

LISTENERS' USE OF THE 'INFORMATION-ACCENTUATION' INTERDEPENDENCE IN PROCESSING IMPLICIT AND EXPLICIT REFERENCES

Wilma van Donselaar
e-mail:donselaa@mpi.nl
Max-Planck-Institute for Psycholinguistics
Wundtlaan 1,
6525 XD Nijmegen
THE NETHERLANDS

ABSTRACT

As 'new' words are usually accented and 'given' words unaccented, listeners may use de-accentuation as a cue referring to earlier given information. An auditory verification experiment was carried out to investigate whether listeners benefit from de-accentuation in solving anaphoric references during sentence processing. Both implicit, synonymous and explicit, identical referring expressions were investigated. The results of the experiment showed that unaccented synonyms were verified significantly faster than accented synonyms. However, latencies showed no difference between the verification of accented and unaccented identical words. This suggests that de-accentuation of referring expressions may be more important to listeners in solving more implicit anaphoric references than in solving explicit ones.

1. INTRODUCTION

Previous studies on speech production and perception have shown that the distribution of accents over sentences and the distinction between 'given' and 'new' information are strongly connected. Speakers generally accent 'new' words and de-accent 'given' words [1]. Listeners rate 'new' accented words and 'given' unaccented words as more acceptable than 'new' unaccented words and 'given' accented words [2]. 'New' words are also processed faster if they are accented, while 'given' words are generally processed faster if they are not accented [3].

In order to answer the question whether there are circumstances that change listeners' dependence on the information-accentuation correspondence, Van Donselaar and Lentz [4] carried out a number of experiments in which they varied the segmental quality of speech. In general, when the speech

signal is degraded, prosodic information is preserved better than segmental information, and listeners tend to rely more on prosodic cues to interpret the signal than when the quality of speech is high. Van Donselaar and Lentz found that listeners depend increasingly on the interdependence between information and accentuation, as speech becomes less intelligible.

In these experiments, the advantage of de-accentuation for 'given' words was less marked than the advantage of accentuation for 'new' words. In other words, the difference in results between 'new' accented and 'new' unaccented words was much larger than the difference between 'given' accented and 'given' unaccented information. This asymmetry was also found in the experiments by Nooteboom and collaborators [1,2,3]. It leaves us with the question whether there are circumstances that induce listeners to make more optimal use of de-accentuation. In the experiments referred to above, words were considered 'given' if they merely repeated words that had been mentioned shortly before. It is quite likely that listeners depend more on de-accentuation if the anaphoric relationship between a word and its discourse context is less straightforward.

In order to verify this hypothesis, an auditory verification experiment was carried out in which both implicit and explicit anaphoric references were investigated. In the experiment, trials of three sentences each were used. Subjects had to verify the information in the third sentence of each trial by comparing its contents with the contents of the immediately preceding sentences. Thus, the example of sentence verification in the visual domain was followed. It was predicted that both types of referring expressions would be verified faster if unaccented than if accented, but the effect of de-accentuation was also expected to be stronger for implicit references than for explicit ones.

2. METHOD

2.1 Material

Explicit referring expressions were realised as a repetition of lexically identical words (e.g., vagabond-vagabond), whereas implicit referring expressions were realised as synonyms (e.g., tramp-vagabond). Synonyms were chosen because their syntactic, semantic and morphological properties can be constructed similar to those of identical words.

Table 1. Design of a set of materials. Stimulus (test) words are in bold.

-
1. The multimillionaire bought a surprise for his wife.
 - 2a. He gave her a *boat*. (stimulus word)
 - 2b. He gave her a *ship*. (synonym)
 - 2c. He gave her a *mink*. (unrelated word)
 - 3a. The wife UNEXPECTEDLY got a **BOAT**.
 - 3b. The wife UNEXPECTEDLY got a **boat**.
-

Table 1 gives an English design of materials. Dutch material was used in the experiment. A stimulus word appeared as the last word of the third sentence in each trial, either accented or not. If the second sentence contained a word that was identical to the stimulus word, the stimulus word was 'given/identical'. If the second sentence contained a synonym of the stimulus word, the stimulus word was 'given/synonymous'. If the second sentence did not contain a word that was either identical or synonymous to the stimulus word, the stimulus word was 'new'. Eighteen sets of stimuli were used, as well as eighteen filler sets.

All sentences were read by an experienced phonetician, recorded on a DAT recorder (Sony DTC1000ES) in a professional studio. The accents were realised as so-called 'pointed hats'. The utterances were digitized with a sampling frequency of 10 kHz (and filtered at a frequency of approximately 5 kHz). Pitch contours were checked afterwards by means of an automatic pitch extraction program.

