

SUFFIXES AS DEEP STRUCTURE CLUES

by

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Recent work on sentence recognition suggests that listeners use their knowledge of the language to directly infer deep structure syntactic relations from surface structure markers. Suffixes may be such clues, especially in agglutinative languages.

A cross-language (Dutch-Finnish) experiment is reported, designed to investigate whether the suffix structure of Finnish words (as opposed to suffixless Dutch words) can facilitate prompted recall of sentences in case these suffixes differentiate between possible deep structures. The experiment, in which 80 subjects recall sentences at the occasion of prompt words, gives only slight confirmatory evidence. Meanwhile, another prompted recall effect (Blumenthal's) could not be replicated.

Transformational grammarians describe sentence structure on two distinct levels. On the one hand they assign to a sentence a surface structure, which determines the phonetic shape of the sentence. On the other hand a deep structure is assigned which incorporates all syntactic information that is necessary for a full semantic interpretation of the sentence. Relational notions as "subject of", "direct object of", are all defined over deep structure elements. The intricate relationships between deep and surface structures are stated in terms of transformations, grammatical rules that map deep structures onto surface structures (see, for instance, Chomsky 1965).

A THEORY OF SENTENCE RECOGNITION

No modern theory of sentence perception can avoid these notions. They have to account for the fact that the listener arrives at a certain interpretation on the basis of a certain phonetic event. But this phonetic form in itself generally does not contain in any explicit way (i.e. by order or segmentation) the information about semantically important relations between the parts of the sentence. Therefore the listener has to use his

knowledge of the transformational structure of his language to decode the sentence.

One can think of several ways in which this knowledge is employed in sentence processing. In fact, two main types of theory have dominated the psycho-linguistic scene of the past ten years. The original and most elaborate theory holds that the listener decodes the sentence by paralleling each grammatical transformation by a certain psychological process. Initially one thought of a series of de-transformations, each de-transformation "undoing" one grammatical transformation. In this way the surface structure was step-wise reduced in order to yield the underlying or deep structure. Another version of this theory, analysis-by-synthesis, had the listener generate successive approximations to the input sentence by a set of operations which were linked in a one-to-one way to grammatical rules. Both versions of the theory imply that the psychological complexity of a sentence is a function of type and number of rules applied in the grammatical generation of the sentence. This is what Fodor and Garrett (1967) call the derivational theory of complexity (DTC).

A second more recent type of theory was proposed by Fodor and Garrett (1967) and Levelt (1967). In its most general form it says that the knowledge of his language makes it possible for the listener to *directly* infer deep structure relations from surface structure clues. Levelt's example is the hearer catching the word *persuade* while listening to a sentence. The mere occurrence of this word is sufficient to infer a deep structure where there is a human object that is persuaded by a subject of something. Transformational grammar assigns *persuade* a lexical structure that prevents it from appearing in any other deep structure. The existence of the phonetic shape [persuade] is therefore (nonsense not taken into consideration) sufficient to decide that the deep structure under concern did exist in the mind of the speaker.

Fodor, Bever and Garrett (1967, 1968) already accumulated considerable evidence for the superiority of this latter theory. Their first accomplishment was to show that it gave a better account of sentence complexity than DTC, but they also added some elegant detective work to find out what surface structure clues were used for the determination of deep structure. Though lexical verb structure turns out to be important indeed, other markers may also be effective. Fodor et al. experimented with pro-

nouns and mentioned the possible importance of the lexical structure of nouns and adjectives.

The present study was designed to investigate the role of suffixes as possible guides to deep structure. In contrast to languages like English and Dutch, agglutinative languages like Finnish show an abundance of syntactical information in the suffix structure of the sentence. Part of this information is directly related to the deep structure functions of the different sentence parts. Take, for instance, the sentence

(1a) *the dog has bitten,*

where *the dog* is subject of the sentence. The Finnish translation is

koira on purrut

Now compare

(1b) *the dog has been bitten*

where *the dog* is object. In Finnish, this information is expressed in the suffix structure:

koiraa on purtu

Any native speaker of Finnish doubtlessly attends to affixes like these in order to determine the underlying relations between the elements of the sentence.

A more interesting example is the sentence

(2a) *the shopgirl is too ugly to seduce [anybody]¹,*

where *the shopgirl* is subject. The Finnish for this sentence is

myyjätär on liian ruma viettelemään

Now compare

(2b) *the shopgirl is too ugly [for anybody] to seduce*

The Finnish translation of this "passive" form is

myyjätär on liian ruma vieteltäväksi

For Finnish the only difference between (2a) and (2b) resides in the verb affix structure. While listening to a sentence like this, the hearer who has no further data can only decide on the deep structure on the basis of the

1. It seems that in English the object of *seduce* is not deletable. The brackets are added in order to indicate that these parts are not translated into Finnish and Dutch, where object (and subject) deletion is possible.

information carried in the very tail of the sentence. What makes the sentence especially interesting is that the Dutch translations of (2a) and (2b) are homonyms:

de verkoopster is te lelijk om te verleiden

That is, this sentence is deep structure ambiguous. For the Dutch listener disambiguation by context is the only way out.

Such ambiguity does not arise for the Dutch equivalents of (1a) and (1b). They are:

de hond heeft gebeten

and

de hond is gebeten

respectively. The auxiliary is the "disambiguating element": in contrast to Finnish, verb and noun structure keep unchanged.

PROMPTED RECALL OF SENTENCES

The present experiment is on prompted sentence retrieval. Starting from the above theoretical considerations the assumption is made that the listener while processing the sentence uses surface markers (clues) to determine the underlying structure. If he is, moreover, requested to memorize the sentence, he will — under certain general conditions of time and motivation — do this in terms of the deep structure relations that he has found by his decoding. This assumption is sometimes called the *coding hypothesis*. A hypothesis it is: one may think of sentence recall in alternative ways. The subject might code the sentence in terms of surface structure segments (Johnson, 1965) or as just a concatenation of words. But assuming the coding hypothesis to be correct, the following can be hypothesized about sentence recall.

The subject can be asked to reproduce the sentence at the occasion of a certain prompt word. The prompt word can be selected from the sentence in view of its syntactic structure. The *effectiveness of such a prompt word should be predictable from the information it carries about the structure it is to retrieve*. For instance the Finnish *purtu* (has been *bitten*) may be effective as a prompt for (1b), because it informs the experimental subject that he has to look for an *object of bite* in his memory in order to reconstruct the "surface *subject*" of the sentence. In the Dutch case no

such guiding information is carried by *gebeten*, this word does not tell which of the two kinds of deep structure relations has to be scanned in the memory code. Therefore, *purtu* should be a more effective prompt than *gebeten*. Notice that if the memory code is in terms of surface segmentation or simple concatenation this prediction has to fail. Let us call this theory of prompted recall and more generally the corresponding new theory of sentence perception, *the deep structure clue theory* (DSC-theory).

Blumenthal's experiments

The distinction between surface level and deep (relational) level was the target of Blumenthal's prompted recall experiments (Blumenthal, 1967; Blumenthal & Boakes, 1967). Blumenthal's purpose was to demonstrate this distinction experimentally. He shows, for instance, that the word *John* is a more effective prompt for the sentence

(3a) *John is eager to please*

than for

(3b) *John is easy to please*

and explains this from the fact that *John* is involved in different relations in each sentence. In (3a) *John* is subject of the main sentence (*John is eager for to S*), and also of the *for* -complement (*John pleases someone*). In (3b) *John* is only object of the *for to*-complement (*someone pleases John*). According to the clue theory, however, effectiveness is determined by the deep structure information the prompt element carries. Of course, this does not exclude the possibility that the prompt effectiveness is also dependent on the type of deep relations in which the element is involved. The effectiveness can be a combined function of the prompt's deep structure information and its deep structure role. But it should be noted that the deep structure clue theory alone would not predict Blumenthal's above findings; the form *John* does not differentiate between (3a) and (3b). The question is whether this *should* be predicted. These considerations, namely, led to a scrutiny of Blumenthal's experimental procedure.

