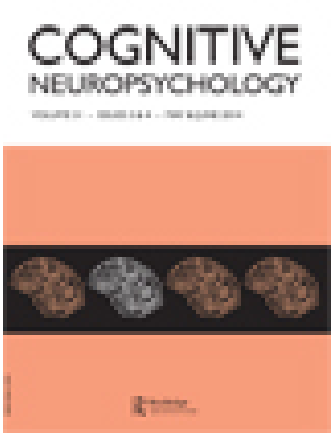

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The facilitation of picture naming in aphasia

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The Facilitation of Picture Naming in Aphasia

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A series of four experiments are described investigating the effects of a number of treatments on the ability of aphasic patients to retrieve picture names, at some time after the treatment is applied. Auditory word-to-picture matching, visual word-to-picture matching and semantic judgements are found to have effects lasting for up to 24 hours. It is argued that durable facilitation of aphasic word retrieval is a consequence of treatment techniques that require the patients to access the semantic representation corresponding to the picture name, and this is contrasted with the short-term effects of techniques that provide patients with information about the phonological shape of the name. The theoretical and therapeutic implications of these results are discussed.

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INTRODUCTION

When an aphasic patient cannot find a word, provision of additional information about some aspect of the word (typically either its phonology or its semantics) may assist its retrieval. Various aspects of this "cueing" process can be subjected to empirical scrutiny. One can, for example, assess the efficacy of different types of cue (e.g. Rochford & Williams, 1962), the relationship between type of aphasic syndrome and benefit from cueing (e.g., Myers, Pease, & Goodglass, 1978) or the time course of cueing effects (e.g., Patterson, Purell, & Morton, 1983). From a theoretical perspective, one can then attempt to use such descriptive results in specifying the nature of a naming deficit. If, as seems likely, the ability to name an object involves several functionally separable sub-processes, then a failure to name could arise from a deficit at one of several different loci. An understanding of the conditions for successful cueing may permit the specification of compromised and intact sub-processes (e.g., Howard & Orchard-Lisle, 1984).

We wish to distinguish three paradigms in the study of cues for aphasic naming which we shall label, somewhat arbitrarily, the paradigms of *prompting*, of *facilitation*, and of *therapy*. All three paradigms involve techniques or treatments intended to assist naming. The most common techniques are: repetition (pronouncing of the target word for the patient to repeat), phonemic cueing (providing the initial sound of the target word) and sentence cueing (providing a sentence which must or can be completed with the target word). By *prompting*, we mean application of a single technique which is intended to ameliorate naming difficulty *at the time* that a patient is trying unsuccessfully to find a word. If, in such a case, after hearing the word or its initial sound or an appropriate sentential context, the patient is *immediately* able to produce the target word, we say that prompting has been successful. By *facilitation*, we mean one application of a single technique with a view to assessing its specific effects *at some later time*. If the patient is significantly more likely to be able to name the appropriate object some minutes, hours or days after a specific treatment has been applied to the target word, we would say that facilitation has been successful. By *therapy*, we mean multiple applications of various techniques, perhaps singly but more typically in combination, intended to produce lasting improvement in word-finding which might be restricted to the treated words or which, with luck, might "generalise" to other words.

The distinction between prompting on the one hand and facilitation and therapy (taken together) on the other obviously involves the contrast between immediate and long-term effects. The distinction between facilitation and therapy, the two paradigms concerned with long-term effects, involves the issue of whether any observed effect can be directly attributed to a specific event. In the process of therapy, a target word will have been treated a number of times with a variety of techniques; as a result, it is

impossible to attribute any improvement in the retrieval of that word to the effects of any specific technique. However, in a study of facilitation, as long as the necessary control conditions are included, conclusions can be drawn about the specific source of any observed effect.

The existing literature offers a number of studies of prompting (e.g., Rochford & Williams, 1962; Myers Pease & Goodglass, 1978), a few of therapy (e.g., Wiegel-Crump & Koenigsknecht, 1973) and only one or two of facilitation (e.g., Patterson, Purell & Morton, 1983). We would argue that, from a theoretical perspective (and from the perspective of rehabilitation if this is to have a coherent theoretical basis), facilitation is the most crucial type of investigation. This is because, as outlined above, a paradigm of facilitation enables one to relate the outcome to specific treatment techniques. We would suggest that these three paradigms fall into an approximate hierarchy. A technique that is successful as a prompt may or may not be an effective facilitator, but we would be surprised to find that an ineffective prompt worked as a facilitator. Similarly we would expect that a successful facilitator might be useful as a therapy technique, whereas a facilitator with only very short-term effects would be less likely to result in any lasting improvement in word finding when used as a therapy technique.

The experiments reported in this paper all use the paradigm of facilitation. Before turning to the question of facilitation we will briefly review the current state of knowledge in the paradigms of prompting and therapy.

Prompting of Aphasic Naming

Rochford and Williams (1962) studied the effectiveness of four different sorts of prompts in picture naming. Their results showed that a sentence completion (e.g., "it is a wrist ... (watch)"), a rhyme ("not a scotch but a ...") or the spelled word ("it is a W, A, T, C, H") were about equally effective, while a description ("we tell the time by it") was only about half as useful. Hatfield et al. (1977) suggested that this was because the functional description provided no additional information to the subjects; the aphasics already knew what the object was and what it was for—what they could not retrieve was its name. Myers Pease and Goodglass (1978) examined six sorts of prompt; two provided phonological information: a phonemic cue ("/læ/" for ladder) and a rhyme. The remaining four provided semantic information: location ("it's on the beach, it's a ..."—shell), superordinate ("it's a kind of silverware, it's a ..."—spoon), description and sentence completion. Different diagnostic groups did not differ in their patterns of response to the prompts, although patients with more severe naming problems were less likely to benefit from them. Phonemic prompts were the most effective, followed by sentence completions, with no differences among the remaining prompts.

