The Effects Of Environmental Sound On The Naming Performance Of Aphasic Subjects: A Pilot Study

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Introduction

Studies of normal (Atkinson and Wescourt, 1974; Lachman, 1973) and impaired (Mills, Juola and Knox, 1975) cognitive processing have resulted in a model of the processes involved in confrontation naming shown in Figure 1.

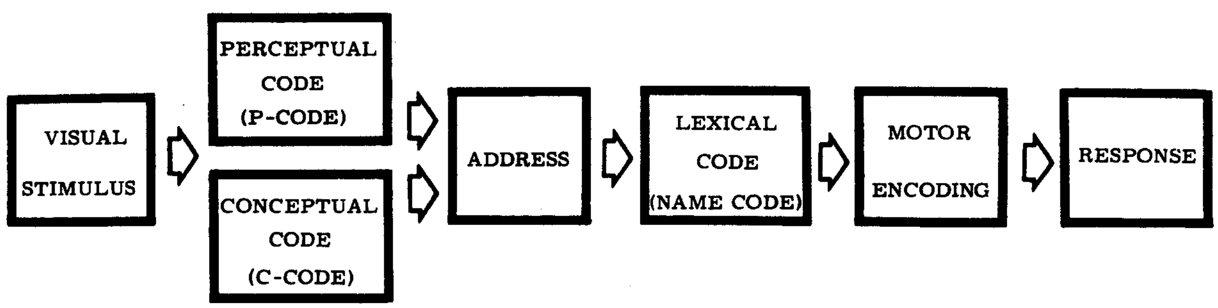

Figure 1. A model of the cognitive processes involved in confrontation naming.

According to the model, successful naming begins with perceptual and conceptual recognition processing. Retrieval of the perceptual and conceptual information codes allows the subject to generate an address to the target name stored in the lexicon. The retrieved name is then converted into appropriate motor movements and spoken as a response.

Aphasic subjects who are impaired in naming have been shown to be impaired in (recognition) processing. However such aphasic subjects perform much better in recognition tasks than they do in naming tasks. It appears that while the aphasic subject can retrieve perceptual and conceptual information, he is impaired in the ability to use this information to generate the appropriate address to the target lexical item. Wiegel-Crump and Koenigsknecht (1973), completed a naming training study in which four aphasic patients demonstrated improved naming on drilled and undrilled items after training. Their training procedure was based on the presentation of several types of conceptual information codes to "cue" correct naming. An important feature of the procedure was reinforcement of correct responses. While this approach demonstrated that naming performance could be improved, their "shotgun" application of information types does not allow one to determine which cue(s) was/were responsible for the improvement in naming. The present study was designed to determine if one type of perceptual information (environmental sound) could be used in a training procedure to improve aphasic naming. Environmental sound was chosen as the perceptual information type because it is applicable to many nominal stimuli and can normally exist in the subject's environment.

Research Questions:

1) Is there cognitive representation of environmental sound in the aphasic individual's information processing system?

2) Will the training procedure based on environmental sound cause improvement in the naming of drilled items which have closely associated environmental sounds?

3) Will the procedure cause improvement in non-drilled items which have closely associated environmental sounds?

4) Will the procedure cause improvement in drilled items which do not have closely associated environmental sounds?

5) Will the procedure cause improvement in non-drilled items which do not have closely associated environmental sounds?

Stimuli

Four neurologically normal subjects rated each of 212 line drawings of objects as having or not having a characteristic environmental sound. Subjects were instructed to list items as having environmental sounds only if they believed the stimulus would be recalled when only the environmental sound was present. The subjects rated 84 stimuli as having such sounds. Total agreement was achieved on 51 items as having sound. Thirty-two of these items were chosen to form the Environmental Sound (ES) group of stimuli. Thirty-two additional items, which none of the subjects rated as having characteristic sounds, were chosen to form the No Sound (NS) group. Sixteen items from each group were selected to form List A. The remaining sixteen ES and NS items formed List B. Both lists were matched in mean and range of word frequency according to the values published by Thorndyke and Lorge (1944). All items were of relatively low average uncertainty (Shannon, 1949). Summary stimulus data are given in Table I.