In order to test his hypothesis, Blumenthal used two groups of sentences. The first group consisted of sentences of the type (3a), e.g. *children are anxious to play*, the second set contained ten (3b)-type sentences,

e.g. *Rome is fun to visit*. The sentences were preceded by a two-sentence context, in order to stimulate deep structure processing. Each sentence was paraphrased by the subject after it was read, and also repeated verbatim. Then, the whole series of 20 sentences was read and repeated two more times, after which the subject was asked for a free recall of as many of the sentences as possible. The free recall was followed by the prompting session: nouns being the prompt words (in one case), e.g. *children*, *Rome*, etc. Prompt effectiveness was measured by the difference between the number of prompted sentences of a given type and the number of free recalled sentences of that type. Blumenthal found that the nouns were more effective prompts for (3a)-type sentences than for (3b)-types ones. The same procedure was used for testing various other grammatical structures.

The problem with this procedure is that prompting differences that may turn up can be attributed to *any* difference between the sentences in the two groups, not exclusively to deep structure differences. For instance, *children* might be an effective prompt for *children are anxious to play* because strong associations between *children* and *play* exist in the mind of the native speaker of English. If so, *children* would also be an effective prompt for *children are fun to play with*, where *children* is object, i.e. this would be independent of deep structure relations holding between the words of the sentence. Though nothing especially indicates that this is the case in Blumenthal's experiments, such explanations are not excluded by his experimental paradigm. The use of *different* sentences in the two groups always leaves the possibility to attribute prompting differences to any superficial or fundamental difference between the sentences, whatsoever. Such differences can be systematic by the fact that all sentences are constructed by the same experimenter who generated the hypothesis to be tested. So, at present, it is not necessary to accept Blumenthal's view of prompted recall on the mere basis of his experimental findings. On the other hand, his accumulated data are at least suggestive and his theory looks attractive. It makes sense, therefore, to look for an experimental way out.

Hypotheses

The solution may exist in using two groups of sentences that are homo-

nyms, i.e. sentences that are deep structure ambiguous, like the Dutch version of (2), *de verkoopster is te lelijk om te verleiden*. The effectiveness of *de verkoopster* (*the shopgirl*) as a prompt should be dependent on the way the sentence has been coded by the subject. If the shopgirl is understood to be the one who seduces, *de verkoopster* should be a more effective prompt than if it is taken as the object of seduction. The particular interpretation of the sentence can be induced experimentally by first presenting a disambiguating context. This may consist of two sentences, just as in Blumenthal's experiments. The DSC-theory alone does not predict any difference in prompting in these cases and similarly if *verleiden* (seduce) is taken as a prompt. From Blumenthal's point of view, however, a difference in the noun prompting case might be expected. This is at least so for one interpretation of Blumenthal's results. We have noted above that Blumenthal intended to demonstrate that prompt effectiveness is also dependent on the deep relations in which the prompt word is involved. For his sentence types (*John is eager/easy to please*) the most striking difference is *John's* role of either subject or object of *please*. If this is the relevant variable, a difference should be expected for the noun prompting case of our *shopgirl-type* sentences. *Shopgirl*, namely, is either subject or object of *seduce*. There is, however, an alternative interpretation² of Blumenthal's findings to which we will return in the Discussion. Our present argument is based on the assumption that the relevant variable in Blumenthal's experiment is the subject versus object role of the prompt word. From this point of view we would expect a similar effect for the noun prompting in our *shopgirl-type* sentences.

The DSC-theory, on the other hand, will make a cross-language prediction which cannot be made from the Blumenthal-effect alone. In Finnish, *seduce* (see 2a) would be more effective than in Dutch, for because of its suffix structure in Finnish it is more informative of deep structure relations than in Dutch. This, however, is not the case for *shopgirl* which, both in Finnish and Dutch, does not differentiate between the two possible deep structures. On the basis of the DSC-theory alone, therefore, the following predictions can be made:

- (i) the noun phrase (*the shopgirl*) should be equally effective as a prompt

2. This was pointed out to me by Dr. Edward Walker.

for the two sentence structures, in Finnish as well as in Dutch,

(ii) the same should hold for the verb (*seduce*),

(iii) for both structures the verb (*seduce*) will be more effective in Finnish than in Dutch,

(iv) this will not be true for the noun phrase (*the shopgirl*).

A further test of the deep structure clue theory can be made by prompted recall of sentences of types (1a, b), i.e. *the dog has (been) bitten*. Just as for the *shopgirl-sentences* DSC-theory does not predict the Blumenthal-effect, i.e.,

(v) the noun phrase (*the dog*) would be equally effective as a prompt for structures (1a) and (1b), in Finnish as well as in Dutch,

(vi) the same should hold for the verb *bitten*.

In this case, however, a definite cross language difference can be predicted from DSC-theory. The verb (*bitten*), but also the noun phrase (*the dog*) differs in suffix form when used in Finnish structures (1a) and (1b), respectively. In Dutch, however, no such difference exists. Therefore,

(vii) the noun phrase (*the dog*) will be a more effective prompt in Finnish than in Dutch,

(viii) the same should hold for the verb (*bitten*).

The hypotheses (i) through (viii) are exemplified in terms of two illustrative sentences. The present experiment is designed to test them over a large group of such sentences.

THE EXPERIMENT

Sentence material

Two sets of sentences were designed. The first set consisted of the *shopgirl-type*, the second set contained dog-type sentences. The construction of the *shopgirl-set* gave special problems, for in Dutch, such sentences are deep structure ambiguous. In order to avoid sentences that show extreme dominance of one of their meanings, we carried out the following procedure. Twenty ambiguous Dutch sentences were constructed, and read one by one to a group of 136 undergraduate students of psychology. They were instructed to immediately write down a paraphrase of the sentence that was read. It was stressed that they had to paraphrase their first interpretation of the sentence. The paraphrases were scored as *subject* in case the noun phrase was taken to be the underlying

subject of the sentence, as *object* in case it was taken to be the logical object, and as *doubtful*, if neither of the former cases could be decided on from the paraphrase. In the worst case 19 subjects were doubtful for a certain sentence, the mean, however, was 7.5. For the doubtless cases the percentage of *subject*-interpretations was determined for each sentence. This ranged from 10.8 to 92.0 %. In that stage one of the very equilibrinous sentences (48.8 %) had to be discarded because it was untranslatable into Finnish³. Finally, the ten most equilibrinous sentences were taken as test sentences. They ranged from 25.4 to 77.8 %, with a mean of 49.1 % (see Appendix A): on the average the chances of subject- and object interpretation are about equal. For each of the ten sentences the two Finnish translations were made. This resulted in ten subject-type and ten object-type Finnish sentences (Appendix A).

The dog-set of sentences gave less problems. Sentence pairs (*the dog has (been) bitten*) were constructed both in Finnish and Dutch⁴ and checked on their translatability into the other language. Adverbs were added to the sentences (*the dog has been badly bitten*), to make them sound more natural. Calling a sentence a subject- or object-type sentence according to the grammatical function of the noun phrase (*the dog*), ten subject-type and ten corresponding object-type sentences were created and translated. In all sentence construction it has been a working principle that nouns, verbs, adjectives, and adverbs could only be used once. This can be seen from Appendix A, where all test sentences are given.

