

Naming in Aphasia: Interacting Effects of Form and Function

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The naming difficulties of Broca's and anomic aphasics were explored in relation to a recently developed model of the normal mental lexicon which stresses the importance of integrating perceptual and functional information in the act of naming, and equally stresses the inherent vagueness of conceptual categories based on such information. Subjects were shown line drawings of various food containers varying in physical features such as height and width; they were required to select a name for the object from a multiple choice list (cup, bowl, or glass). Prototypical as well as nonprototypical objects were shown. The Broca's aphasics showed relatively normal naming profiles. In contrast, the posterior patients were unable to integrate perceptual and functional information and were insensitive to the fuzzy boundaries between conceptual categories. The results obtained for the posterior patients are interpreted as reflecting an impairment in the underlying conceptual organization of the lexicon rather than retrieval difficulties.

The inability to name common objects upon visual confrontation remains one of the most poorly understood neurological symptoms. Anomic behavior can be described in any number of pathological states including dementia, delirium, and various psychiatric conditions (Geschwind, 1967). Naming difficulties, however, are most intimately related to those conditions of central nervous system damage resulting in aphasia. Almost every aphasic, regardless of clinical type or the anatomical localization of his lesion, has some difficulty producing names for common objects (Goodglass & Blumstein, 1973). Indeed, in some patients only naming seems significantly impaired, the word *anomia*, in fact, figuring in the diagnostic label—*anomic aphasia*.

Previous studies of *anomia* in its more general sense have focused on many different variables. Thus, word finding has been analyzed in relation

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to the frequency with which words appear in the language (Wepman, Bock, Jones, & Van Pelt, 1964; Howes, 1967); as a function of the age of acquisition of words (Rochford & Williams, 1962); in terms of broad semantic categories (Goodglass, Klein, Carey, & Jones, 1966); and as a function of the internal structures of various semantic domains (Goodglass & Baker, 1976; Zurif, Caramazza, Myerson, & Galvin, 1974). Even nonlinguistic factors have been examined in attempts to explain anomia—factors such as the picturability of an object to be named (Goodglass, Hyde, & Blumstein, 1969) and the sensory-motor schema involved in the knowledge of a word's referent (Gardner, 1973).

The above factors have associated with them a wide assortment of theoretical notions, but the theories are somewhat vague and their broad range makes consensus and synthesis difficult. Further, in the studies referenced above, attention has been paid more to the properties of the words themselves and their interrelations, rather than to the actual process of naming. In addition, major confusions still remain concerning the characteristics of anomic behavior in different types of aphasia: Is anomia the same process in all states of brain damage in which it appears? If not, how does it differ? Does the anomic behavior of a Broca's aphasic, for example, differ from that of an anomic aphasic?

Clearly, naming behavior can be disrupted by malfunction in any one of a series of stages along the information-processing chain which generates the label for a visually perceived object. These stages need to be made more explicit, however. In addition, the conceptual basis of lexical organization must itself be characterized; in the case of the various anomias, it remains to determine whether the problem has to do with a disruption at the level of this conceptual representation or with a disruption to mechanisms concerned with retrieving the lexical information. This last issue has not received the attention it deserves. To address this issue, however, we need a clear formulation of the nature of the mental lexicon itself.

Initial steps to provide an explicit model of the conceptual representation have been taken by Labov (1973) and by Miller and Johnson-Laird (1976). One such step turns on the notion that conceptual categories are inherently "vague"; that is, that boundaries between categories are ill-defined or fuzzy (Labov, 1973). One can imagine, for example, being asked to name a very wide but shallow food container with a single handle—an object, in other words, that possesses some perceptual properties of a cup (e.g., handle) and some of a bowl (e.g., width). The choice between labeling this object a cup and a bowl is seen as being a matter of degree rather than as being all-or-none (see also Hersh & Caramazza, 1976). Only prototypical objects belong almost exclusively to one particular category.