Subjects

Pretest and identification data for the four aphasic subjects chosen to participate in the pilot study are presented in Table II. All had been diagnosed as aphasic following a left cerebral hemisphere CVA and were at least one month post onset at the time data were collected. All demonstrated impaired naming on their most recent PICA examinations. Two of the subjects were undergoing treatment in the Speech Pathology Unit of the Ann Arbor VA Hospital. No therapy was provided for the naming impairment while data were being collected.

TABLE I. Mean Word Frequency Ratings For Experimental Stimuli.

List	Stimulus Type	Number of Items	Mean Word Frequency* (Occurrences/Million Words)
		32	45.1
A	ES	16	44.8
	NS	16	45.4
		32	46.3
B	ES	16	47.6
	NS	16	45.1

*Thorndyke and Lorge (1944).
ES = Environmental Sound stimulus items.
NS = No Sound stimulus items.

TABLE II. Pretest and Identification Data For Four Aphasic Subjects.

Subject	Lesion Type	Months Post-Onset	Pica Overall	Environmental Sound Recognition Score
NS	LCVA	19	12.32	100%
CL	LCVA	2	9.54	91%
HP	LCVA	2	11.56	97%
WW	LCVA	1	12.82	100%

Procedures

All subjects were first given an environmental sound recognition test in which they were required to point to the picture which produced a given environmental sound in an array of four pictures. Subjects heard each of the 32 ES group sounds once. Results of the ES recognition task are presented in the right hand column of Table II. Upon completion of the recognition task the subjects began the naming training procedure. Responses were measured by two dependent variables: (1) voiced response time of correct responses and (2) error rate or percent errors.

Each subject first received baseline testing (B). During this session he saw each of the 32 pictures in List A and List B. He was asked to name each picture as rapidly as possible with the best single-word name he could recall. The pictures were presented without environmental sound. Following the collection of the baseline data each subject received four training trials of naming practice on either List A or List B. Each training trial lasted approximately 12 minutes and each picture in the list being trained was presented once for naming. The presentation of NS and ES pictures differed. When an ES item was presented on the screen the subject was simultaneously presented with the characteristic environmental sound binaurally via ear phones. The slide and sound were present for a period of 15 seconds after which the projector automatically advanced to the next item. NS items were presented with simultaneous white noise being delivered through the ear phones. Correct responses were reinforced by the illumination of a red lamp mounted next to the screen. No feedback was provided for incorrect responses. Following the completion of trial number four the baseline measure (both List A and B without sound) was repeated (P-4). Training trials five through eight were then provided. The data collection was completed with a third administration of List A and List B without sound (P-8).

Instrumentation

The 35mm diazachrome-blue stimuli were presented by an Ektagraphic slide projector. Presentation of the auditory stimuli and rate of presentation of the slides was controlled by a Sony sync-pulse tape recorder. Voiced response times were measured by a Lafayette Voice Operated Relay and an ITRON 650 digital counter.

Results and Discussion

Environmental Sound Recognition Task. Subjects responded correctly to at least 91% of the recognition items presented in the ES recognition task. Response times in this task were not measured. The results indicate that all four subjects had a cognitive representation of environmental sound within their systems. In addition, for the vast majority of items presented, this perceptual code could be related to at least one other perceptual code (visual) of the concept in question. Because of the acceptable performance level of these subjects it was considered appropriate to continue on to determine whether this perceptual code could be used as a retrieval cue.

Word Frequency Variable

Response Time. The effects of the word frequency variable on response times of correct responses are illustrated in Figure 2. Many previous studies have shown word frequency to have strong effects on naming performance of normal and aphasic subjects. In this study word frequency was shown to have a strong effect on RT at the time of the baseline measurement. Correct responses to high frequency items were produced more rapidly than correct responses to low frequency items. This is consistent with previous naming data. At P-4 the same relationship holds; however, the differences are less marked. After eight treatment sessions, the relationship of the four functions has changed and now correct responses to drilled items are produced more rapidly than correct responses to non-drilled items. So after eight trials, amount of practice produces greater effects than does word frequency.

Error Rates. The effects of word frequency on error rates at the three measurement points in the study are given in Figure 3. The high frequency items begin with fewer errors at the Baseline than low frequency items. The relationship remains the same at P-4 and P-8. However, notice that the slopes of the functions are greater for drilled items. So again, extent of practice was expectedly important in reducing errors but was not free of the continuing effects of word frequency.