Next, all sentences were provided with a context. In full analogy to Blumenthal's experiments each test sentence was preceded by two other sentences that could facilitate the interpretation, this in order to obtain deep structure processing. This was especially important for the ambiguous Dutch *shopgirl*-sentences; the verbal context should disambiguate the test sentences, i.e. two contexts had to be invented for each of the ambiguous sentences. The contexts were also translated, they are shown in Appendix A. Again the contexts did not have content words from their corresponding test sentences.

3. The sentence was *de scholieren zijn te jong om te ontgroenen* (*the pupils are too young to (be) initiate(d)*). These anachronistic initiation rites do not take place at Finnish universities.
4. The first author is a native speaker of Dutch, the second author a native speaker of Finnish (she also ran the Finnish experiment).

Design

Each subject would get 20 test sentences, 10 from the *shopgirl-set* and ten from the *dog-set*. Of the 10 *shopgirl-sentences* 5 should be of the subject-type (the shopgirl seduces) and 5 of the object-type (the shopgirl is seduced), and similarly for the 10 *dog-sentences* (dog bites, dog is bitten). Moreover, a sentence that had been presented as a subject-type sentence should not be presented in its object form to the same subject. Therefore, the *shopgirl-set* (Sl) was divided in two subsets of 5 sentences (Sl1 and Sl2). The chance of a subject-interpretation for the Dutch sentences was on the average 48.2 and 50 %, respectively. Similarly, the set of dog-type sentences was split in two subsets (Dg1 and Dg2). A subject, then, got *either* the Sl1 and Dg1 sentences in their subject (S) form and the Sl2 and Dg2 sentences in their object (O) form, *or* the Sl1 and Dg1 sentences in their O-form and the Sl2 and Dg2 sentences in S-form. It was thus necessary to divide both the Finnish and Dutch group of 40 subjects in two subgroups of 20. Let us call these subgroups F1 and F2, D2 and Do, respectively. The final design is presented in Table 1.

Table 1. *Experimental design*

	Finnish subjects (N = 40)		Dutch subjects (N = 40)	
	F1 (n = 20)	F2 (n = 20)	D1 (n = 20)	D2 (n = 20)
Sentence types:				
<i>Shopgirl-type</i>				
Sl ₁ (5 sentences)	S	O	S	O
Sl ₂ („ „)	O	S	O	S
<hr/>				
<i>Dog-type</i>				
Dg ₁ (5 sentences)	S	O	S	O
Dg ₂ („ „)	O	S	O	S

S = subject form of sentences

O = object form of sentences

Subjects

The experiment was first run in Finland. The 40 Finnish subjects were university students, but psychology and language students had been excluded. Mean age was 21.6, ranging from 19 to 28. The 18 female and 22 male students were divided evenly over F1 and F2.

The Dutch group of 40 university students was matched as well as possible to the Finnish group. Psychology and language students were again excluded. Mean age was 21.4, ranging from 18 to 24. Both D1 and D2 had 9 female and 11 male subjects. Subjects were paid \$1.20 for their services.

Procedure

Each subject was tested individually. Except for the instruction everything said was tape-recorded. The procedure was analogous to Blumenthal's: in the learning phase the experimenter (female native speakers of Finnish and Dutch, respectively) read in a natural, but not expressive voice, and in computer-generated random order the twenty sentences, preceded by their contexts. The subject was instructed to memorize the sentences. After each sentence the subject gave a short paraphrase and then repeated the sentence verbatim. The experimenter checked whether the sentence had been understood correctly (especially important for the ambiguous cases), and if not, E repeated context plus sentence and asked for a new paraphrase. If only the verbatim reproduction was wrong, the subject was asked to correct it, and if he did not succeed, the sentence was repeated. The paraphrase series was followed by presentation of the same 20 sentences without contexts, in a new random order. The subject had to repeat each sentence immediately after presentation. This was repeated once more in another random order.

After this learning phase the recall phase started. The subject was requested to reproduce as many sentences as he could remember. Special stress was placed on verbatim reproduction. This free recall lasted three minutes, which turned out to be sufficiently long: most subjects stopped reproduction long before their time was up.

Then prompted recall started. The 20 noun phrases from the test sentences (i.e. in Dutch including the article) were pronounced one by one in random order and the subject tried to reproduce the sentence under concern. He was allowed 10 sec. at maximum for his reproduction. If he finished within that time the next prompt was presented immediately.

Finally, the 20 verbs were given as prompt words, also in a random order. Only this latter phase deviates from Blumenthal's procedure. Blumenthal never applied two prompting phases to one subject. In our pro-

cedure the risk is taken that sentences correctly reproduced in the first prompting phase are strengthened in memory by that fact alone. If this is the case, eventual effects in the second prompting phase may be spurious. We will have to consider this point in the discussion of results.

Scoring

Each recall was scored + or — . A plus score was obtained for verbatim reproduction and also when minor errors were made. Minor errors were:

- (a) a change in tense from present to past in the *shopgirl*-type sentences
- (b) disappearance or change of adverb or change of adverb-position in the *dog*-type sentences (remember that the adverb had only been added to increase the naturalness of the sentences, it plays no syntactic role of any importance with respect to our hypotheses)

In all other cases a minus was scored. These criteria are slightly more liberal than Blumenthal's.

For each of the three recall runs the number of plusses was counted within each of the four subgroups of 5 sentences (Sl1,2, Dg1,2). Of course these numbers could range from 0 to 5. This makes 12 scores for a subject. The 80 x 12 scores of all subjects are presented in Appendix B.

From these data we computed weighted scores. A weighted score is the prompt score minus the free recall score for a certain sentence type. Weighted scores, therefore, can range from +5 to —5. These weighted scores are direct measures of prompt effectiveness, they are the *extra* number of sentences reproduced by means of prompting. By using weighted scores Dutch and Finnish data become comparable. Weighted scores were computed for both noun and verb prompting.

RESULTS AND CONCLUSIONS

For the noun phrase prompting each of the 80 subjects got 4 weighted scores: 2 for the *shopgirl*-type sentences, and 2 for the *dog*-type ones. Similarly 4 x 80 scores were obtained for the verb prompting results. For these two sets of 320 scores planned comparisons were run for each of the specific predictions in the hypotheses (i) through (viii). The estimated variances for the comparisons were computed from the appropriate error terms, obtained in the usual analysis of variance way (fixed effects). All

levels of significance mentioned in the following discussion of results were obtained by this procedure.

The shopgirl-type sentences

The data for these sentences are summarized in Fig. 1. Effectiveness of prompting by noun phrase is shown in Fig. 1a, for verb prompting in Fig. 1b. S and O indicate that the sentence had been learned in its subject form (*the shopgirl is too ugly to seduce [anybody]*) or object form (*the shopgirl is too ugly [for anybody] to seduce*), respectively. Prompt effectiveness is expressed as the mean weighted score (number of prompted sentences minus number of free recalled sentences of the same type). The hypotheses (i) through (iv) concern the *shopgirl-type* sentences. We will now consider them one by one.

(i) The noun phrase (*the shopgirl*) should be equally effective as a prompt for the two sentence structures, in Dutch as well as in Finnish.

