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Grammaticality, Paraphrase and Imagery

1. INTRODUCTION

The concept of grammaticality is a crucial one in generative linguistics since Chomsky (1957) chose it to be the very basis for defining a natural language. The fundamental aim of linguistic analysis was said to be to separate the grammatical sequences from the ungrammatical ones and to study the structure of the grammatical ones. It is, therefore, not surprising to see that this central linguistic notion became the subject of much study and controversy. A major part of the discussions centered around the following points: (a) semigrammaticality, (b) reliability and validity of grammaticality judgments, (c) the psychological status of linguistic (e.g., grammaticality) intuitions.

(a) Though the principal distinction is that between grammatical and ungrammatical, there may be different degrees of ungrammaticality. Various authors have developed theories on degrees of ungrammaticality (Chomsky 1964; Katz 1964; Ziff 1964; Lakoff 1971). They are all based on the consideration that given a grammar, ungrammaticality can be varied as a function of the seriousness and number of rule violations. These theories are based on the principle that absolute grammaticality exists and that only strings outside the language show degrees of (un-) grammaticality. It should be noted that other linguists never used a notion of absolute grammaticality. Harris' transformation theory, especially his operator grammar (1970), is based on the principle that transformations preserve the order of grammaticality; e.g., if two passives have a certain order of grammaticality, this order should be preserved for the corresponding actives. This is a major test case for the correct formulation of transformation rules. In this way there is no linguistic need for the notion of absolute grammaticality. Levelt (1974c) studied the question to what degree linguists would be handicapped (i.e., linguistic theory would become untestable) if the notion of absolute grammaticality were replaced by this 'preservation-of-order' principle. It

turns out that very little of interest is lost, whereas some unexpected gains are made. Moreover, the logical definition of a language as a set of strings no longer requires the notion of absolute grammaticality. Fuzzy set theory (Zadeh 1971) makes it possible to meaningfully discuss *degrees* of set-membership. It would be very advantageous if linguistic theory construction could do without the notion of absolute grammaticahty, especially in view of the following point.

(b) The reliability of absolute grammaticality judgments turns out to be very low. Various recent experiments (Levelt 1972; Greenbaum 1973; Snow 1974) testify to this. In the early years of the transformational grammar this was not an important issue, since the 'clear cases', i.e., the highly uncontroversial cases of grammaticality and ungrammaticality, were sufficient for constructing and testing linguistic theory. It was expected that, in its turn, the theory constructed in such a way would decide on the 'unclear cases'. This hope has vanished: more and more subtle theory is now being constructed on less and less clear cases. In such a situation one would expect linguistics to turn to appropriate behavioral methods of data gathering and (statistical) analysis. Nothing of the sort occurs, however. Levelt (1972) showed that various procedures that are used for obtaining grammaticality judgments lead to systematic biases and distortions. We know of no linguistic studies, except Greenbaum's, where grammaticality judgments are put to statistical test in order to accept or reject certain linguistic hypotheses. Levelt (1974c) gives examples of testing various linguistic theories by means of experimentally obtained linguistic judgments.

The validity of grammaticality judgments has been studied by several authors *(cf.* Maclay and Sleator 1960; Quirk and Svartvik 1966), especially in order to relate the notion to other linguistic intuitions, such as meaningfulness, or to psychological variables like comprehensibility. In the present paper another psychological variable, imagery, will be related to grammaticality.

(c) The theoretical scope of Chomsky's transformational grammar was greatly expanded when it was taken to be a description of the language user's linguistic competence, not merely a formal system characterizing a certain linguistic set. Linguistic intuitions became the royal way into an understanding of the competence which underlies all linguistic performance. However, if such a linguistic competence exists at all, i.e., some relatively autonomous mental capacity for language, linguistic intuitions seem to be the least obvious data on which to base the study of its structure. They are very derived and rather artificial psycholinguistic phenomena which develop late in language acquisition

(Gleitman *et al.* 1972) and are very dependent on explicit teaching and instruction. They cannot be compared with primary language use such as speaking and listening. The empirical domain of Chomskian linguistics is linguistic intuitions. The relation between these intuitions and man's capacity for language, however, is highly obscure. An extensive discussion of these issues can be found in Levelt (1974c).