Labov's exploration of naming as a function of these fuzzy conceptual boundaries centered on the category of food containers. By manipulating perceptual features such as height, width, shape, and number of handles,

various line drawings of containers were created; after a suggestion by Black (1937), Labov used consistency of naming as his measure of vagueness. This measure is based on the empirical fact that prototypical objects are named consistently, whereas borderline cases are named inconsistently. Thus, for his normal subjects, Labov demonstrated relatively smooth naming profiles in which changes in perceptual characteristics (e.g., increasing width) yielded consistent changes in the choice of a label (e.g., more and more "bowl," rather than "cup" responses).

Labov also explored the interaction of perceptual and functional information in the act of selecting names for the line drawings of the objects. Asking his subjects to imagine a depicted container being used to hold various types of food, he observed that the use to which the object was put altered the naming profiles in predictable ways. For example, imagining coffee in an indeterminately drawn object generated more "cup" responses; imagining solid food in that same indeterminate object generated more "bowl" responses.

Miller and Johnson-Laird (1976) also stress this important interaction between perceptual and functional information and, indeed, provide a more comprehensive framework for the integration of such information in lexical memory. They view the concept "cup," for example, as being defined and given meaning by a set of procedures which includes both perceptual and functional information. "Cup" might have the following entry in the lexicon: It is a connected and rigid object, it is composed of a hard, usually ceramic, material, and it is used to hold liquids, usually hot liquids, for the purpose of drinking. This lexical entry includes both the perceptual and functional information necessary in deciding whether a given object is a cup or not a cup.

That even moderately impaired aphasics are capable of integrating such perceptual and functional information in their patterns of everyday action and thought is well known and not at issue here. What is of concern here, however, is the ability of aphasics of various clinical types to utilize and to integrate this information *in order to find a verbal label*. More specifically, building on the notion that perceptual and functional information structures the conceptual domains in which words and their meanings are embedded, we attempt to chart the *locus* of naming problems in aphasia. It is an initial step and rests on the distinction between retrieval mechanisms, on the one hand, and the storage of the to-be-retrieved information, on the other. Thus, as one possibility, although aphasic patients may control conceptual elements at a nonlinguistic level, it is nonetheless conceivable that these elements are insufficiently structured for adequate lexical organization. Alternatively, it is possible that brain damage spares the conceptual structures underlying lexical organization but dissociates and disrupts mechanisms responsible for addressing and/or retrieving information from these structures.

The task we have used to study these possibilities is a slightly modified version of Labov's (1973) paradigm. Whereas Labov required his subjects to name the drawings, we have provided our patients with a multiple-choice-response mode. Both Labov's original task and our modified version allow study of the integration of perceptual and functional information in the act of selecting the name of an object. The modification, however, additionally minimizes retrieval demands, so that any errors can more easily be attributed to alterations in the underlying lexical structure.

METHODS

Subjects. Ten aphasic inpatients at the Aphasia Research Center of the Boston Veterans Administration Hospital served as subjects. Each patient was administered the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) and the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1976) by staff speech pathologists and neuropsychologists. On the basis of the test results and on clinical examinations performed by staff neurologists, five patients were diagnosed as Broca's aphasics and five as anomic aphasics. In all instances, neurological diagnostic techniques confirmed that the Broca's aphasics suffered from anterior damage and that the anomic aphasics had posterior damage. Age (range, 50-65), sex (all male), and education (average, high school) were matched as closely as possible in the two groups.

Stimuli. The objects to be named were 24 line drawings of containers drawn by an artist to careful specifications. The modal form was in the shape of a prototypical cup: It had a handle and was 5.1 cm wide and 3.2 cm high. Variations on this modal form were fashioned along two linear series. One series consisted of six objects increasing in height with height-to-width ratios relative to the modal form of 1.2, 1.5, 1.9, 2.4, 3.0, and 4.0. The second series was composed of six objects of increasing width with width-to-height ratios (relative to the modal form) of 1.2, 1.5, 1.9, 2.5, and 3.0. Twelve of the 24 drawings had a single cup-like handle; the other 12 drawings were identical in form to the first 12, except that they were missing the handle.