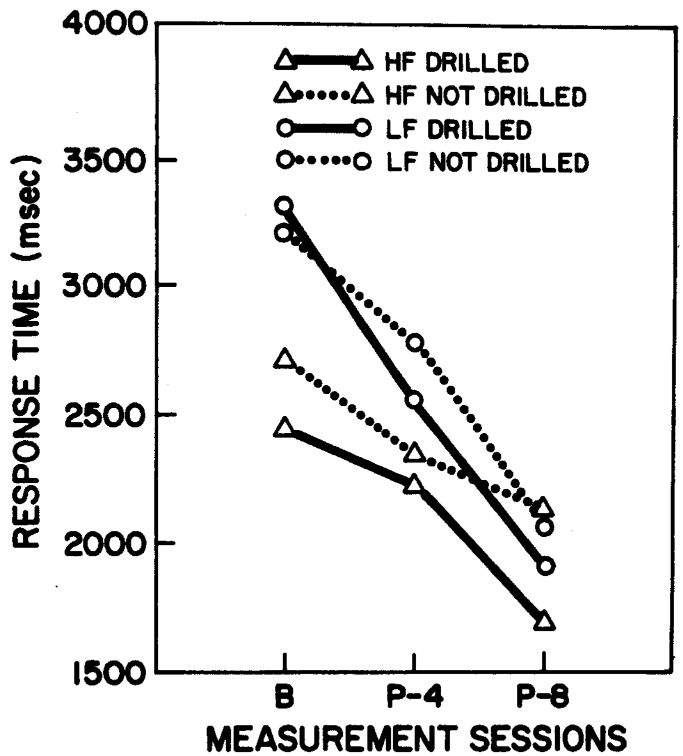

Figure 2. Group mean naming response time data for high versus low frequency item groups.

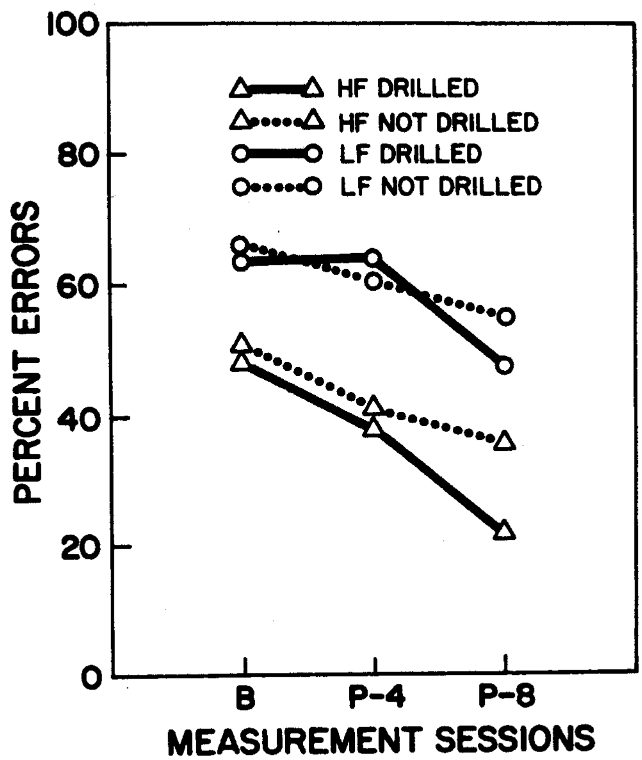

Figure 3. Group mean naming error rate data for high versus low frequency item groups.

Environmental Sound Variable

Response Time. Figure 4 illustrates the effects of the environmental sounds on response times. A comparison of the group mean response times for ES and NS items shows no difference at B. At P-4 the RT data indicate a separation of responses to the ES and NS items. The data indicate that response times for ES items are longer than for NS items at P-4. A comparison of the slopes of the RT functions shows that RT's for NS items decreased more rapidly between B and P-4 than the RT's for ES items. This difference in slopes may represent the greater time taken to retrieve names via a compensatory retrieval strategy based on environmental sounds.

After eight treatment sessions (P-8) the RT data show that responses to correct ES items were produced no faster than correct responses to NS items.