It is this latter point that we want to take up in the present article. Our question will be a psychological one: Where do grammaticality intuitions come from? It makes no sense to assume *a priori* that the domain of linguistic intuition is a relatively closed one, as many linguists appear to do. Such intuitions are highly dependent on our knowledge of the world and on the structure of our inferential capacities. So the general question should be: what sort of process underlies the formation of a grammaticality judgment? The only way to approach this question is to ignore all *a priori* linguistic restrictions and to regard it as a problem in human information processing.

At the same time it should be obvious that answering this question will require much experimentation. At present, however, this is still a virginal area. We know of one remarkable study where a process analysis is made of grammaticality judgments: Moore (1972) studied this behavior *vis-à-vis* sentences where subject, verb or object was the locus of ungrammaticality. Reaction time analysis showed a definite order of focusing the different parts of the sentence in forming the judgment.

Moore did not go into the question of how judgment of the focused part took place. One could think of various factors playing a role here. It is one possibly important factor which we want to take up in this paper: imagery. Analysis of this factor may, as we shall see, show some light on the processing of sociolinguistic cues in speech perception.

2. THE USE OF IMAGERY

If one asks an informant how he performs the judgment task, a usual answer is something like: 'I try to imagine a situation in which the phrase or sentence can be said.' The informant seems to 'use' imagery in answering the grammaticality or acceptability question: he tries to find a cognitive, preferably visual, context in which the sentence could make sense. But what exactly does it mean to 'use imagery'?

A decade of imagery research has not solved this problem. It is especially still controversial whether humans have two separate representational systems for verbal and nonverbal information, respectively.

If one believes this to be the case (Paivio 1971, 1974), 'using imagery' is addressing the non-verbal representational system during information processing. The facilitative effect of using imagery in interpreting words, phrases or sentences could then partly be ascribed to the fact that two representational systems, instead of one, are involved in the comprehension or judgment task. If one assumes the existence of only one general representational system (Anderson and Bower 1973), 'using imagery' reduces to an attractive triviality: instructing the subject to use imagery in some comprehension or memory task would only encourage him to spontaneously generate 'expansion' of the verbal material. He would, in a more extensive way, 'scan' the meanings (i.e., representations) of the different elements in the material, which means retrieving various connected memory structures, etc. This would increase the probability of finding the connections that are crucial for the experimental task. The facilitative effect of 'using imagery' should be a-specific, according to this theory: it is not the image that intervenes and causes the solution, but the experience of an image is an epiphenomenon which is caused by enhanced memory activity. Anderson and Bower present rather convincing experimental evidence for their position, but it is not necessary here to prejudge this theoretical controversy. There is full agreement that the instruction to 'use imagery' is facilitative for a large variety of comprehension and memory tasks. This facilitative effect can, moreover, be obtained by using concrete (or 'high imagery') material. Abstract (or 'low imagery') material is harder to use in verbal tasks, leading to more errors and longer reaction times. It is, therefore, clear that the judgment process itself is different in the two cases.

3. GENERAL HYPOTHESES

In this paper we want to consider whether this difference in process also leads to differences in grammaticality judgments. In line with the general findings we would, more specifically, expect the following results:
   (1) Grammaticality is higher for high imagery (or concrete) verbal material than for low imagery (or abstract) material.
   (2) Grammaticality judgments are faster for high imagery (H.I.) material than for low imagery (L.I.) material.
We assumed that, in making a grammaticality judgment, the subject tries to find a context in which the sentence or phrase makes sense, i.e., a possible interpretation of the sentence. If this is the crucial part of the process, we would expect the same pattern of reaction times in para-

phrase production as in grammaticality judgments:

(3) Paraphrasing will be quicker for H.I. than for L.I. material.

4. THE EXPERIMENT

Material and pre-experiment. In this experiment we used Dutch compounds as material to be judged. We took care that these compound constructions were not standard lexical items in Dutch, since in that case the judgment task could be performed by straight reference to the internal lexicon without further inference. In all other cases, using compounds is a productive process, in the same sense as creating sentences. However, we were interested in varying this productivity for the following reason. Certain types of lexical compounds are much more frequent than others. Frequent types are noun/noun (NN) and verb /noun (VN) compounds, whereas noun/adjective (NA) and adjective /noun (AN) compounds are rather infrequent. It is quite likely that a certain type of lexical compound is relatively frequent if the number of possible semantic relations between the two constituent elements is relatively high. This is certainly true for NN compounds where we have a large diversity of possible semantic connections. Lees (1960), who treats compounds as surface structures which are transformationally derived from deep structures, observes the following underlying grammatical relations to be mirrored in NN compounds, examples in parentheses referring to different sub-types:

subject/predicate *(girlfriend)*
subject/middle object *(doctor's office, arrowhead, armchair)*
subject/verb *(snake bite, gunshot, farm production, investment bank)*
subject/object *(windmill, milk bar, fingerprint, grocery store)*
verb/object *(bullfighting, birth control, book review, bartender, disc jockey)*
subject/prepositional object *(ashtray, airmail, bulldog, egghead, snowball, date line, aircraft)*
verb/prepositional object *(reception desk, color photography)*
object/prepositional object *(tearoom, football, apple sauce, mud pie, apple cake, iron age).*

Underlying relations for VN compounds are, according to Lees:

subject/verb *(wading bird, dance team)*
verb/object *(call girl, pickpocket, chewing gum)*
verb/prepositional object *(bakehouse, playing cards).*

These productive forms are contrasted with AN compounds, which only express subject/predicate relations *(madman, red skin).* Lees does not treat N A constructions, since his object of study is nominalizations. One could think of 'as-as' relations *(blood red, stone dead),* adjective + prepositional phrase relations *(top heavy),* etc. (see Quirk *et al., 1912,* 1028).

According to Dutch frequency counts, VN constructions are about 6 times as frequent as AN constructions (which are more frequent than NA compounds); NN compounds are 4 times as frequent as VN constructions. This order corresponds well with the order of transformational productivity.

We would expect that for non-lexical compounds (i.e., compounds which are not standard items in the dictionary), those that allow for a large variety of semantic relations (NN and to a lesser degree VN) will allow for quicker processing, i.e., smaller reaction times for paraphrase and grammaticality judgments. Psychologically, this is for exactly the same reason as the facilitative effect of imagery: more 'expansions' of the verbal material are generated since the compound type allows for a higher diversity of semantic relations. An additional hypothesis, therefore is

(4) Lexically productive types of compounds (NN, VN) are, with respect to less productive types (NA, AN), judged and paraphrased faster and rated more grammatical.

A corollary to this last hypothesis is that ambiguous types of compounds (i.e., compounds like *'gold light'* which can be conceived of either as NN or as NA) will more probably be interpreted, and therefore paraphrased, as the more productive form (in this case NN). Also, they will behave like the more productive form with respect to reaction times and grammaticality judgments.

In order to compose the experimental material a preliminary list of 24 supposedly high-imagery and 24 low-imagery compounds were constructed for each category (NN, VN, NA, AN), as well as 9 ambiguous compounds for the 4 possible ambiguous types NN/NA, VN/AN, NN/AN, and NN/VN. This set of 228 compounds was, in different random orders, presented to 24 subjects for imagery ratings. Twenty-four of these compounds occurred twice in the list, in order that there should be a check on the subjects' rating consistency. All 24 subjects turned out to be sufficiently consistent: rank correlations ranged from .52 to .99, with an average of .83. We followed an adaptation of the original Paivio (1971) instructions which ask the subject to rate how easily the material leads to mental images of things or events. The

subjects were asked to rate their judgment for each compound on a seven-point scale (from 1 for 'low imaginable' to 7 for 'high imaginable'). These rating were averaged over subjects, and on the basis of these data we selected the 15 highest- and 15 lowest-rated compounds for each type (NN, VN, NA and AN). The eight average imagery values are given in the first and fifth row of Table 1. Also the four highest and four lowest valued compounds in the ambiguous categories were determined. Since the latter involved leaving out one compound for each ambiguous type we did not obtain clear-cut imagery dichotomies for the ambiguous compound types. Table 2 presents average imagery values for these types.

The compounds obtained in this way formed the experimental material for the main experiment. Summing up, the stimulus material consisted of 15 H.I. and 15 L.I. compounds for each compound type, plus 8 for each of the 4 ambiguous types, i.e., 4 (15 + 15) + 4 (8) = 152 stimuli.

5. PROCEDURE AND SUBJECTS

Since we wanted to release both grammaticality judgment and paraphrases for each compound, each of our 10 subjects participated in two sessions. In one session they did the paraphrase task and in the other the grammaticality judgments. The two sessions were separated by at least one day. Five subjects had the paraphrase session first, and the other five the grammaticality session. Subjects were men and women, of slightly post-college level education and ranging in age from 20 to 40. Each subject was treated individually.