Context was provided by additional line drawings constructed to the same scale as the target objects. In the cup, bowl, and glass context conditions the depicted target container (i.e., the container to be named) was shown to the subject in the context of a drawing of a coffee pot with coffee pouring into the container, a cereal box with breakfast cereal pouring into the container, a pitcher of ice water with water pouring into the container, respectively. The figures were drawn so that when the context figure and target object were put together they appeared as one picture of a food substance being poured into a container. In the neutral context the depicted target object was shown to the subject on a white background.

Procedure. All subjects were tested in the same quiet room facing the experimenter over a small table. Each session was approximately 30 to 45 min in duration, depending on the individual patient's tolerance. An average of three to five sessions was required to complete the testing. During the initial session a number of pretests were performed which included asking the subject to name other line drawings of different prototypical food containers and asking him to name objects to a verbal functional description (e.g., what do you usually drink coffee from?) Any patient who could not name the prototypical cups, bowls, and glasses was excluded from further testing.

During the main testing procedure, the subjects were shown 24 blocks of the 24 line drawings described above. The blocks were divided into six groups with four blocks in each group. In each group, one block was shown under each of the four context conditions (neutral, cup, bowl, and glass). Thus, each of the 24 line drawings was shown to each subject 24 times—six repetitions under each of four different context conditions. Eight different random orders of

the 24 drawings were used randomly for the different blocks. The blocks were randomized in the groups, and the groups themselves were randomized in their order of presentation.

On each trial the subject was offered a name choice for the target object—cup, bowl, or glass. The choices were presented orally, in random fashion, and the subject indicated his choice by raising his hand when the experimenter spoke the desired name. Admittedly, this multiple-choice technique narrowed the possible response alternatives, but it had the advantage of not requiring a verbal response from the subject. Thus, individual differences in the effort required to produce the names were eliminated. Subjects became quite facile with the response mode. Spontaneous verbalization on the part of all subjects could not be eliminated.

RESULTS

The results will be considered in two sections. First, the consistency of naming profiles will be described in relation to the ability to integrate various perceptual elements. Of particular importance here will be the patients' sensitivity to fuzzy boundaries between conceptual categories. Second, the effect of functional contexts on the labeling behavior of the two patient groups will be described.

Naming Profiles

Figures 1 and 2 represent consistency-of-naming profiles for the anterior and posterior aphasic patients. The graphs show the relationship between physical (perceptual) characteristics of the object (on the abscissa) and labeling behavior (on the ordinate). Figure 1 illustrates the results for the physical dimensions of increasing width; Fig. 2 illustrates increasing height. All objects in these two example graphs had handles. The normal naming profile is an ogive with objects at each end of the two series being named relatively consistently (high and low frequency of naming the objects "cup"). The borderzone objects in the middle of the series are named inconsistently and give the curve its sloping ogive shape.

From the figures one can conclude that the Broca's aphasics show relatively normal naming profiles. Specifically, these patients seem to be able to name prototypes consistently and to be sensitive to the fuzzy boundaries between concepts. Indeed, their data strongly resemble the naming profiles that Labov (1973) has charted for his normal subjects. The anomic aphasics, in contrast, do not show the normal naming profile; rather, the data indicate that they are unable to integrate the perceptual information provided by the target objects.

These qualitative observations were confirmed by statistical analyses. The data were subjected to Friedman's two-way analysis of variance by ranks for correlated samples. Separate analyses were carried out for each patient group and width/height dimensions. For the anterior group, a significant effect of labeling was obtained for both perceptual dimensions (width: $\chi^2(5) = 16.2, p < .01$; height: $\chi^2(6) = 13.67, p < .05$). Subsequent monotonic trend tests for correlated samples (Ferguson, 1976) on the two per-

