

Comprehension of Directly and Indirectly Pictured Verbs by
Aphasic and Nonaphasic Listeners

R.H. Brookshire and L.E. Nicholas
Veterans Administration Medical Center, Minneapolis, Minnesota

The study that I am going to present today grew out of questions suggested by several studies of sentence comprehension by aphasic listeners that we have completed in the last several years (Brookshire and Nicholas, 1980a, 1980b). These studies made use of the "sentence verification procedure." In this procedure, spoken sentences are presented along with pictures which either do or do not represent the meaning of the picture. Listeners are then asked to respond "yes" if sentence and picture match, and "no" if they do not.

Two recurring findings from these experiments led us to the experiment that I will present today. First, we found that both aphasic and non-aphasic listeners resorted to a "find and compare" strategy (Carpenter and Just, 1975) whenever that strategy was permitted by the experimental conditions. The "find and compare" strategy consists of a series of serial comparisons between words in the sentence and elements in the picture (usually in the order subject-verb-object) with subjects responding "no" whenever they detect a mismatch between words in the sentence and elements in the picture. For example, if we were to present the following picture



together with the spoken sentence "The woman is washing the clothes," subjects would (correctly) respond "yes" after finding no mismatches between sentence and picture elements. However, if we were to present the same picture along with the sentence "The man is washing the clothes," subjects would quickly respond "no," because the mismatch on sentence subject occurs early in the sentence. If we were to present the picture along with the sentence "The woman is drying the clothes," subjects would respond less quickly because the mismatch occurs later in the sentence. Mismatches on sentence direct objects, then generate the slowest responses

of all, because these mismatches occur very late in the sentence. Figure 1 shows the reaction times to correct identifications of mismatches on subject, verb, and object in one of our sentence verification experiments in which pictures and sentences were presented simultaneously.

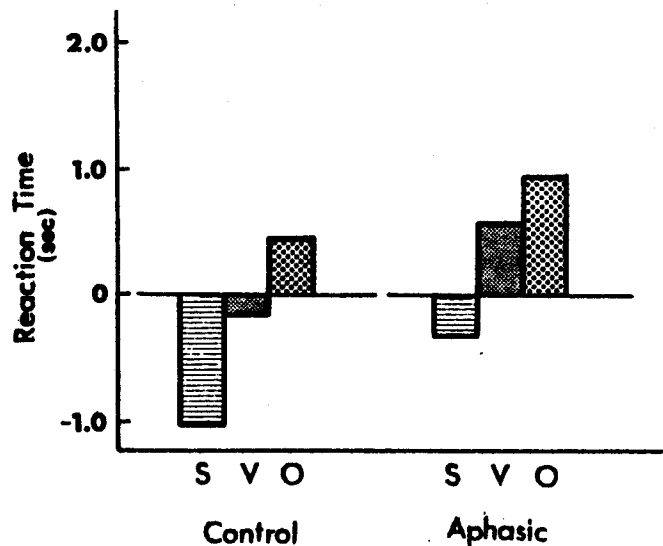


Figure 1. Aphasic and nonaphasic subjects' reaction times for identifying mismatches on subjects (S), verbs (V), and direct objects (O).

Observe the increasing reaction times to mismatches on subjects, verbs, and objects. Observe also that the increase in reaction time is not linear, but that reaction times to verb mismatches are closer to reaction times for direct objects than they are to reaction times for sentence subjects. This might suggest that detecting mismatches on verbs may take slightly longer than detecting mismatches on subjects or objects.

We found more evidence to suggest that verbs take longer to comprehend than subjects or direct objects in another verification study, in which we staggered the presentation of pictures and sentences (Figure 2). Once again, it appeared that verbs took longer for subjects to comprehend than subjects and direct objects did.

It seemed to us that there were two possible explanations for these findings. First, it seemed possible that verbs take longer to verify simply because they are verbs--they are more abstract, less frequent, and less concrete than nouns. Second, it seemed possible that our subjects took longer to respond to verbs because verbs do not usually appear in pictures. The verb is inferred from relationships among the agents and recipients of the actions specified by the verbs. Consequently, subjects' longer reaction times might not represent any innate characteristic of "verbs" that makes them more difficult to comprehend, but may reflect only the fact that verbs do not usually appear in pictures, making "find and compare" more difficult for verbs than for subjects and objects, which do appear in the pictures.

However, there are some verbs that may be represented in pictures. Verbs such as hammering, sawing, or ironing may be represented by implements in pictures depicting those activities. We decided to use this characteristics of some verbs to evaluate whether verbs that are represented in pictures are easier for aphasic and nonaphasic listeners to comprehend than verbs that are not pictorially represented.