(1) *The paraphrase task.* The subject was seated in front of a memory drum by means of which the 152 compounds could be presented one by one. Each subject received a different random order. The list was preceded by 8 trial stimuli to accustom the subject to the task.

At a signal of the experimenter a new stimulus appeared in the window of the memory drum, which simultaneously started an electric timer. As soon as the subject had his paraphrase available he pressed a button, which stopped the timer, and gave his paraphrase. The latter was noted down by the experimenter, who then proceeded to present the next stimulus, etc. The paraphrase-instruction was presented to the subject in written form, and his comprehension was carefully checked during the eight-trial stimuli. The instruction' stressed that the subject should describe the meaning or interpretation of the compound.

(2) *The grammaticality task.* The stimulus presentation was the same as for the paraphrase task. The subject was instructed to push the button as soon as he had made up his mind about the grammaticality rating. At or directly after pushing the button, the subject orally expressed this rating, which could be any number from 1 (highly grammatical) to 7 (highly ungrammatical). This numbering was continuously available to the subject on top of the memory drum. (In the further data analysis this numbering will be inversed, i.e., 7 for highly grammatical; this in order to make the grammaticality values compatible with the imagery values). The instruction given to the subject asked him to rate whether the stimulus could be a Dutch compound word, i.e., was 'good Dutch'. So, the term 'grammaticality' was not used, since it seems wrong to ask a naive subject to use an ill-defined linguistic technical term.

6. RESULTS AND ANALYSIS

Average results for the different conditions and tasks are presented in Table 1. Three separate analyses of variance were computed on the raw data: one for the grammaticality ratings, one for the grammaticality rating times and one for the paraphrase reaction times. Apart from the main factors high/ low imagery, type of compound (NN, VN, NA, AN;

Table I. *Average values for imagery (1-7), grammaticality (1-7),*
rating time (sec.) and paraphrase time (sec.)

Type of compound	NN	VN	AN	NA
High imagery				
Imagery value	5.448	5.811	5.112	5.526
Grammaticality	5.440	5.767	4.649	5.340
Grammaticality rating time	1.863	1.773	2.031	1.883
Paraphrase reaction time	2.685	2.211	2.553	2.351
Low imagery				
Imagery value	2.426	2.411	2.162	2.126
Grammaticality	3.233	3.467	2.913	2.706
Grammaticality rating time	2.190	2.030	2.200	2.317
Paraphrase reaction time	4.288	3.897	4.228	4.109

the ambiguous compounds were analyzed separately) and subjects, another factor was carried into the analysis, namely, first vs. second session. It could be the case that prior presentation of the experimental material in the paraphrase task affects the grammaticality ratings of a subject in the second session, and inversely. However, no significant effect of this variable was found, so that we will ignore it in the following. We will now discuss each of the three analyses in turn.

6.1 Grammaticality ratings

Our first hypothesis predicted higher grammaticality for high imagery (H.I.) compounds than for L.I. compounds. This is what we found. The average grammaticality scale value for H.I. compounds turns out to be 5.299, for L.I. compounds 3.180. The difference is highly significant ($p < 0.00004$). The other significant result relates to compound type: different compounds have different grammaticality ($p<0.01$): the productive types are more grammatical than the less productive types: 4.337 for NN, 4.627 for VN versus 3.781 for NA and 4.023 for AN. This is in accordance with hypothesis 4.

6.2 Grammaticality rating times

The second hypothesis predicted quicker grammaticality judgments for H.I. compounds than for L.I. compounds. Average ratings times are 1.888 sec. and 2.184 sec., respectively. The difference of 296 msec., is significant ($p < 0.02$) and in accordance with the prediction. We did not find a significant compound type effect.

6.3 Paraphrase reaction times

From the third hypothesis we expected shorter paraphrase reaction times for H.I. compounds than for L.I. compounds. The average reaction times are 2.450 sec. and 4.130 sec., respectively. The difference (1.680 msec.) is highly significant ($p < 0.0004$), in support of the hypothesis. Again, there is no significant effect of compound type, contrary to the prediction in hypothesis 4.

6.4 Ambiguous compounds

The results for the ambiguous compounds are given in Table 2. In a corollary to hypothesis 4, we supposed that these constructions would behave like the more productive form with respect to reaction times and grammaticality judgments. In spite of several ways of analyzing the data we could not find any trace of such an effect. This is mainly due to the lack of compound-type effects for the non-ambiguous material. Hypothesis 4 is only supported for grammaticality ratings, not for reaction times. The effect of lexical productivity seems to be quite small. We will return to this in the discussion.