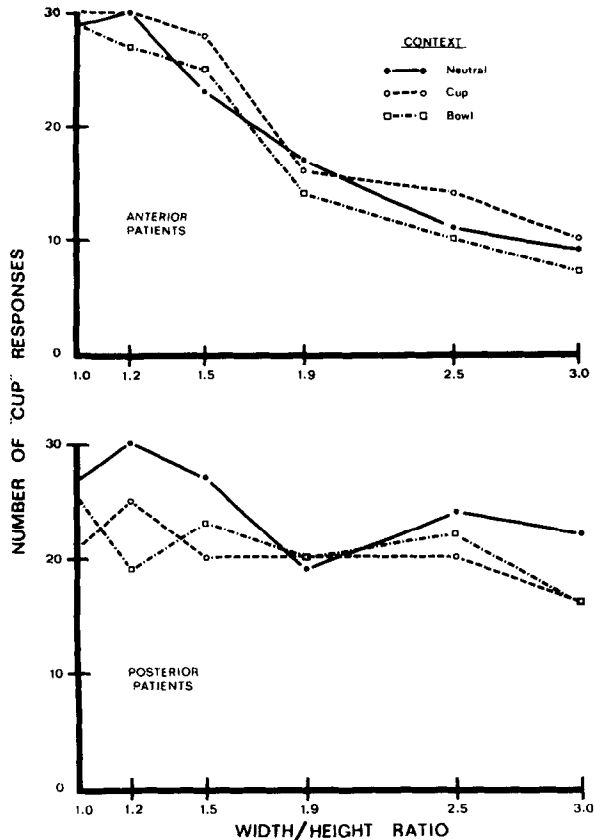


FIG. 1. Number of "cup" responses for anterior and posterior aphasics as a function of context and height to width ratio—increasing width.

ceptual dimensions were also statistically reliable (width: $z = 3.5, p < .01$; height: $z = 3.4, p < .01$). No reliable effects were obtained with Friedman's analysis of variance for the posterior group (width: $\chi^2(5) = 9.0$, not significant (ns); height: $\chi^2(6) = 2.3$, ns), and therefore monotonic trend tests were not carried out on these patients' data.

A consideration of each patient's data shows at least two patterns of behavior in the anomic aphasics, both patterns reflecting an inability to integrate perceptual information. Thus, three anomic patients were markedly unable to name any object with normal consistency. Even prototypical shapes were not completely immune from their inconsistent approach. Two other anomic patients seemed to select object names using overly simplified rules. For these latter patients an object appeared to be labeled a "cup" solely on the basis of whether or not it had a handle. This kind of rule ignores the integration of dimensional information (width and height) with the handle information, integration that is characteristic of

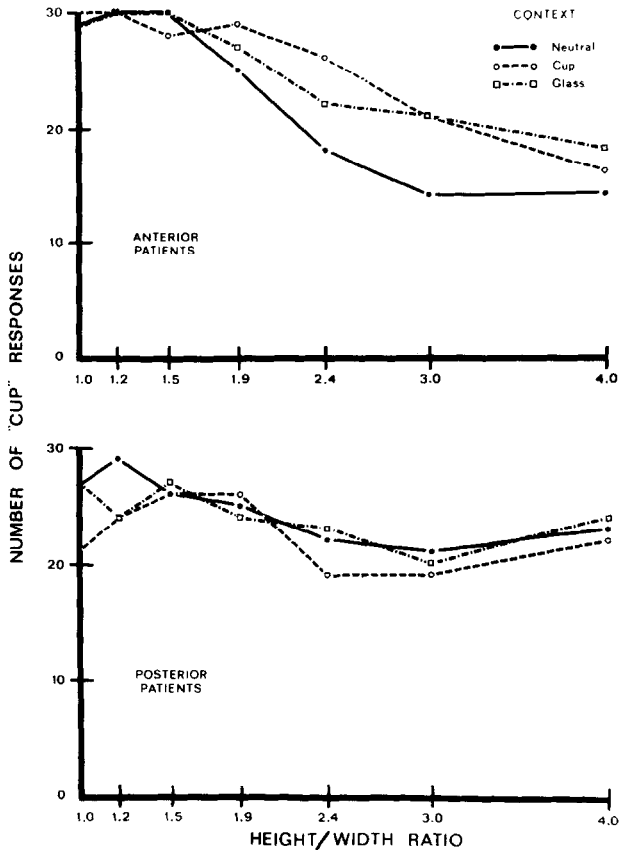


FIG. 2. Number of "cup" responses for anterior and posterior aphasics as a function of context and height to width ratio—increasing height.

normal and Broca's aphasic performance. One subject in this latter group rather remarkably (and over three testing sessions) referred to all objects with handles as cups and those without handles as bowls. He ignored the possibility of using the word "glass" even for tall and narrow objects without handles.