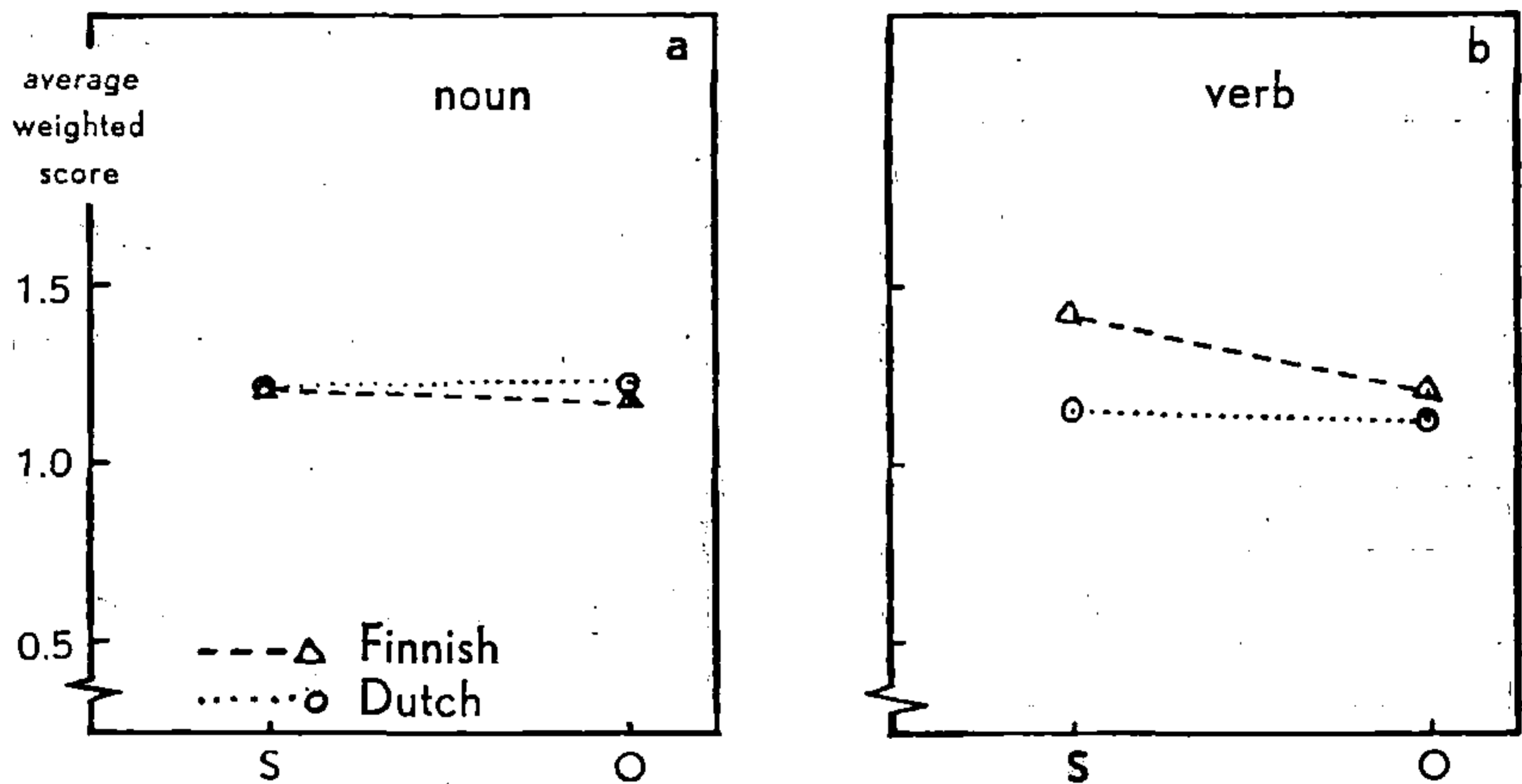


Fig. 1. *Shopgirl-type*, sentences. Average weighted scores for prompting by noun phrase (Fig. 1a), and for prompting by verb (Fig. 1b). S and O: subject and object form of the sentence, respectively.

It is immediately clear from Fig. 1a that for both Finnish and Dutch the noun phrase is as effective as a prompt in the S and O cases, i.e. independent of its deep structure role (subject or object) in the sentence. Therefore, by using ambiguous sentences (Dutch) or sentences that differ

by only one suffix (Finnish) we could not confirm Blumenthal's results. The prompting procedure has been identical to Blumenthal's and the n on which the Fig. 1a data are based is the same as Blumenthal's. The mere subject/object distinction in itself is apparently not sufficient to explain the Blumenthal-effect. It should be noted, however, that the sentence type in our experiment differs from Blumenthal's *John is eager/easy to please*. We will return to this point in the Discussion.

(ii) The verb (*seduce*) should also be equally effective as a prompt for the S and O sentence structures, in Dutch as well as in Finnish. (This would also be predicted by Blumenthal). Indeed no significant differences between subject- and object-type sentences turn up, as is apparent from Fig. 1b.

(iii) For both structures the verb will be more effective as a prompt word in Finnish than in Dutch.

Fig. 1b shows that the Finnish verb is more effective, both for the object- and for the subject-type sentences. This difference, however, is not significant (for the subject-sentences it reaches a marginal 12 % p-level). The average increase in weighted score is by 16 % when suffixed verb prompts are used. If such a difference holds up at all in further experimentation, a doubling of n is necessary to reach an acceptable level of significance.

(iv) The noun phrase (*the shopgirl*) will be equally effective in Finnish and in Dutch.

It is clear from Fig. 1a that in this respect the Finnish and Dutch results coincide. This is in accordance with the hypothesis.

In conclusion, then, we find evidence for those hypotheses that predict absences of differences. In the first place this means that we have not been able to replicate Blumenthal's effect, by the use of sentences that are deep structure ambiguous (Dutch) or that differ by only one suffix (Finnish). The procedure and the number of cases being identical to Blumenthal's, this negative result casts serious doubts on the subject/object interpretation of Blumenthal's results.

Secondly, the expected non-difference between Dutch and Finnish noun prompting was confirmed. This had been predicted from the fact that the Finnish and the Dutch nouns were equally a-specific as to the two possible underlying structures. However, the counterpart of this prediction, a de-

finite larger effectiveness of the Finnish verb as a prompt because of its differentiating between subject- and object-type sentences (as opposed to the Dutch verb) was not substantiated significantly. The result is in the expected direction, but further experimentation is needed before it can be sustained with confidence that people do use the suffix information in these cases.

One additional remark has to be made. It should be remembered that the verb prompting session followed noun phrase prompting, so that verb prompting effects might be a result of the previous prompting session, and therefore be spurious. However this cannot have had any systematic effect on the results of the verb prompting of the *shopgirl* sentences, because there was no difference in prompt effectiveness between any of the noun prompting conditions (see Fig. 1a).

The dog-type sentences

The hypotheses (v) through (viii) concern the dog-type sentences.

(v) The noun phrase (*the dog*) will be equally effective as a prompt for structures (1a) and (1b), both in Finnish and in Dutch.