Table 2. *Average values for imagery, grammaticality, rating time and paraphrase time for ambiguous compounds*

Type of compound	NN/AN	NN/VN	NN/NA	VN/AN
Imagery value	3.770	4.359	4.778	3.843
Grammaticality	4.537	4.975	4.225	4.750
Grammaticality rating time	i.970	1.994	1.947	2.022
Paraphrase reaction time	3.387	2.830	2.761	3.135

The other prediction was that ambiguous compounds would be more probably paraphrased in terms of the more productive form. To check this, we analyzed all paraphrased protocols, but again with largely negative results: for NN/NA compounds we found 56% NN interpretations; for VN/AN there were 51% VN interpretations; for NN/AN we had 45% NN-type paraphrases; and for NN/VN compounds, there were 41% NN responses. In fact, within each type some compounds were judged one way by all subjects and other compounds just the other way. Many compounds gave very idiosyncratic reactions. In this light the number of different items per type (8) is certainly too small to draw conclusions either one way or the other.

7. DISCUSSION

The results of the present experiment are strongly supportive of our main hypotheses (1,2, and 3), namely, that high imagery compounds are more grammatical and more quickly judged than low imagery com-

pounds and that paraphrasing is quicker for H.I. than for L.I. material. Shortly, we will try to interpret these findings in terms of a process model for judging grammaticality. But let us first consider the additional hypothesis 4 for which the data gave little support. We did find that grammaticality is higher for lexically productive types of compounds than for less productive types, but neither grammaticality rating times nor paraphrase times were quicker for the productive types. Moreover, the data for ambiguous compounds did not show the expected tendency of a preference for the more productive interpretation of the compounds. In retrospect, it seems to us that the main reason for this lack of support is that it is naive to suppose that a productive compound type (such as NN) consists of productive compounds. A compound type was called productive if it allows for a large variety of semantic relations. This does not mean, however, that each compound itself allows for a large variety of semantic interpretations, but only that there exists a large divergence of compound interpretations within the type. Actually, it seems to be the case that for each compound there is a strong bias towards one particular interpretation, irrespective of the type of the compound and irrespective of ambiguity. *Hangman* will always be interpreted as 'the man hangs X', whereas *pin-up girl* is uniquely taken as 'X pins up the girl'; in our data we found similar strong biases for compounds of ambiguous types, as we mentioned earlier. Therefore, productivity does not seem to be a property of individual compounds. Differences in reaction times between compounds may be related to other linguistic properties.

One noteworthy candidate is the 'transparency' of the compound, i.e., the distance between surface form and semantic interpretation. For example, compare *madman* (the man is mad) to *redskin* (the skin is red the red skin belongs to a man the man belongs to a certain ethnic category). The latter one may take longer paraphrase and judgment reaction times. This transparency variable seems to be an interesting topic for further experimentation on grammaticality.

Let us now turn to the main results relating to the imagery variable. Theoretically we had supposed that the judgment process involves a search for a possible interpretation of the compound and that this search is quicker for H.I. than for L.I. material. In its turn the latter can be explained either by the existence of a dual verbal/ nonverbal representational system (Paivio) or by a larger 'expansion potential' of high imagery material (Anderson and Bower). Since in both cases interpretation search is an integral part of the judgment process, one would expect a similar imagery-effect for paraphrase reaction times (hypothesis 3),
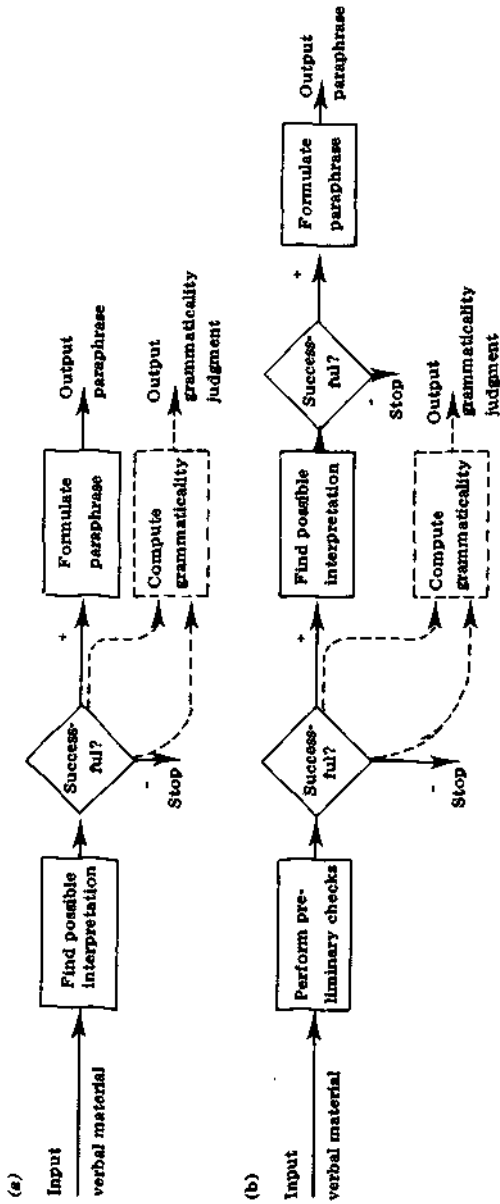
Figure 1. Two models for grammaticality judgment and paraphrasing