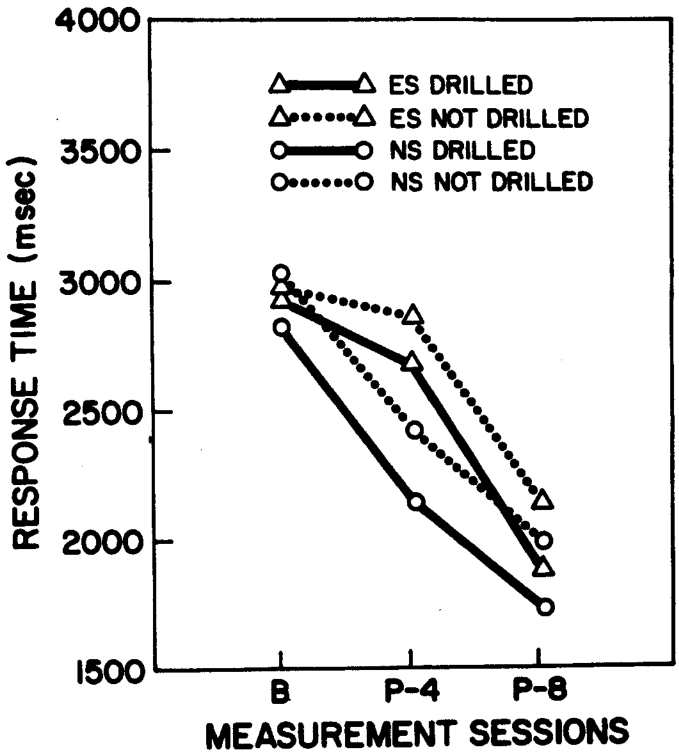

Figure 4. Group mean naming response time data for environmental sound versus no sound item groups.

Error Rates. Figure 5 shows the effects of environmental sound on error rates. At B the only notable feature is slightly fewer errors produced by the ES list under treatment. This difference may be due to the small sample size utilized in the pilot study. At P-4 the percent error values for ES items also appear to be slightly smaller than for NS items. Observation of the P-8 error rate data show striking differences among the four functions. The drilled ES function has decreased significantly and shows the smallest error rate. The second lowest error rates were produced by the non-drilled ES items. The decrease in the drilled ES function indicates that providing the environmental-sound-based practice resulted in a retrieval strategy which was internalized by the subjects. The improvement in the non-drilled ES items indicates that the strategy learned was generalized to a lesser extent to the items in the non-drilled ES list.

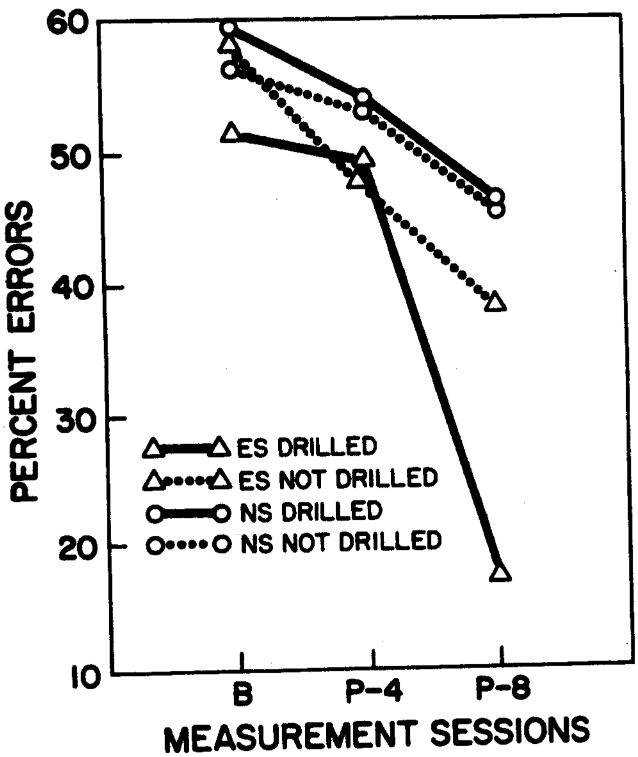

Figure 5. Group mean naming error rate data for environmental sound versus no sound item groups.