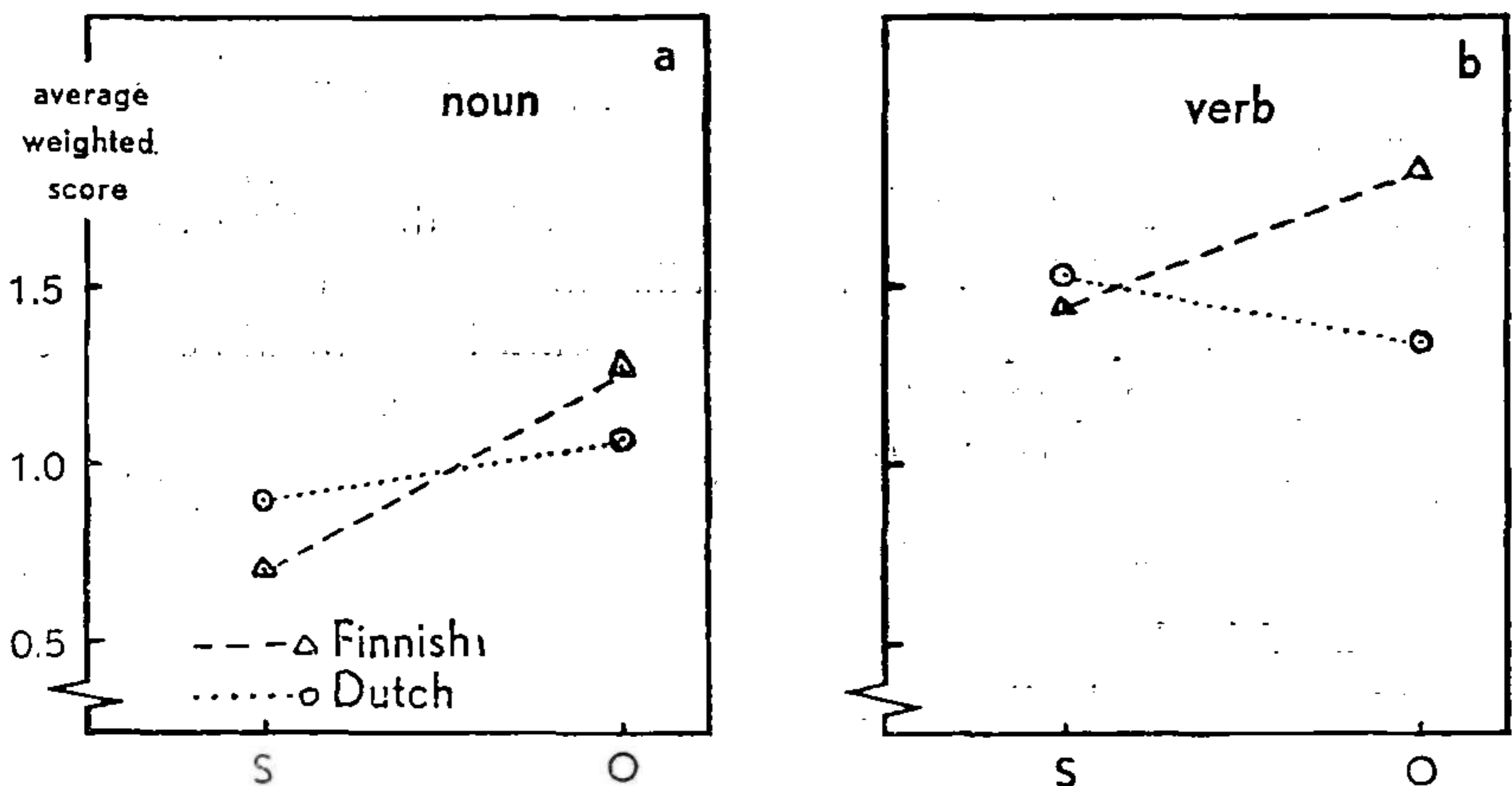


Fig. 2 *Dog-type* sentences. Average weighted scores for prompting by noun phrase (Fig. 2a), and for prompting by verb (Fig. 2b). S and O: subject and object form of the sentence, respectively.

Fig. 2a shows that this hypothesis is not supported. In both languages the object prompt is more effective than the subject prompt ($p < .02$), and stronger so in Finnish than in Dutch. This is the Blumenthal-effect in reverse.

Neither Blumenthal's, nor the deep structure clue theory explains this finding. The latter theory, however, can in retrospect explain why this reverse effect is stronger in Finnish than in Dutch. In Finnish there may have been an unforeseen interaction between the *shopgirl* and the *dog*-type sentences. The subjects, namely, had learned *mixed* lists of sentences. If the effectiveness of a prompt word is dependent on the deep structure clue it contains, then the noun phrase prompts should be very ineffective in Finnish in precisely the present case. The noun in the subject form of the *dog* sentence (*koira*) carries the same suffix structure as the noun in both forms of the *shop girl-typo*, sentences. Therefore, the listener might be confused at the presentation of *koira* and work at the retrieval of a *shopgirl-sentence*. Such a confusion, however, is impossible in the case of the object form of the *dog*-type sentence: *koiraa* is absolutely specific for that structure, it cannot enter in any of the two *shopgirl-type* sentences.

Notice that an eventual reverse interaction effect (from *dog* to *shopgirl-type* sentences) is in any case a-specific: though the Finnish *shopgirl* (*myyjätär*) can in principle enter the subject form of a *dog-type* sentence, it should still be equally effective as a prompt for the subject or object form of the *shopgirl-type* sentence. Similar interactions can have taken place for all Dutch prompt nouns. But such confusions will all be a-specific with respect to subject or object form of the sentence.

Another possible cause for the stronger S-O difference in Finnish may be the fact that the subject prompt is the noun stem, only the object prompt has a suffix. Though the subject and object functions are well differentiated in this way, only the object form is explicitly *marked*. It is not impossible that the listener's attention is especially drawn by marked forms.

(vi) The verb (*bitten*) should be equally effective as a prompt for structures (1a) and (1b) — subject and object form — both in Finnish and Dutch.

Fig. 2b shows that this is the case for Dutch, but not for Finnish. Again

we see that Finnish object-type sentences are prompted more easily than subject-type sentences. Though the difference is less than in the noun prompting case (and not even significant: $p < .20$, two tail) we feel that some explanation is to be looked for, the more so because this difference, if real, cannot be explained in the same way as the corresponding unexpected effect for noun prompting. The verb affix-structure is namely specific to the dog-type sentence, both in its object form and in its subject form. Neither *purrut* (*(has) bitten*), nor *purtu* (*(has been) bitten*) can enter a *shopgirl-type* sentence.

A reasonable explanation seems to be that the noun prompt effect is transmitted to the verb prompting session. That is, the mere retrieval of a sentence in the noun prompting session would increase the chance that the same sentence is correctly recalled in the verb prompting session. To investigate this possibility we checked over the protocols of the Finnish subgroup. For each subject we took the *dog-type* sentences that had been missed at the free recall session. These sentences were divided in two subgroups, namely the $n+$ sentences: those recalled at the noun prompting session, and the $n-$ sentences: those not recalled at the noun prompting session. For each subject we determined how many of the $n+$ sentences had been recalled in the verb prompting session, and similarly for the $n-$ sentences. It turned out that, summed over the 40 subjects, 86 out of 100 $n+$ sentences (86 %) were recalled correctly in the verb prompting session, but only 61 out of 115 $n-$ sentences (53 %). This difference is highly significant ($p < .001$). So, at the verb prompting session the chance of recalling a noun phrase prompted sentence (that had not been freely recalled) is higher by 33 % than the chance of recalling a sentence that had not been noun phrase prompted.

So, there is good evidence that the slope in the "curve" for Finnish in Fig. 2b is an artifact of having the verb prompting session follow the noun prompting session (see also the discussion under (viii)).

(vii) The noun phrase (*the dog*) should be a more effective prompt in Finnish than in Dutch. There is no support for this hypothesis. The evidence is in the wrong direction for subject-type sentences and in the right direction for object-type sentences. It should be noted again that the Finnish noun is affixless in its subject form. It could be that the affix information is only used if it is in marked form, i.e. if a suffix is present.