Context Effects

Normal subjects use functional information, where possible, when choosing a name for an object. Thus, as already mentioned in the introduction, in "transitional" perceptual regions, different functional contexts lead to shifts in the naming profiles of normal subjects.

Figures 1 and 2 include naming profiles for the patients in the functional context conditions as well as in the neutral condition. Note that the curves for the anterior patients are shifted in directions consistent with expecta-

tions: The Broca's aphasics tend to call the target objects "cups" more often in the cup context and less often in the other context. Only the glass context in Fig. 2 does not lead to fewer cup responses, probably reflecting the influence of the handle and the fact that water is very often drunk out of cups. At any rate, the performance of the anomic patients once again contrasts with that of the Broca's patients'. That is, unlike the Broca's subjects (and normal subjects), they do not show the expected effects of functional context.

In addition to charting the obvious qualitative differences in the naming profiles of the two clinical groups, a quantitative estimate of these profiles was obtained for statistical evaluation. For each patient and each object named, the data were scored in terms of positive, neutral, and negative effects of context. In other words, each time a context resulted in an appropriate increase in the expected direction, a score of "one-positive-effect" was awarded (e.g., if for a given target line-drawing the cup context resulted in two more "cup" responses, a score of plus two was recorded). Negative context effects were scored when the context represented a shift in an unexpected direction (e.g., for a given object the cup context led to fewer cup responses). Neutral changes were any other context effects not relevant to the issue of an appropriate shift (e.g., for a given object a cup context being associated with changes from bowl to glass responses). Table 1 shows the data from each patient summed across all 24 objects and all four contexts.

To assess the positive and negative effects of context, ratios of number of positive to neutral shifts and negative to neutral shifts were calculated for each patient. A ratio of one reflects equal numbers of positive (or negative) shifts and neutral shifts—a finding suggesting no important effect of context in altering the patients' naming behavior. The only mean ratio above one was the positive effect of context in the Broca's aphasics. Statistical analyses confirmed that there was a significant difference between the two clinical groups in the number of positive context shifts ($t(8) = 2.50$, $p < .05$) but showed also that there was no significant difference in the number of negative context shifts ($t(8) = 0.84$, ns).

The higher number of neutral shifts in the posterior group probably reflects this groups' tendency toward generally inconsistent naming. The three posterior patients with the largest number of neutral shifts were, in fact, the same three patients grouped together on the basis of their naming profiles. The two patients who seemed to use oversimplified rules had far fewer context shifts, suggesting an inability to incorporate functional information into their rules.

DISCUSSION

The experiments reported in this paper represent an attempt to describe patterns of anomic behavior in Broca's and anomic aphasics with special

TABLE I
CONTEXT EFFECTS

	Neutral Δ	Positive Δ	Negative Δ	Number of positive Δ Number of neutral Δ	Number of negative Δ Number of neutral Δ
Anterior patients:					
L	17	27	14	1.59	0.82
D	13	29	12	2.23	0.92
W	22	40	31	1.82	1.41
R	30	32	31	1.07	1.03
J	22	33	17	1.50	0.77
Mean	21	32	21	1.64	0.99
Posterior patients:					
Gu	40	51	33	1.28	0.82
P	16	18	19	1.12	1.19
G	62	49	33	0.79	0.53
S	53	55	44	1.04	0.83
F	0	0	0	—	—
Mean	34	35	26	1.06	0.84

focus on whether the naming disturbance can be attributed to underlying lexical structural impairments. The results did allow differentiation of the two groups. The Broca's patients demonstrated a relatively intact underlying lexical structure with normal abilities to integrate perceptual and functional information and to deal with fuzzy conceptual boundaries. The anomic patients showed evidence of lexical distortion, manifested as an inability to integrate perceptual information (e.g., dimensional and handle features) as well as an inability to integrate perceptual with functional information (e.g., dimensional with context). Additionally, the anomics seemed insensitive to category boundaries. Evidence for two different patterns of performance in the anomic patients was presented, although the sample size is relatively limited and prevents strong generalization to the population of anomic aphasics as a whole.