2.2 Procedure

Sixty listeners were tested individually in a sound-treated booth. All subjects received written instructions. The contents of the last sentence of each trial had to be verified as either 'true' or 'false'. It was emphasized that these last sentences need not be exact repetitions of earlier information. Decisions had to be made as rapidly as possible, by means of pressing a button marked 'true' or 'false' on a pushbutton box. The trial structure was as follows: sentence 1, 500 ms of silence, sentence 2, 1500 ms of silence, a short warning bleep and sentence 3. The interval in between trials was 2500 ms. Latencies were measured from the onsets of stimulus words, and they were registered as missing if they exceeded 2000 ms. The experiment sessions took approximately 10 minutes.

2.3 Design

The crossed combinations of Accent and Information led to six different experimental conditions. The conditions were divided over the groups according to a Latin square. Two conditions were 'false' ('new' plus/minus accent) and the other four ('given') conditions were 'true'. The design of the experiment is best seen from the perspective of different comparisons. For each different type of information, the accented and unaccented realisations were compared. A comparison between 'new' and 'given' words was not made, however, since 'new' words were meant to be correctly verified as 'false' and 'given' words as 'true'.

A multi-level analysis was used for the (correct) verification latencies. By means of this analysis, pair-wise comparisons can be made while taking differences between individual subjects and items into account. The model employed in this experiment was in effect a model for the analysis of variance with two fixed factors (Information, Accentuation), two random factors (Subjects, Items) and a dependent variable (latency in ms). Its output consisted of estimates for each parameter specified in the model, and the standard errors of these parameter estimates. The relative magnitude of the standard error of a parameter estimate can be used as a test statistic for the accuracy of the parameter estimate itself, since the standard error of an estimate is approximately t-distributed.

3. RESULTS

Some of the tapes appeared to contain distortions in sentences with the stimulus word *boterham* (slice of bread) and this item was therefore removed from the data set. Table 2 gives the numbers of incorrect and missed responses over all experimental conditions. Listeners frequently failed to respond to conditions with 'synonymous' information. A total of 69 responses in synonymous conditions were missed or incorrect (20%). Apparently, the subjects did not immediately consider all word pairs to be true synonyms.

Table 2. Numbers of incorrect and missed responses over all stimuli minus 'boterham'

condition	incorrect	missed
new +accent	3	10
new -accent	9	13
synonymous +accent	18	18
synonymous -accent	20	13
identical +accent	5	9
identical -accent	11	4

It was therefore decided to discard four items to which subjects frequently failed to respond (correctly). After this selection of items, listeners still missed a total of 31 responses overall (4%), and gave incorrect answers in 37 cases (5%). Eleven percent of the responses on synonyms were still missed or incorrect, this percentage equalled that of the new words (10%).

The correct decisions were analysed in terms of response latencies. Figure 1 gives the average verification latencies. The verification latencies for accented and unaccented realisations of 'new' (unrelated) information are compared first. Figure 1 shows that accented 'new' words were verified faster than unaccented 'new' words, but the difference between accented and unaccented realisations (41 ms) failed to reach significance (at a one-sided $\alpha=.05$). The absence of a significant effect of accentuation for 'new' words needs to be explained since prior research indicated that accented 'new' information is processed faster than unaccented 'new'

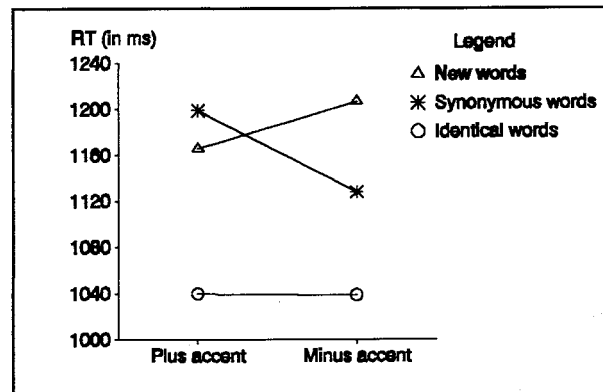


Figure 1. Average verification latencies as a function of Information and Accent.

information. One explanation would be that the 'falseness' of 'new' information confused the listeners in this task, and that, consequently, no significant effect of accent was found. Another explanation would be that the 'flat hat' intonation patterns of the sentences did not really help listeners to anticipate upcoming accents. Terken and Nootboom [4] noticed in their experiments that the gain due to appropriate (de-)accentuation was much greater for words in predicate position than in subject position. They explained this difference in terms of preceding intonation contours. They suggested that the facilitative effect of (de-)accentuation becomes more apparent if, at an early stage, the listener can deduce from the preceding intonation contour that a word is going to be (de-)accented. The 'flat hat' contours used in the present experiment made it hard to predict whether words would be accented or not. Thus, the effect of accentuation was probably not as strong as it might have been otherwise.