Going back to the measurements taken at P-4; if only partial learning of a new retrieval strategy had taken place after session T-4 (in which ES's were present), removal of the environmental sound at P-4 would be expected to produce an increase in the number of errors for ES items. Figure 6 suggests that that is what happened. Notice also that there appears to be a slight negative effect on NS items at P-4. That is, more errors were produced when the white noise was removed at P-4 than were produced at T-4 when the white noise was present.

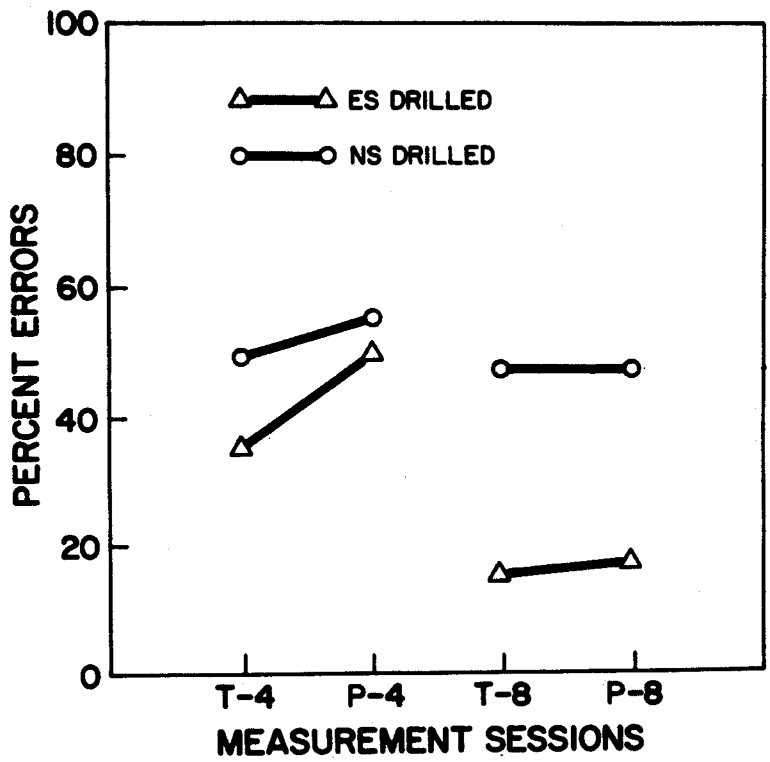

Figure 6. Group mean effects of sound withdrawal on error rate data at the midpoint (T-4, P-4) and endpoint (T-8, P-8) of training.

In contrast to the T-4 vs P-4 comparison, the T-8 vs P-8 comparison shows no such negative effect when the aural information was removed. This would be consistent with the effect expected if a new retrieval strategy had been completely internalized after eight training trials. A comparison of the amount of decrease in error rates is shown in Figure 7. As can be seen the largest percentage of decrease was for drilled ES items. The second greatest change was for non-drilled ES items. The NS items showed equivalent amounts of improvement, with drilled and non-drilled items not significantly different from each other.

