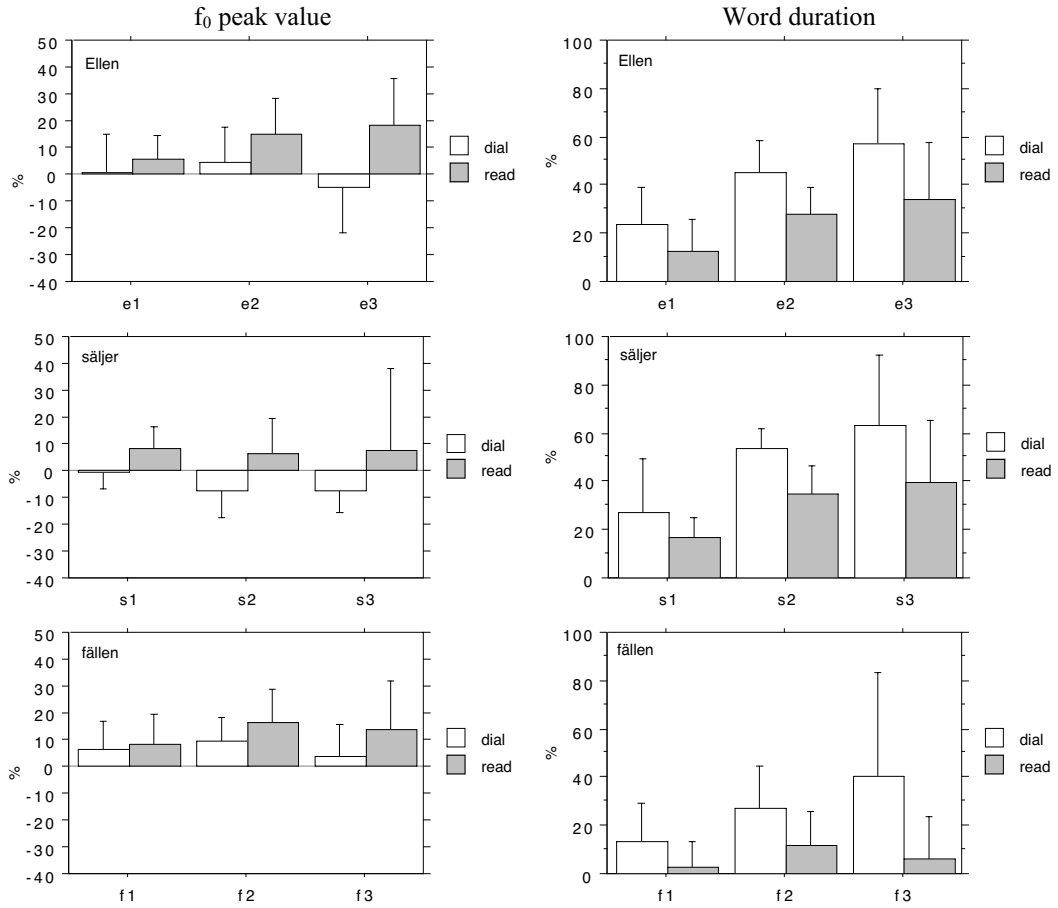

Figure 1. Mean changes of f_0 peak value (left) and word duration (right) in focused words upon emphasis in three steps (e1, e2, e3 for *Ellen*; s1, s2, s3 for *säljer*; f1, f2, f3 for *fällen*) in % relative to a low emphasis reference value (e0; s0; f0) for each word. Means for six speakers each in dialogue and reading experiments. 95 % confidence intervals included.

Table 1. Number of speakers inserting a pause and range of pause durations (ms) at successively increased levels (0-3) of emphasis before (pre) and after (post) focused *Ellen*, *säljer* and *fällen*. Pooled data for 6 speakers each in dialogue and reading experiments.

	Ellen	post	pre	*säljer*	post	pre	*fällen*
Dial; level 0		1 (12)	1 (94)				
level 1		2 (205-349)	1 (111)		1(378)	2 (61-84)	
level 2		5 (54-468)	2 (135-139)		2 (184-220)		
level 3		4 (156-500)	4 (95-165)		2 (130-257)	2 (58-165)	
Read; level 0		1 (57)					
level 1		1 (238)	1 (18)		1 (163)	1 (90)	
level 2		2 (116-581)	1 (33)				
level 3		4 (75-470)				1 (31)	

4. Discussion and conclusions

Successively higher emphasis leads to adjustments in the dialogue as well as the reading, though to a much lesser extent in the reading. These differences most reasonably result from the different demands on the speakers in the two situations. In reading – without interaction with a (physically present) listener and thus without any feedback about communicative success or failure – the speaker has to adapt to what he/she *believes* is required in the specific situation. A dialogue situation, such as the one in the current study, is considerably more demanding. When forced by the listener to be more and more distinct, the speaker has to put in some extra effort. The means to do this are primarily temporal. The speakers lengthen the focused word much more than when reading-aloud, and insert pauses more frequently.

f_0 adjustments, in contrast, are more restricted. This most reasonably can be explained by more constraints on f_0 than duration. A focused word already has a high f_0 peak and given the range over which f_0 can vary, an additional increase should be restricted. However, the different patterns in the dialogue (with a decrease in f_0 peak values in two of the words) and the reading experiment (with positive changes) cannot be explained on the basis of the data presented. It may be that the speakers in the dialogue start out from a higher level and therefore are less apt to change f_0 any further. However, as the speakers in the dialogue were not the same as in the reading experiment, this assumption cannot be checked against data.

The dialogue data, finally, point towards a possible trading relationship between f_0 and duration; f_0 tends to decrease, when word durations and pause insertions increase.

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