The Effect of Semantic Redundancy on Auditory Comprehension in Aphasia

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The role of contextual influences on auditory comprehension in adult aphasia has been studied extensively in recent years. Most experimenters investigating this notion compared comprehension of sentences or paragraphs presented in isolation to comprehension of the same stimuli when they were preceded by additional related information. The form of the supplemental contextual information has varied. Waller and Darley (1978), Pierce and Beekman (1985), and others utilized verbal descriptions and pictorial representations as context. Wilcox, Davis and Leonard (1978) utilized videotaped scenarios. Pierce (1986) found that verbal context that was provided subsequent to test sentences facilitated comprehension as did context provided prior to test sentences.

In most studies of context as a facilitator of sentence comprehension, the contextual information was provided before or after the test sentences. In the present study, context was provided within stimulus sentences. One word was placed in the context of another semantically related word within a sentence, and both words referred to the same object. Thus, the semantic redundancy of the sentence was increased. There are frequent references to within-sentence semantic redundancy as a facilitating technique, but little empirical evidence exists to support it.

Two questions were addressed in this investigation. 1) Does the presence of semantic redundancy within a sentence facilitate comprehension? 2) Does the amount of redundancy affect comprehension?

METHOD

Twelve aphasic adults and 10 normal subjects participated. Eleven of the aphasic subjects had suffered a CVA and one a closed head injury. Evidence of unilateral left brain damage was obtained from CT scans, EEG's, and other neurological data in medical records. Nine of the aphasic subjects were male and three were female. Their ages ranged from 26 to 73 years (mean = 59). Time post onset ranged from one to 36 months (mean = 10). Type and severity of aphasia was determined from Western Aphasia Battery performance (Kertesz, 1982). Aphasia quotients ranged from .3 to 51.2. Three of the subjects had Wernicke's aphasia, three had Broca's, four global, one conduction, and one isolation. Scores on the Auditory Word Recognition subtest of the Western Aphasia Battery ranged from 6 to 53 of a possible 60. Aphasic subjects passed a pure-tone air conduction screening test conducted in the testing environment. Criteria for passing was 30 dB Hearing Level for 500 and 1000 Hz and 40 dB for 2000 Hz in the better ear.

The normal subjects were recruited from a senior center. Their ages ranged from 71 to 86 years (mean = 78.3). Five were male, and five were female.

The subjects heard 90 sentences presented live voice. Each sentence was a question requesting the subject to point to a pictured object. Half the sentences were nonredundant, and half were redundant. For both the

nonredundant and redundant conditions, there were three types of sentences and 15 sentences of each type.

In the nonredundant sentences an object was identified by one critical word. In one type of these sentences, an object was identified by its name. In the other two types, respectively, an object was identified by a verb strongly associated with the name or by one weakly associated with it. For example:

While one is the knife?
Which one cuts?
Which one chops?

Which one is the book?
Which one do you read?
Which one do you study?

In the redundant sentences, an object was identified by two semantically related words. In one type of these sentences, the name appeared along with a strong verb associate. In the second type, the name appeared along with a weak verb associate, while in the third there were strong and weak associates. For example:

Which one is the knife that cuts?
Which one is the knife that chops?
Which one cuts and chops?

Which one is the book you read?
Which one is the book you study?
Which one do you read and study?

In order to generate the sentences, we compiled a list of 15 word trigrams. Each trigram was composed of an object name, its strong semantic associate and its weak semantic associate. They were determined from a preliminary oral word association study of 12 normal adults (Clark, 1986). Clark's subjects were presented with incomplete sentences and were required to say as many words as possible to complete them. For example, "A dog is a thing that _____." The following criteria were used in selecting the trigrams. All names were common objects that had both a strong and a weak associate. Strong verb associates were given by at least 50 percent of the subjects and were always given first or second on the word association test. Weak verb associates were given by no more than 20 percent of the subjects and were never listed first or second. The three lists were equated for frequency of occurrence in the English language using the word counts of Thorndike and Lorge (1944).