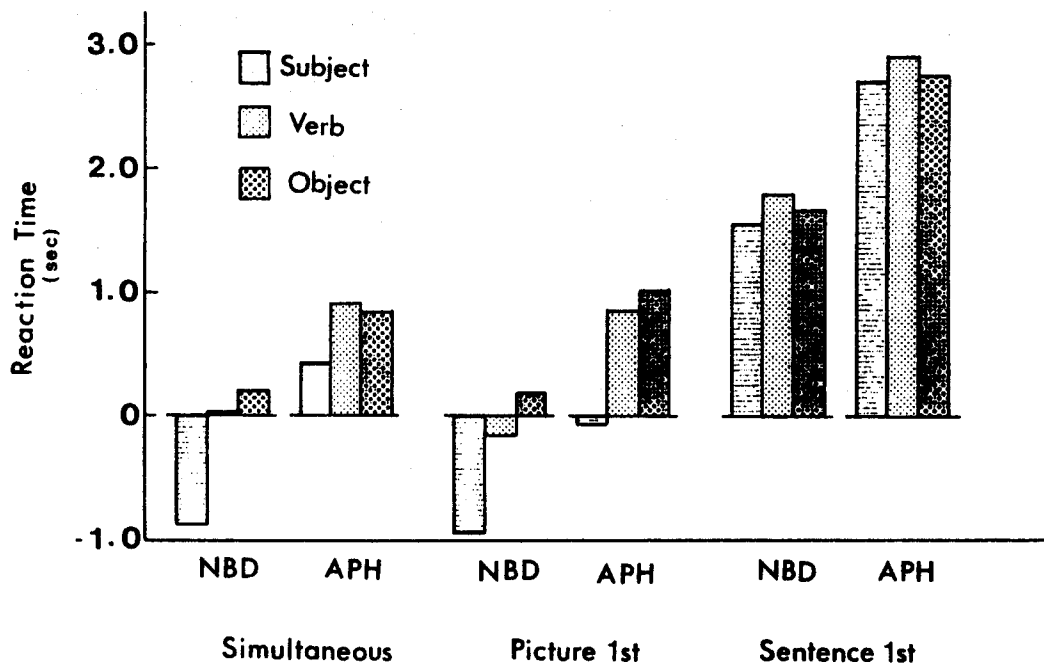


Figure 2. Aphasic (APH) and nonaphasic (NBD) subjects' reaction times for identifying mismatches on subjects, verbs, and direct objects in three experimental conditions.

METHOD

We constructed three sets of 20 sentences each. These sentences were to be presented along with pictures in a sentence verification task. Sentences were of the form

"He (she) is (verb)ing."

In one set of 20 sentences, the verbs in the sentences were represented by implements in the pictures that accompanied the sentences, (e.g., hammering, ironing, sawing). The verbs in this set of sentences were transitive; that is, they could naturally take a direct object, but direct objects were not specified by the sentences. In the second set of 20 sentences, verbs were not represented in the pictures, although the verbs were transitive, and could naturally take a direct object (e.g., driving, cooking, eating). In the third set of 20 sentences, verbs were not represented in the pictures, and were intransitive; that is, they did not naturally take direct objects (e.g., smiling, sitting, jumping).

In summary, then, we devised three sets of sentences. One set contained pictured transitive verbs, a second set contained nonpictured transitive verbs, and a third set contained nonpictured intransitive verbs. We then tape recorded these sentences in random sequence at normal speech rate.

Then we recruited 10 aphasic persons to serve as listeners. Five were fluent, and five were either dysfluent or mixed. We also recruited ten nonaphasic, non-brain-damaged persons of equivalent age and education to serve as a control group. We tested each aphasic subject with the Token Test and the Auditory Comprehension subtests of the Boston Diagnostic Aphasia Examination.

Subjects were seated, one at a time, at a table in a single-wall audiometric booth. They faced a rear-projection screen. Beside them was a high-fidelity loudspeaker, which was connected to a tape recorder and an amplifier in an adjoining room. An experimenter sat beside the subject, near a remote-control unit that could activate the tape recorder. On the table in front of the subject was a small cabinet. In the sloping face of the cabinet were located two 1" diameter pushbuttons. One pushbutton was labeled with the word "yes" in block letters and a line drawing of a smiling face. The other pushbutton was labeled with the word "no" and a frowning face.

Presentation of sentences and pictures was controlled by electronic equipment in the adjoining room, which caused the slide projector to show a picture on the rear projection screen and simultaneously started the tape recorder, which played the appropriate sentence through the loudspeaker on the table near the subject.

Subjects were instructed that they would see a picture on the screen and hear a sentence from the loudspeaker. If the sentence accurately represented the meaning of the picture, subjects were instructed to operate the "yes" pushbutton. If the sentence and picture did not match, they were instructed to operate the "no" pushbutton.