(viii) The verb (*bitten*) should be a more effective prompt in Finnish than in Dutch.

This hypothesis is supported for the object-type sentences ($p < .05$, one tail). There the Finnish verb-prompting is significantly better than the Dutch verb prompting (see Fig. 2b). The subject-type sentences do not show the expected difference between Finnish and Dutch. It is reasonable to suppose that this asymmetry is also caused by the transfer taking place from noun phrase to verb prompting session. In order to show that this would, in fact, cause most of the asymmetry, we can take the *noun phrase prompting* results as a basis for determining verb prompting effectiveness (i.e. instead of the *free recall* results). The scores computed in this way for verb prompting are presented in Fig. 3. They show the expected pattern, which is (and ought to be) very similar to that in Fig. 1a). Note that it is also in agreement with hypothesis (vii).

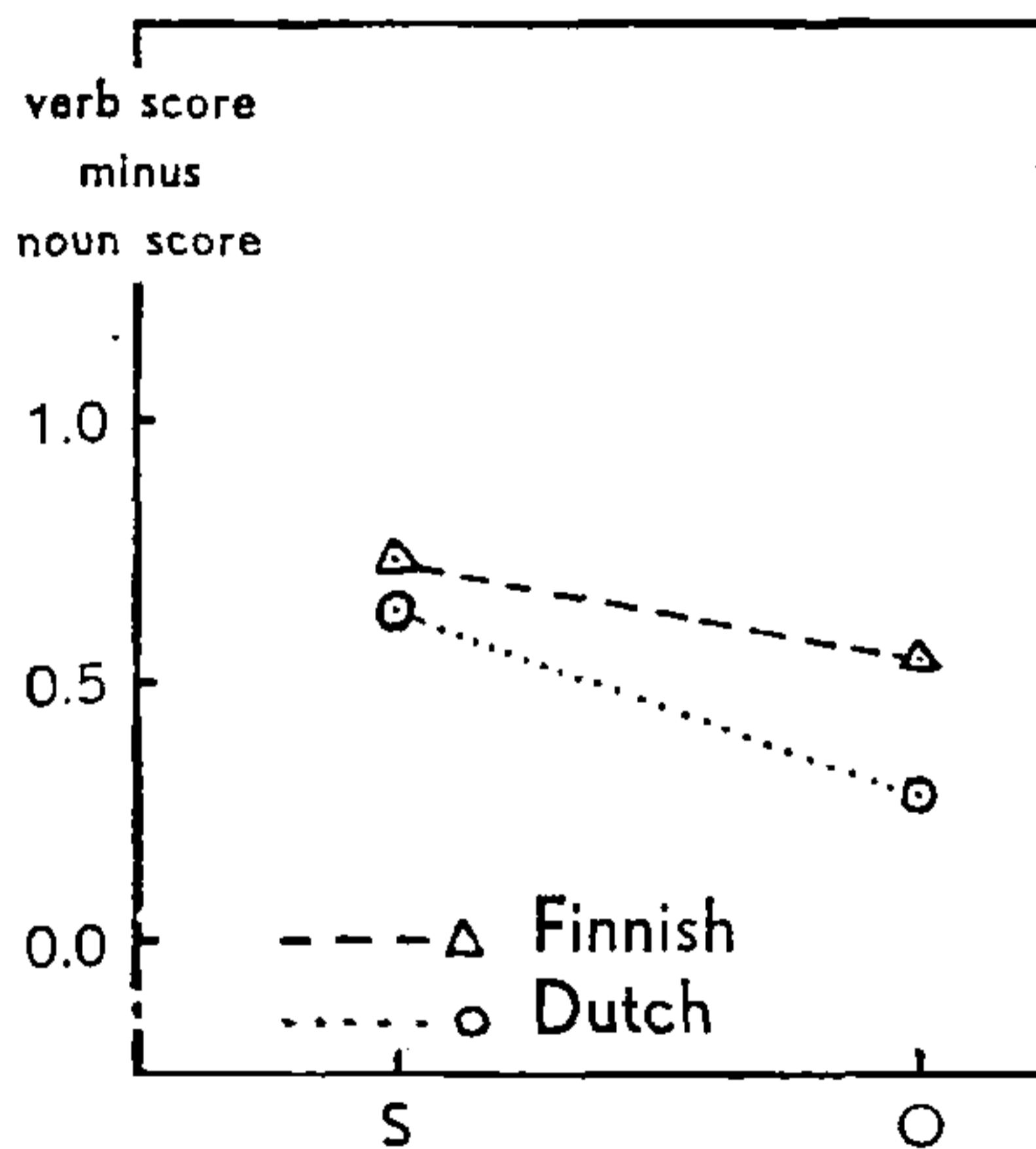


Fig. 3. *Dog-type* sentences. Verb prompting effectiveness, relative to noun prompting effectiveness.

In conclusion, the *dog-type* sentences did not give the same picture as the *shopgirl-type* sentences. The main unexpected result was the relative ineffectiveness of the Finnish noun as a prompt for the subject-type sentences. There may have been some interference between the *dog-* and *shopgirl-type* sentences: the subject noun (*dog*) also fits the two syntactic structures of the *shopgirl-type*. There is good evidence that this unex-

pected noun prompting result is, then, transferred to the verb prompting data, causing a similar asymmetry in that case. No evidence for the Blumenthal-effect could be found, nor any substantive evidence for the deep structure clue theory.

DISCUSSION

The present experiment was introduced by a discussion of some theories of sentence perception. It was shown that according to recent views the listener may be able to *directly* infer important deep structure relations from certain markers in the surface structure of the sentence. The main verb in particular may be an important clue to the underlying syntactic relations that exist between the parts of the sentence. By using his knowledge of the lexical structure of the verb, the native speaker can often decide on the deep structure conditions that have necessarily been fulfilled for that verb to appear in the sentence.

But apart from using verbs and other words, the listener can also use his knowledge of the affix structure of his language to detect deep structure properties of the sentence. In agglutinative languages like Finnish, affixes are often transformational "traces" mirroring the underlying functions of the sentence parts. This is, for instance, the only way for the Finnish hearer to differentiate between the two possible *shopgirl*-sentences.

The present experiment was only a rather indirect test of this theory of perception. Even if suffixes do not play any facilitating role in the process of prompted recall — but there is a slightly supporting tendency in the data — this theory of sentence perception would not be disconfirmed. A major difference, namely, between prompted recall and perception of sentences is that only in the former case a complete semantic interpretation has already taken place. The meaning of the prompt word itself may be completely dominant in the recovery of the semantic memory trace. The syntactic lexical aspects of the word can be relatively unimportant in this situation.

This is rather different in the sentence perception case. Syntactic processing is necessary for a full semantic understanding to occur. The syntactic lexical structure of the word can be a decisive clue so long as the semantic picture is still incomplete.

If a deep structure clue theory of sentence perception turns out to be superior to other theories, psychologists will have to face the situation that a theory of sentence perception will be specific to a language in important aspects. The syntactic differences between languages reside mainly in their transformational apparatus. But it is precisely this part of the grammar that relates deep to surface structures. In different languages, therefore, listeners are likely to use very different surface cues for the deduction of underlying relations. The Finlander may direct his attention to the affix structure, the Dutchman will be tuned to markers that are more similar to those the native speaker of English uses. Further cross-language research will be necessary to determine which aspects of human sentence processing are universal, and which aspects are specific.