The second and third comparisons are of main interest and concern the realisation of the two types of 'given' information. It was expected that both 'identical' and 'synonymous' words would be verified faster if de-accented than if accented. The advantage of de-accented words over accented words was also predicted to be much stronger for 'synonymous' than for 'identical' information. Figure 1 shows that unaccented synonyms were indeed verified faster than accented ones. This difference (71 ms) was significant in the analysis ($p<.03$). No difference

was found between the verification of accented and unaccented 'identical' words. This finding matched earlier results by Franssen [5]. Following Terken and Nootboom [3], Franssen carried out a combined auditory/visual verification task. His results indicated that 'given' information was more difficult to verify than 'new' information, which confirmed earlier results by Hornby [6], but that there was no effect of accentuation. Neither higher percentages of correct responses, nor different reaction times were found for accented 'given' information as compared to unaccented 'given' information. Finally, a comparison is made between the verification of 'synonymous' and 'identical' information. It took listeners significantly longer to verify 'synonymous' words than 'identical' words. This outcome is in line with results by McKoon and Ratcliff ([7] e.g., burglar-criminal) in the visual domain.

4. GENERAL DISCUSSION

The main aim of the present experiment was to examine whether listeners' use of de-accentuation is stronger for implicit than for explicit anaphoric references. The verification results indicated that unaccented synonyms were indeed verified significantly faster than accented synonyms and that there was no difference between the verification of accented and unaccented identical words.

The absence of an effect of de-accentuation for identically 'given' words plainly confirmed earlier results for 'given' information by Franssen [5], but deviated from earlier findings by Fowler and Housum [8]. Fowler and Housum claimed that listeners can use the perceived reduction of a word as information that a word has been mentioned before to facilitate recall of the word's prior context. Counter-evidence for this claim came from Bard, Cooper, Kowto and Brew [9]. They replicated and extended the experiment by Fowler and Housum. Bard et al. found similar durational differences between 'new' and 'given' words, but failed to achieve the same results in the verification task. It was already mentioned above that Terken and Nootboom [2] did find significant differences between accented and unaccented realisations of identical, 'given' words in predicate position, but not in grammatical subject position. Apparently, the use of prosodic cues in processing information varies.

The present finding suggests that the more the relation between new tokens and the words they refer to is attenuated, the more important the function of de-accentuation is likely to be.

ACKNOWLEDGMENT

This research was carried out at the Institute for Language and Speech of Utrecht University, the Netherlands.

REFERENCES

- [1] Nootboom, S.G. and Terken, J.M.B. What makes speakers omit pitch accents? An experiment. *Phonetica*, 1982, 317-366.
- [2] Nootboom, S.G. and Kruyt, J.G. Accent, focus distribution and the perceived distribution of Given and New information: An experiment. *Journal of the Acoustical Society of America*, 1987, 1512-1524.
- [3] Terken, J.M.B. and Nootboom, S.G. Opposite effects of accentuation and deaccentuation on verification latencies for 'given' and 'new' information. *Language and Cognitive Processes*, 1987, 145-163.
- [4] Donselaar, W. van & Lentz, J. The function of sentence accents and given/new information in speech processing: Different strategies for normal-hearing and hearing-impaired listeners? *Language and Speech*, 1994, 375-391.
- [5] Franssen, J. On the influence of intonational accent on the verification of spoken accent. Dissertation/Internal report IPO, Eindhoven 1992.
- [6] Hornby, P.A. Surface structure and presupposition. *Journal of Verbal Learning and Verbal Behavior*, 1974, 530-538.
- [7] McKoon, G. and Ratcliff, R. The comprehension processes and memory structures involved in anaphoric reference. *Journal of Verbal Learning and Verbal Behaviour*, 1980, 668-682.
- [8] Fowler, C.A. and Housum, J. Talkers' signaling of 'new' and 'old' words in speech and listeners' perception and use of the distinction. *Journal of Memory and Language*, 1987, 489-504.
- [9] Bard, E.G., Cooper, L., Kowto, J. and Brew, C. *Psycholinguistic studies on incremental recognition of speech*. DYANA Deliverable R1.3B, University of Edinburgh 1991.