On each test item, subjects were presented a card with four 2" by 2" pictures on it. They were instructed to listen carefully, to look at the pictures while a question was being asked, and to point to the picture which was the best answer to the question. One picture was the correct choice and two were pictures of objects in the same superordinate category as the correct one. The fourth picture was unrelated to the others and was chosen from the pool of test pictures. The same array of pictures was presented each time an item was tested in the six conditions, but the pictures were arranged in a different order each time.

There were two orders of presenting the 90 sentences, and half of the subjects were assigned randomly to each order. For each order of presentation, the redundant and nonredundant sentences were distributed equally between the first and second halves of the list. Each half of a list also contained

three of the six sentences referring to a test picture. No two questions referring to the same test item were presented consecutively.

In scoring, a correct and prompt response received 3 points. Responses delayed by 1 to 3 seconds received 2 points, and those delayed by more than 3 seconds received 1 point. Raw scores were converted to percentage scores for data analysis.

To determine reliability of scoring, a second person simultaneously scored 3 aphasic subjects with the investigator. Point-by-point percent agreement was 92, 93, and 96 percent for the 3 subjects.

RESULTS

The results are illustrated in Table 1. The total test scores for the aphasic subjects ranged from 19 to 84 percent correct. The Spearman rank order correlation between these scores and scores on the auditory word recognition subtest of the Western Aphasia Battery was .80. To assess differences among the six sentence types for the aphasic group, a one-way analysis of variance for repeated measures was calculated. The sentences were significantly different ($p < .001$). The Duncan Multiple Range Test was used to compare sentence types. The aphasic subjects comprehended all three types of redundant sentences significantly better than all three types of nonredundant sentences. The sentences highest in redundancy (name plus strong associate) were comprehended significantly better than all other sentence types.

Table 1. Group mean scores and standard deviations for the six test conditions.

Sentence Type	Normal Group		Aphasic Group	
	Mean	S.D.	Mean	S.D.
Name	96.7	3.9	52.6	24.7
Strong Associate	97.1	2.9	49.8	24.6
Weak Associate	86.1	7.2	38.1	17.7
Name + Strong	100	0	67.4	22.6
Name + Weak	100	0	59.8	24.6
Strong + Weak	98.7	2.4	60.1	21.4

Among the nonredundant sentences, the aphasic subjects' scores on the name alone sentences were not significantly different from their scores on the strong associate sentences. However, their comprehension of sentences with only a weak associate was significantly poorer than their comprehension of all other sentence types.

Test scores were analyzed to determine if the superior performance in the redundant conditions was due to improved efficiency, accuracy or both. Ten subjects tended to be more accurate as well as more immediate for redundant sentences. One subject was more immediate but not more accurate, and one subject was more accurate but not more immediate. The results indicated that both increased accuracy and increased efficiency accounted for the redundancy effect.

In order to measure the strength of the redundancy effect for individual aphasic subjects, we calculated a Redundancy Index. To obtain this measure, we subtracted a subject's mean percent score for the nonredundant sentences from his mean percent score for the redundant sentences. In this equation, the mean score for the nonredundant sentences was the average of only the sentences containing a name and those containing a strong associate. The sentences with only a weak associate were not included because they did not have a redundant sentence counterpart with which to compare them.

The Redundancy Indices were positive for 11 of the 12 subjects, indicating better comprehension of redundant sentences. The mean Redundancy Index was 13.6 percent with a standard deviation of 7.5. The redundancy indices were compared with the aphasia quotients and the auditory word recognition scores in two Spearman rank order correlations. The index correlated -.39 with the aphasia quotient and .05 with the auditory word recognition subtest.

An item analysis revealed that the redundancy effect was present for all 15 items on the test.

DISCUSSION

It was shown in this study that providing linguistic context in the form of increased redundancy in a sentence improves aphasic persons' comprehension. Aphasic subjects performed better when sentences contained two words that were semantically related than when the sentences contained only one critical word. All three types of redundant sentences were comprehended better than their nonredundant counterparts. This result held even though the redundant sentences contained more words and were syntactically more complex. The consistency of the results in all test conditions, and that 11 of 12 aphasic subjects showed the effect, strongly support the notion that aphasic patients respond to semantic redundancy. This was true even for the four subjects typed as global aphasic.