An electronic timer measured the time that elapsed between sentence onset and the subject's operation of the "yes" or "no" pushbuttons. The timer was on the table in front of the experimenter, who recorded correctness and reaction time for each response.

At the beginning of the session, each subject was given several practice trials with sentences not used in the experiment proper, to teach the subject what he was expected to do and to establish a comfortable listening level for each subject. When the experimenter was certain that the subject understood the task, experimental sentences and their accompanying pictures were presented, and subjects' responses were tabulated.

RESULTS

The results are summarized in Figure 3.

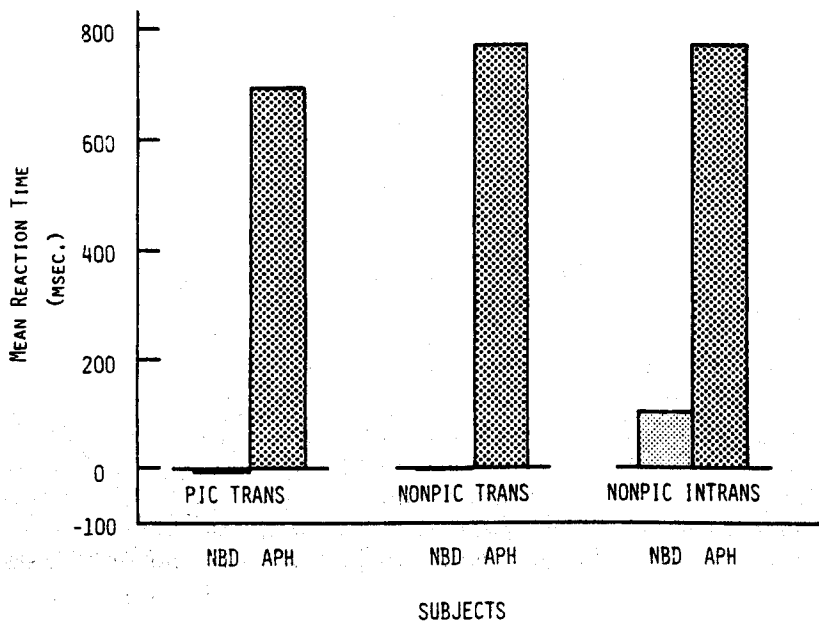


Figure 3. Aphasic (APH) and nonaphasic (NBD) subjects' reaction times to pictured (PIC) and nonpictured (NONPIC) transitive (TRANS) and intransitive (INTRANS) verbs.

An analysis of variance suggested that there were no significant differences in reaction time among dysfluent, fluent, and mixed aphasic subjects' responses to experimental conditions. Therefore, fluent, dysfluent, and mixed groups were combined into a single group for subsequent statistical analyses

Group Data Analysis

A repeated measures analysis of variance was carried out on the reaction time data, with aphasic subjects combined into a single group (Table 1). The analysis of variance demonstrated a significant difference between groups. Inspection of Figure 1 shows that aphasic subjects responded more slowly to sentences than non-brain-damaged subjects did. The analysis of variance also suggested a marginally significant ($p < .07$) difference among conditions. Inspection of Figure 1 suggests that non-brain-damaged subjects' reactions times were affected most by sentence transitivity, while aphasic subjects' reaction times were affected most by whether or not verbs were represented in the pictures that accompanied sentences. However, the absence of a significant interaction between groups and conditions in the analysis of variance suggests that these differences may not be statistically significant.

Table 1. Analysis of variance summary table.

Source of Variance	df	Mean Square	f	Significance
Groups	1	7.57	30.90	$p < .01$
Error B	18	0.25		
Conditions	2	0.05	3.13	$p < .07$
G X C	2	0.15	0.94	n.s.
Error W	18	0.016		

Individual Subject Data Analysis

In order to determine whether the group mean values presented in Figure 1 represented the performance of group members, we analyzed the direction of changes in reaction time between conditions for each aphasic and non-brain-damaged subject.

Effects of Picturability (Transitive Verbs). Six of ten aphasic subjects responded faster to sentences for which (transitive) verbs were pictured than to sentences for which verbs were not pictured. One subject exhibited no difference in reaction time between pictured and nonpictured verbs, and three subjects responded faster to nonpictured than to pictured verbs. Six of ten non-brain-damaged subjects responded faster to pictured verbs than to nonpictured verbs. Four subjects responded faster to non-pictured than to pictured verbs.