Although the anomic and Broca's aphasics can be broadly differentiated on the basis of their performance in the experimental task, there is some overlap in scores. Certain anomic patients seemed better able to integrate contextual and perceptual information than others; one Broca's aphasic seemed relatively insensitive to context. In an attempt to account for this variability, we explored the possibility that the results from several of the subtests of the Boston Diagnostic Aphasia Examination might similarly

differentiate among our patients. We chose such standardized measures as total severity ratings, auditory comprehension, rated word-finding difficulty, and the Boston Naming Test. None of these measures, however, accounted for the variability observed in the present study, presumably reflecting the fact that these standardized naming tests emphasize the quantitative rather than the qualitative nature of the patient's performance.

Yet, this lack of agreement notwithstanding, the findings reported herein do receive some support in the research literature—at least in terms of a general anterior (Broca)–posterior distinction. Thus, making use of a task in which patients had to group words according to similarity of meaning, Zurif, Caramazza, Myerson, and Galvin (1974) observed that although Broca's aphasics seemed to base their similarity judgments on functional information, posterior patients were unable to make use of functional information in structuring lexical items. This distinction can be drawn more forcefully in a study reported by Goodglass and Baker (1976). Asking their patients to squeeze a bulb each time a spoken word reminded them of a pictured target object, they found that Broca's, but not posterior patients, recognized functionally based relations, i.e., relations between the target object and the spoken names of situations and actions normally associated with it. Again, therefore, as in the present study, it seems that the Broca's internal lexicon is more richly elaborated and better structured in terms of practical or functional information than is the internal lexicon of the patient suffering posterior damage.

Undue emphasis should not be placed only on functional information, because there is also, as we have pointed out, an important perceptual part to the conceptual structures which provide words with meaning. In this respect, there are scattered observations that naming difficulties, at least for some posterior patients, can be traced to a relative inability to use perceptual data to organize the lexicon. Kok (1964), for example, has reported several cases of anomia associated with left temporal–occipital lesions where visual recognition is intact when assessed clinically but impaired when assessed tachistoscopically. Further, Tsvetkova (1972) has suggested that certain posterior patients may have an impaired image of the object associated with the verbal label. This image has perceptual attributes and may need to be generated from the perceptual features stored in the lexicon.

To this point, then, we have argued that the naming difficulties observed for posterior, especially anomic aphasics, can be attributed to a problem with the manner in which the concepts underlying word meaning are organized. We have argued, however, that this problem can be traced to an inability to organize the concepts in terms of functional and perceptual information. Even granting the legitimacy of this analysis, what can we say about the Broca's aphasics for whom we found normal performance on our task despite clinically evident naming disturbance? One possible answer,

it seems to us, is that suggested by Luria: namely, that the anterior aphasic's difficulty with naming has more to do with accessing the articulatory form of the required label than with the manner in which the information corresponding to the labels is stored (Luria, 1973). The multiple-choice response mode used in the present paradigm, therefore, circumvented the Broca's problems. It eliminated the need for the patient to generate his own verbal response.

In summary, we have presented evidence that suggests that at least one source of difficulty in naming is a disturbance of the conceptual representation associated with a label (For a more detailed discussion on this question see Caramazza & Berndt, in press). This conclusion does not exclude the possibility that some anomic disorders may result from difficulties purely at the retrieval level, that is, from problems that directly affect retrieval mechanisms. In the research we have reported, demands on retrieval mechanisms were minimized via a multiple choice task that emphasized the patient's ability to integrate various sources of information in naming. In this context, our data suggest that whereas posterior aphasics cannot readily integrate perceptual and functional information in naming, anterior aphasics perform normally in this domain. This difference bears an intriguing relation to one very well-established clinical difference: Though the Broca's aphasic has a word-finding problem, the content words he finds are very often correct; patients with posterior damage, in contrast, often do not find the correct words.

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