We concluded that the evidence for a deep structure clue theory of prompted recall is only weak. What can be concluded with respect to Blumenthal's findings? Did we really fail to replicate, or are different factors involved in our experiment?

Blumenthal intended to show that prompt effectiveness is also dependent on the underlying relations in which the prompt word enters. For the sentence pair *John is eager/easy to please* the difference in deep relations for *John* can be summarized as follows: For the *eager*-sentence *John* is subject of main clause (*John is eager*) and of embedded clause (*John pleases someone*). For the *easy*-sentence *John* is only object of the embedded clause (*someone pleases John*). So, the relational distinction is "subject of main and embedded clause" versus "object of embedded clause". Up till now we have only considered the subject-versus-object aspect of this distinction. If this variable in itself were sufficient to obtain the prompting difference, our *shopgirl-type* sentences should have given similar results. It is namely the case that for the embedded clause of our *shopgirl-type* sentences this is the main difference (*the shopgirl seduces someone* versus *someone seduces the shopgirl*). We conclude that we could not obtain evidence for the mere subject/object interpretation of Blumenthal's findings.

There is, however, another aspect to the relational distinction between Blumenthal's sentences, namely "prompt word is part of main clause" vs. "prompt word is not part of main clause". This distinction does not hold for our *shopgirl-sentence*, because for both interpretations of this ambi-

guous sentence, *shopgirl* is subject of the main clause (*the shopgirl is too ugly*). Our findings, therefore, only refute the subject/object interpretation of Blumenthal's findings, but leave open the other possibility: main clause/not main clause position of the prompt word. So there is at least one interpretation that would be consistent with both Blumenthal's and our findings. This interpretation is, moreover, experimentally testable.

This leads us to two final methodological conclusions: Firstly, Blumenthal claims that deep relations are relevant for prompted recall. We have seen that in his experiments, the obtained effect can be attributed to *any* difference between the experimental sentences; they are therefore not conclusive. The only methodological way out is, in our opinion, the use of ambiguous sentences, where the *only* difference between sentences is at the deep relational level.

Secondly, a more explicit theory is needed about *how* relational differences affect prompting. We have seen two different interpretations above, but others are not excluded. It should be noted that Blumenthal's general claim — the relevance of deep relations for prompting — would also have been confirmed if he had obtained the *opposite* effect, i.e. if prompting by object would have turned out to be superior than prompting by subject. That such a finding would nevertheless have been surprising clearly shows that there are implicit theories about the prompting mechanism that are in need of further explication.

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APPENDIX A-1

FINNISH CONTEXTS AND SENTENCES

Shopgirl-type sentences, S11, subject form

1. Yliopiston senaatti hylkäsi syytöksen
Syytös ei voinut perustua totuuteen
Professori on liian hyväluontoinen pettämään
2. Vihollinen pysyttelee kovin kaukana
Voimme kyllä luopua voiton toivosta
Tykki on liian pieni osumaan
3. Meidän on parempi pyytää naapuria apuun
Tällä tavalla emme saa pianoa koskaan alakertaan
Muuttomies on liian lihava kantamaan
4. Liikkeen myyntivaihto ei ole odotusten mukainen
Se johtuu suureksi osaksi henkilökunnasta
Myyjätär on liian ruma viettelemään
5. Kilpailua voimme joukkueemme osalta pitää hävittynä
Hän onjo jäänyt kokolailla jälkeen
Pyöräilijä on liian hidas seuraamaan

Shopgirl-type sentences, S11 object form

1. Monet olivat yrittäneet "luntata" kirjallisissa kuulusteluissa
Se tuli kuitenkin ilmi
Professori on liian hyväluontoinen petettäväksi
2. Vihollisella on enää vain kevytrakenteinen kanuunansa käytettävissä
Raskaimman aseistuksen olemme sentään saaneet tuhottua
Tykki on liian pieni osuttavaksi
3. Annetaan hänen maata hetki sairasautossa
Meidän on parempi hakea pyörillä varustetut paarit
Muuttomies on liian lihava kannettavaksi
4. Hän yrittää löytää sopivaa tanssiseuraa itselleen
Valinta on jo kokolailla rajoitettu
Myyjätär on liian ruma vieteltäväksi
5. Ajo ei suju suunnitelmien mukaan
Joukkue tarvitsee toisen vetäjän
Pyöräilijä on liian hidas seurattavaksi

APPENDIX A-2

Shopgirl-type sentences, Sl2, subject form

1. Musiikkiesitys joudutaan vähän väliä keskeyttämään
Se ei johdu laulajattaresta
Sellisti on liian huono säestämään
2. Villieläimet ovat kuulema hyökänneet ihmisten kimppuun
Niitten on täytynyt olla leijonia
Tiikeri on liian kesy tappamaan
3. Se mitä sanoitte ei voi olla totta
Tuollainen käytös ei ole hänen tapaistaan
Lapsi on liian herkkäluontoinen lyömään
4. Meidän täytyy pyytää tukea muualta
Tässä tapauksessa ei anomisesta näytä olevan hyötyä
Yhdistys on liian vanhanaikainen auttamaan
5. En sittenkään ole oikein tyytyväinen apulaiseemme
Lapset eivät saa tarpeeksi huomiota osakseen
Tyttö on liian sulkeutunut hemmottelemaan

Shopgirl-type sentences, Sl2, object form

1. Orkesteri soittaa haluttomasti
Ei ole kovinkaan mukavaa työskennellä harrastelijan kanssa
Sellisti on liian huono säestettäväksi
2. Ainoastaan villieläimet täytyy lopettaa
Päätös koskee varsinkin leijonia
Tiikeri on liian kesy tapettavaksi
3. Teidän täytyy hillitä kiukunpuuskianne
Rangaitus ei saa olla liian ankara
Lapsi on liian herkkäluontoinen lyötäväksi
4. Meille on tullut koko joukko avustus-anomuksia
Tämä hakemus meidän kyllä täytyy hylätä
Yhdistys on liian vanhanaikainen autettavaksi
5. Hänen syntymäpäivänsä tuottaa aina vaikeuksia
Ei ole helppoa keksiä hänelle lahjaa
Tyttö on liian sulkeutunut hemmoteltavaksi

APPENDIX A-3

Dog-type sentences, Dg1₁ subject form

1. Maalaistalossa oli taas kerran riitaa
Isäntä on lyönyt
Emäntä on ilkeästi raapaissut
2. Luokanvalvoja lausui kaikki tervetulleiksi
Oli vanhempien-ilta
Opettaja on sydämellisesti tervehtinyt
3. Urheiluhalli luovutettiin käyttöön
Useita puheita pidettiin
Pormestari on ensimmäisenä onnitellut
4. Pidätetyllä ei ollut alibia
Siitä huolimatta hän kieltää tehneensä teon
Poliisi on pilkällisesti kuulustellut
5. Kylässä on puhjennut kulkutauti
Sen leviämistä pelätään
Sairaanhoitaja on välittömästi rokottanut

Dog-type sentences, Dg1, object form

1. Isäntä on pelästyttänyt kissan
Yh'äkkiä sen kynnet tulivat esiin
Emäntää on ilkeästi raapaistu
2. Loma on taas lopussa
Ensimmäinen tunti alkaa
Opettajaa on sydämellisesti tervehditty
3. Uusittu kaupungintalo oli valmis
Oli järjestetty suuri vastaanotto
Pormestaria on ensimmäisenä onniteltu
4. Mellakat oli tukahdutettu laittomalla tavalla
Tuomari otti asian vakavasti
Poliisia on pitkällisesti kuulusteltu
5. Miehen todettiin sairastavan tarttuvaa tautia
Häntä hoitaneet täytyi suojata
Sairaanhoitajaa on välittömästi rokotettu