Effects of Transitivity (Nonpictured Verbs). Four of ten aphasic subjects responded faster to (nonpictured) transitive verbs than to intransitive verbs. Five aphasic subjects responded faster to intransitive verbs

than to transitive verbs, and one aphasic subject responded equally quickly to intransitive and transitive verbs. Eight of ten non-brain-damaged subjects responded faster to transitive verbs than to intransitive verbs. The remaining two non-brain-damaged subjects responded faster to intransitive verbs than to transitive verbs. Analysis of subject-by-subject performance suggests, then, that group performance is reasonably representative of the performance of subjects within the groups.

DISCUSSION

The results of this experiment suggest that some verbs take longer to comprehend than other verbs, at least in sentence verification tasks such as the one used in this experiment. Aphasic subjects as a group responded faster to sentences in which verbs were represented in accompanying pictures than they did to sentences in which verbs were not represented in accompanying pictures. Aphasic listeners appeared not to be greatly affected by whether verbs were transitive or intransitive.

Non-brain-damaged subjects were not so strongly affected by whether or not verbs were represented in accompanying pictures. However, non-brain-damaged subjects' reaction times were strongly affected by whether or not verbs were transitive or intransitive, with transitive verbs generating shorter reaction times than intransitive verbs.

Two explanations for the effects of verb picturability on aphasic listeners' reaction times appear plausible. First, verbs that were represented in pictures may have been verified more quickly because their representation in the pictures may have made a "find and compare" strategy possible. According to this hypothesis, aphasic listeners can verify pictured verbs by a "find and compare" procedure, but are forced to use other less-direct and slower processes for nonpictured verbs.

One way to test this hypothesis would be to devise a procedure in which subjects verified sentences containing verbs such as those used in this experiment, but without access to pictures. If aphasic subjects' faster reaction times to sentences containing picturable (but not pictured) verbs is a result of using a "find and compare" strategy, then eliminating pictures should preclude use of a "find and compare" strategy, and reaction times to sentences containing picturable and nonpicturable verbs should be equivalent.

The second possible explanation for the effects of verb picturability on aphasic listeners' reaction times to sentences relates to the concept of "imagery" or "imageability." Paivio (1971) among others, has suggested that words that are high in "imagery value" are easier to comprehend and remember than words that are low in imagery value. It seems intuitively reasonable to speculate that we may more readily visualize verbs that are represented by implements than verbs that cannot be so represented. A test of this hypothesis would require that picturable and nonpicturable verbs with various levels of imageability be presented to aphasic listeners. If a general effect for imagery were obtained in the absence of an effect for picturability, it would suggest that imageability, and not picturability, is an important factor in aphasic listeners' comprehension of verbs.

At any rate, our experiment has demonstrated that, unlike "a rose is a rose is a rose," a verb is not a verb is not a verb, at least when aphasic listeners are involved. Because verbs play a central role in language, it behooves us to know when and why some verbs may be easier than others for the aphasic listener.

REFERENCES

- Brookshire, R.H. and Nicholas, L.E. Verification of active and passive sentences by aphasic and nonaphasic subjects. J. Speech and Hearing Research, 23, 878-893, 1980a.
- Brookshire, R.H. and Nicholas, L.E. Sentence verification and language comprehension of aphasic persons. In R.H. Brookshire (Ed.), Clinical Aphasiology: Conference Proceedings, 1980. Minneapolis, MN: BRK Publishers, 1980b.
- Carpenter, P.A. and Just, M.A. Sentence comprehension: A psycholinguistic processing model of verification. Psychological Review, 82, 45-73, 1975
- Paivio, A. Imagery and Verbal Processes. New York: Holt, Rinehart, and Winston, 1971.

DISCUSSION

- Q: Did you report anything on errors?
- A: Error rates were purposely kept low. In reaction-time studies, one has to keep error rates low, for two reasons. First, a reaction-time to an error doesn't tell you anything about the process of comprehension. Second, if the task involves "yes-no" responses, and the subject makes, say, 5 errors, it means he guessed wrong 5 times. Which probably means that you've got, according to the rules of probability, 5 more times where the subject guessed right. So there are 5 instances of mis-comprehensions mixed into your data for comprehensions, and there's no way to tell which is which.
- Q: Were negative "foils"--that is, the "mismatch" sentences, always within the same class? Transitive, intransitive, picturable, nonpicturable?
- A: Yes, they were.
- Q: I'm still not sure what you mean by "pictured." Take, for example, "hammer." Was it the name of the verb and also the name of a noun in the picture?
- A: No. The sentence for such a picture would be, "He(he) is hammering." Subjects were specified by pronouns and direct objects were not specified. Your question leads me to an interesting extension to our study, in which one might present a picture of someone, say, hammering, along with the sentence "He(he) is pounding." In that case, the name of the verb wouldn't be directly represented in the picture.
- Q: Have you done anything in which you manipulate levels of transitivity?
- A: No. But it's a good idea.