and this is what we found. However, further qualification is necessary in view of the reaction time data. Figure la represents the grammaticality /paraphrase model. If imagery only affects the interpretation search, paraphrase and grammaticality reaction times would be affected to the same degree. But we found a mean reaction time difference for grammaticality judgments of 296 msec, as compared to 1680 msec., for paraphrase reaction times. This leaves nearly 1400 msec., unexplained for the paraphrasing process.

We are left with two ways of accounting for this additional difference. The first is to suppose that imagery not only affects the interpretation search but also the later stage of paraphrase formulation. But neither in the Paivio model nor in the Anderson and Bower model is this particularly likely. For Paivio, paraphrase formulation takes place in the verbal system, which is not affected by imagery. For Anderson and Bower, no further inference is required as soon as the interpretation is available, and the 'expansion potential' interpretation of imagery would not work. We will shortly return to this.

The second is to suppose that no full interpretation is needed in order to give a grammaticality judgment. The subject may perform some preliminary checks on the material before starting his memory search (Figure lb). If these checks involve some 'trial expansions' in the sense of Anderson and Bower, they will also be sensitive to imagery. These checks would then explain the 296 msec., difference in our results, whereas the interpretation search would account for the additional 1400 msec.

In order to experimentally exclude the first alternative, one could choose a task in which no *paraphrase formulation* is required. Instead of compounds one could use sentences and have the subject judge the truth or falsity of the sentence by means of two reaction keys. If the effect of imagery on reaction time reduces to the amount found in the grammaticality task, the conclusion should be that there is an additional imagery effect on paraphrase formulation, If, however, the verification task and the paraphrase task show a substantial difference in the effect of imagery (and this we expect), we can maintain the present supposition that the grammaticality judgment does not require substantial interpretation but can be based on some set of pre-tests.

If this latter model is correct, the major problem is to analyze the nature of these preliminary checks. It is well known that similar tests are performed in normal listening situations. There are not only phonetic checks which are essential for adaptation to a speaker's voice quality, but we also perform preliminary tests in the interpretive domain. Norman

(1972) gives as an example the speaker's question 'What is Charles Dickens' phone number?' The typical reaction is not intensive memory search followed by 'I don't know', but something like 'That's a stupid question'. Especially worth mentioning in this context are sociolinguistic checks, which probably also precede interpretation in a similar fashion. They are sometimes of a phonetic or phonological nature (e.g., in determining a person's dialect), but they may also involve some more interpretive activity. A nice example of the latter is the way in which the Javanese listener is able to quickly infer the speaker's social status. The presence of some words, affixes and turns of phrase are sufficient to immediately derive the status relationship (see Geertz 1968). In all these cases no full understanding is required for the completion of the tests. On the other hand, the results of such checks may have important consequences for the further interpretive process. The interpretations of an utterance will often be dependent on the inferred status relationship, and similarly the interpretative process may be stopped, i.e., communication may break down, if acceptability checks yield negative results.

In conclusion, the imagery data strongly suggest that no full interpretation is required to decide on the acceptability of a linguistic construction. The nature of the tests subjects do perform in order to cope with the grammaticality task stays largely in the dark. But we found that this testing process and its outcome is affected by imagery in the same way as other verbal associative and inferential processes.

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