APPENDIX A-4

Dog-type sentences, Dg2, subject form

1. Pihalta kuului kovaa haukuntaa
Pienokainen itki pelästyneenä
Koira on pahasti purrut
2. Kadulta kuului huutoa ja meteliä
Ilmeiseski siellä oli syntymässä tappelu
Poika on kovin kiusannut
3. Uutta siipikarjan rehua on kokeiltu
Kokeilu tuntuu onnistuneen
Kana on halukkaasti syönyt
4. Asuntovaunua mentiin hakemaan
Tiet olivat liukkaat
Auto on hitaasti hinannut
5. Muotokuvamaalari käytti uutta menetelmää
Pääministerin ei tarvinnut istua mallina
Taiteilija on nopeasti valokuvannut

Dog-type sentences, Dg2, object form

1. Kotieläimet tappelivat
Naapurit juoksivat katsomaan
Koira on pahasti purtu
2. Koululaiset ovat usein ajattelemattomia
He pilkkaavat tyhmintä
Poikaa on kovin kiusattu
3. Jokaisella oli nälkä
Istuttiin ruokapöytään
Kanaa on halukkaasti syöty
4. Oli tapahtunut melkoinen yhteentörmäys
Jarrut eivät toimineet enää
Autoa on hitaasti hinattu
5. Taidenäyttely on virallisesti avattu
Lehdistö oli paikan päällä
Taiteilijaa on nopeasti valokuvattu

APPENDIX A-5

DUTCH CONTEXTS AND SENTENCES

Shopgirl-type sentences, S11, subject form

1. (46.5 %) De senaat van de universiteit wees het protest van de hand
De klacht kon onmogelijk op waarheid berusten
De professor is te goed om te bedriegen
2. (37.5 %) De vijand blijft te ver uit de buurt
We kunnen de hoop op succes wel opgeven
Het kanon is te klein om te raken
3. (63.0 %) We kunnen de buurman om hulp vragen
Op deze manier krijgen we de piano nooit naar beneden
De verhuizer is te dik om te dragen
4. (25.4 %) De omzet in de winkel is niet volgens verwachting
Dat ligt aan het winkelpersoneel
De verkoopster is te lelijk om te verleiden
5. (77.8%) De wedstrijd is een verloren zaak
Hij ligt nu al een heel stuk achter
De wielrenner is te traag om te volgen

Shopgirl-type sentences, S11 object form

1. Velen hadden geknoeid met de tentamenopgaven
Ze vielen allen door de mand
De professor is te goed om te bedriegen
2. De vijand schiet nog slechts met middelgroot geschut
Het grootste geschut hebben we wel kunnen uitschakelen
Het kanon is te klein om te raken
3. Laat hem even in de ambulance liggen
We zullen een rijdende brancard halen
De verhuizer is te dik om te dragen
4. Hij zoekt nog iemand om mee naar het feest te gaan
De keuze is al aardig beperkt
De verkoopster is te lelijk om te verleiden
5. De rit verloopt niet zoals het zou moeten
Het peloton heeft een andere kopman nodig
De wielrenner is te traag om te volgen

APPENDIX A-6

Shopgirl-type sentences, S12, subject form

1. (52.0 %) Het zangrecital wordt steeds onderbroken
Dat ligt niet aan de zangeres
De cellist is te slecht om te begeleiden
2. (55.0 %) Er zijn mensen aangevallen door de wilde dieren
Dat moeten de leeuwen zijn geweest
De tijger is te tam om te doden
3. (36.4 %) Wat u zegt kan niet juist zijn
Dat komt niet met zijn karakter overeen
Het kind is te gevoelig om te slaan
4. (73.5 %) We kunnen ons heil beter elders zoeken
Hier baat geen enkele smeekbede
De vereniging is te ouderwets om te helpen
5. (24.0 %) Ik ben toch niet tevreden met onze hulp
De kinderen krijgen niet genoeg aandacht
Het meisje is te gesloten om te verwennen

Shopgirl-type sentences, SU, object form

1. De orkestleden spelen met tegenzin
Het valt niet mee met een amateur te spelen
De cellist is te slecht om te begeleiden
2. Alleen de wilde dieren moeten worden afgemaakt
Dat geldt vooral voor de leeuwen
De tijger is te tam om te doden
3. U moet oppassen met uw driftbuien
De straf mag niet te ver gaan
Het kind is te gevoelig om te slaan
4. Een aantal instanties hebben om steun gevraagd
Deze aanvraag kunnen we beter negeren
De vereniging is te ouderwets om te helpen
5. Met haar verjaardag is het telkens weer moeilijk
Je weet eenvoudig niet wat je moet geven
Het meisje is te gesloten om te verwennen

APPENDIX A-7

Dog-type sentences, Dg1, subject jorm

1. Er was weer eens ruzie op de boerderij
De boer heeft klappen gegeven
De boerin heeft gemeen gekrabd
2. Het hoofd heette iedereen welkom
Het was ouderavond
De onderwijzer heeft hartelijk gegroet
3. De sporthal werd overgedragen
Er waren vele toespraken
De burgemeester heeft eerst gefeliciteerd
4. De verdachte had geen alibi
Toch bleef hij zwijgen of ontkennen
De agent heeft langdurig verhoord
5. In het dorp brak een epidemie uit
Men was bang voor verdere verspreiding
De verpleegster heeft onmiddellijk ingeënt

Dog-type sentences, Dg1, object form

1. De boer heeft de poes opgeschrikt
Plotseling schoten haar klauwen uit
De boerin werd gemeen gekrabd
2. De vakantie was voorbij
De eerste les begon
De onderwijzer werd hartelijk gegroet
3. Het gerestaureerde stadhuis was klaar
Er was een grote receptie
De burgemeester werd eerst gefeliciteerd
4. De relletjes waren op onwettige wijze onderdrukt
De rechter nam de zaak hoog op
De agent werd langdurig verhoord
5. De man bleek ernstig besmettelijk ziek
Zijn verzorgers moesten worden beschermd
De verpleegster werd onmiddellijk ingeënt

APPENDIX A-8

Dog-type sentences, Dg2, subject form

1. In de tuin hoorde je blaffen
Het kleutertje huilde ontdaan
De hond heeft flink gebeten
2. Je hoorde schreeuwen op straat
Het leek wel een vechtpartij
De jongen heeft erg geplaagd
3. Nieuw pluimveevoer werd geprobeerd
Het lijkt wel een geslaagd experiment
De kip heeft smakelijk gegeten
4. De woonwagen werd opgehaald
De wegen waren glad
De auto heeft langzaam gesleept
5. De portretschilder gebruikte een nieuwe techniek
De premier hoefde niet model te staan
De kunstenaar heeft snel gefotografeerd

Dog-type sentences, Dg2, object form

1. De huisdieren vochten
De burens renden naar buiten
De hond werd flink gebeten
2. De leerlingen zijn vaak onnadenkend
Ze lachen de domste uit
De jongen werd erg geplaagd
3. Iedereen had honger
Men zette zich aan tafel
De kip werd smakelijk gegeten
4. Het was een harde botsing
De remmen hadden geweigerd
De auto werd langzaam gesleept
5. De tentoonstelling werd officieel geopend
De pers was aanwezig
De kunstenaar werd snel gefotografeerd

SUFFIXES AS DEEP STRUCTURE CLUES

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