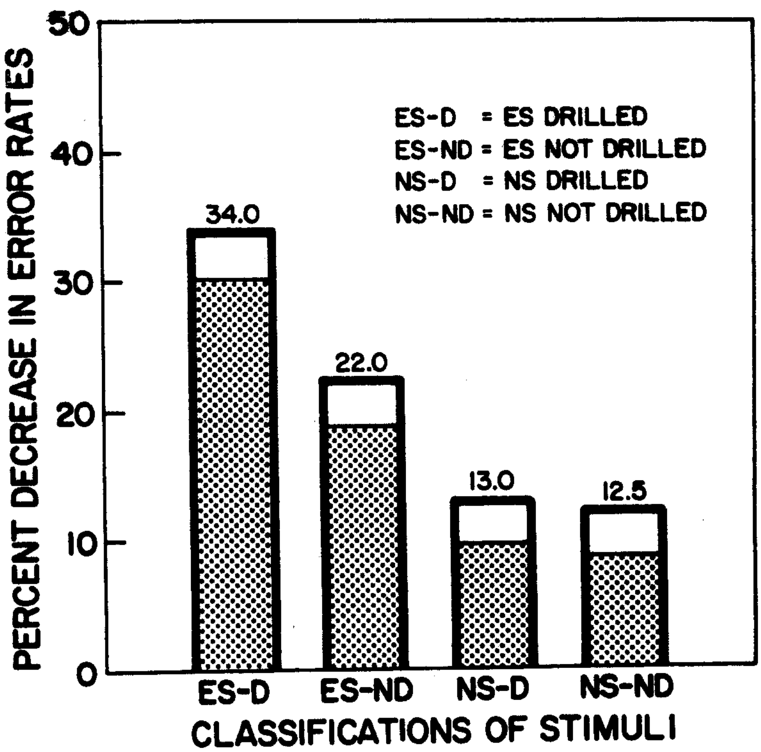

Figure 7. Group mean decrease in error rates for environmental sound versus no sound and drilled versus not drilled item groups.

Conclusions

The trends of the data suggest the following conclusions:

1) The environmental sound treatment procedure was effective in reducing the number of errors produced for ES and NS items.

2) The error reduction for NS items was attributable to the practice effect coupled with correct-incorrect status feedback.

3) The reduction in errors produced for ES items was due in some part to the practice effect and feedback. However, a large part of the improvement was due to the treatment procedure utilizing environmental sounds as cues.

4) The compensatory retrieval strategy learned during the procedure was based on environmental sound, and as such was partially generalized to non-drilled ES items. The degree of generalization shown may have been limited by the short duration of the training procedure (1 hr. 36 min. for the drilled list). It is also possible that even though normals rated the relationship between the stimuli and their environmental sounds as "strong", some environmental sound-visual code complexes may not provide sufficient information to allow subjects to generate the correct lexical address.

5) Because the strategy that was learned was based on environmental sound, the strategy could not be generalized to NS items.

6) If these trends are reflected in the analysis of the full study data, they will indicate that the treatment of aphasic subjects' naming disorders

may make use of environmental sounds as the basis for one retrieval strategy for selected stimuli, but that additional strategies, based on other perceptual and/or conceptual codes will need to be developed to allow successful retrieval of lexical items which do not have commonly associated environmental sounds.

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Discussion

Q. How many sounds were used and how were they selected?

A. A total of thirty-two different sounds were used and they were selected by a group of four normal subjects. These normal subjects sat down and looked at a large pool of 212 items and they said that they did or did not have closely associated environmental sounds. There was a group of fifty-one items where everyone agreed that 1) they did have a sound and 2) they indicated what sound it was, for example, if it was a horse, everyone indicated, "whinny" instead of "clip-clop". So that's the sound that was used.

Q. Did you run those sounds on normals?

A. We had normals listen to those sounds. The sounds were presented randomly on tape and the subjects were asked to write down what they considered to be the best single word response for each sound. There were no ambiguities. We ran three normals (graduate students) and there was really no ambiguity at all in their responses. Everyone gave the same single word response with one exception that I can recall. For the sound of a "horse" one of the subjects wrote down "colt" and I considered it to be acceptable response.

Q. Were the four aphasic subjects tested for recognition of the environmental sounds?

A. Yes, we had that condition right at the onset and minimum performance was 91% correct in selecting the referent picture from an array of four pictures. Two subjects received a score of 100%, and one a score of 97%, so it suggested to me that indeed there was some representation of that sound in their systems and that they could match it to a visual representtation of the concept.

Q. What do you think of the results showing deficits in matching environmental sounds to pictures in Vignolo's study?

A. One difference between the two studies was that the people in the present study were restricted to a single left hemisphere lesion only. And if I recall correctly when Vignolo was looking at his subjects there was a group of right hemisphere people also. One of the reasons that my subjects may have done better is that there was total agreement from the normals as to what had produced the sound. Vignolo and Spinnler did not report this kind of agreement data from a group of normals. They did, however, run a control group through their environmental sound recognition task. The data that they report indicate that over one-half of their control subjects could not complete their environmental sound recognition task at a 100% accuracy level. Their control group was composed of hospital inpatients who had been admitted for spinal cord lesions or for psychoneurosis. The fact that the control group had difficulty with this recognition task suggests that either 1) people with psychoneurosis and/or spinal cord lesions have difficulty with environmental sound recognition or 2) there was something about Spinnler and Vignolo's task which was more difficult than the task presented in the present study.