Not only did the presence or absence of redundancy make a difference, the amount of redundancy was also a factor. Accompanying the name of an object with its strong verb associate was more beneficial than accompanying it with a weak verb associate, although both cases were beneficial.

The mean comprehension level of weak verb associates by the aphasic subjects was 38 percent. This level was sufficient to allow these words to act as facilitators when added to the names or to the strong verb associates. It appears that words not easily comprehended in isolation can act as facilitators when accompanying another word more central to the meaning of the item.

By definition, redundant information in a sentence is that which is unnecessary. The added verb associates in our redundant sentences clearly were unnecessary for our normal subjects, since those subjects comprehended the nonredundant sentences promptly with near 100 percent accuracy. The fact that additional supportive semantic information facilitated the aphasic subjects' comprehension means that the redundant semantic information was not truly redundant or unnecessary for the aphasic group.

It was predicted that in the nonredundant condition the sentences with weak associates would be less easily comprehended than those with object names or with strong associates. This prediction was upheld. However, there was no difference between comprehension of sentences containing object names and those with words that were strongly associated with the object. The strong verb associates were apparently so closely associated with the names that they were as strong a referent to the object as the name itself.

This study was similar to the Gardner, Albert, and Weintraub (1975) study on the effect of redundancy on comprehension in aphasia. The study by Gardner et al. has been cited by Darley (1982), Marshall (1981), and Pierce (1986) among others as evidence for the facilitative influence of within sentence redundancy. On close inspection of their results, it appears that the findings are at odds with ours. Without reporting the data on which their statistics were based, they reported a nonsignificant difference between a word spoken in isolation and their high redundancy sentences, with a trend toward better performance on the target word spoken alone. They had one condition in which a word was used in a neutral supportive context, such as "The cat is nice," and another condition in which the supportive word was semantically related, for example, "The cat is furry." Their conclusion on the effectiveness of redundancy stemmed from their finding that the latter sentences were apparently comprehended better than sentences that contained a neutral word. Again, they did not present data to support that conclusion.

Clinically, it is of interest that aphasic persons who are impaired in single-word comprehension are able to derive more meaning from the presence of two related lexical items than from just one. Single word comprehension is frequently a focus of early treatment (Davis, 1983). For some patients, redundancy can be built into early treatment steps to increase the comprehensi of single words. Gardner et al. (1975) proposed a treatment hierarchy which begins with a single word spoken alone, then moves to the word in a semantically redundant utterance. Results of this study suggest that these treatment steps could be reversed for some patients. Pierce (1986) also suggested that comprehension of a word in isolation may be more difficult than in a contextually supportive sentence, and he questioned the efficacy of the traditional word-sentence-paragraph treatment hierarchy.

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DISCUSSION

Q: I am glad you included the Gardner study in your discussion. That is one of the most misquoted studies that I know of, because the discussion draws conclusions that aren't supported by the results. Most people remember the discussion and not the results. My question is, was your closed-head-injured patient performing differently from your other 11 subjects and why did you include that one closed-head-injured subject?

A: This patient was clearly damaged predominantly on the left side of his brain. He also was right hemiparetic and tested with a profile of aphasia on the Western Aphasia Battery. He, in fact, had the highest Redundancy Index, so he did perform a little differently in that he really responded to the redundancy. He even noticed that he was doing better on some of the items than on others.

Q: I noted that you found no association among the Redundancy Index and the WAB Aphasia Quotient and the Auditory Word Recognition scores. What do you make of the fact that you found no association among severity as indicated by aphasia type or aphasia score and this Redundancy Index?

A: It is hard to draw conclusions about the relationship between severity and the ability to benefit from redundancy because my sample size was small. But I was left with the impression that it was an individual phenomenon -- that some patients will respond well to it and other patients will not.