With a second opportunity to name a picture which was failed on the first attempt, a patient may succeed on a proportion of occasions, even if

given no extra help; Patterson, Purell, and Morton found that this occurred with about 25% of failed items. Indeed, additional time for lexical search is the most effective method that aphasics spontaneously use to aid word finding in speech production (Marshall, 1976; Farmer, 1977). It is, therefore, unfortunate that neither Rochford and Williams nor Myers Pease and Goodglass compared the effects of their prompts with additional time for naming, so that it is impossible to know whether their less useful prompts had any specific effects.

This problem was avoided by Podraza and Darley (1977) using a technique they call "prestimulation". In this technique, the aphasic subject hears a word (or series of words) immediately before being given a picture to name; the effects of different sorts of "prestimulation" may be compared to a control condition in which there is no "prestimulation". They found naming performance to be enhanced, relative to the control, in three conditions—when prestimulation was with a phonemic cue, or with an incomplete sentence cueing the picture name, or with a series of three unrelated words containing the target word. However, hearing a sequence of three names semantically related to the target word before naming the picture (e.g., "sting, honey, hive" preceding a picture of a *bee*) resulted in significantly *reduced* naming performance relative to the control condition; predictably enough, the extra errors in this condition were mostly semantically related to the target.

Therapy for Naming in Aphasia

Therapists have long been interested in using prompts to elicit words from patients with the hope that the patients will subsequently be able to retrieve the names without help. Most discussions of such techniques have emphasised the importance of a "multimodal" approach: a word should be elicited in any one of a variety of ways—repetition, phonemic cueing, reading, writing or listening—and their use practised in a variety of situational and grammatical contexts (Schuell, Jenkins, & Jimenez-Pabon, 1964; Luria, 1970; Eisenson, 1973). The effectiveness of this multimodal approach was evaluated by Wiegel-Crump and Koenigsknecht (1973): four "amnesic" aphasics were each treated in 18 one-hour sessions, where certain words were drilled by repetition, their use in sentences, phonemic and contextual prompts and repetitive stimulation. This resulted in improved retrieval of the picture names that had been practised, and this improvement also "transferred" to the names of other pictures that had not been used in therapy.

A similar technique was used by Seron et al. (1979) to compare two different therapeutic approaches. One group of four patients had 20 therapy sessions over two months involving intensive application of many different therapy techniques to a small set of words. The control group of four patients were treated in the same number of sessions involving what is

described as "traditional language therapy" on a large set of words. Three aphasics from the experimental group and only one of the controls had made significant improvement when re-tested at the end of the treatment period on a 240-item naming test. Seron et al. conclude that "in some cases at least" multimodal therapy based on only a few words may be more effective than traditional therapy.

These last two studies demonstrate that treatment involving the intensive elicitation of words using a variety of methods and practising their use in a number of different ways can result in improved availability of these names. It is not, however, clear that the improvement reported in these experiments is a specific consequence of the particular treatment regimes applied. The difficulty in interpreting them is that it is unclear *which*, if any, of the many techniques that were used actually helped the patients to improve their naming; some may have been beneficial, others useless or even, like Podraza and Darley's (1977) associate prestimulation, actually harmful; we simply do not know.

Facilitation of Aphasic Naming

In a number of papers Weigl describes a technique for facilitation of aphasic performance that he calls "de-blocking" (Weigl, 1961, 1970a, 1970b; Weigl & Kreindler, 1960; Weigl & Bierwisch, 1970). This describes a technique where use of a word in a relatively unimpaired modality subsequently makes it available in an impaired modality. This effect is relatively short-lasting; Weigl and Kreindler (1960) estimate that the immediate effects of de-blocking last for less than 10 minutes. But if, during this period, the "de-blocked" task is successfully performed, the patient will remain capable of performing the task again for a much longer period which may be between two days and two years (Weigl, 1961; Weigl & Bierwisch, 1970). According to Weigl (1961), a precondition for successful de-blocking is that the patient remains unaware of the relationship between the de-blocking task and the task to be de-blocked.

"De-blocking" therefore describes a three-stage process: first, a patient who is unable to perform one task involving a particular word uses it in another task where s/he will be successful (the "de-blocking task"); if then, within the next few minutes, s/he attempts the task which was originally impossible it will now be possible (the task has been "de-blocked"); afterwards, performance of the "de-blocked" task will remain possible for a period of days or years. To take a concrete example, an aphasic who could always repeat words correctly, but made errors in picture naming, was asked to repeat the names of six pictures that he could not name; after a short interval the pictures were presented again, together with other pictures whose names had not been repeated, and he named all the de-blocked pictures correctly. Apparently he remained able to name them "after the end of the experiment" (Weigl, 1961).

Other studies of facilitation have not reported quite such impressive effects. Cohen, Engel, Kelter, and List (1979) compared the effects on aphasic picture naming of facilitation by completion of relatively open-ended sentences with facilitation by completion of over-learned sequences (clichés, folk songs, nursery rhymes, etc.). The patients were given a 50-item naming test; when they could not find the correct names they were given either one of the two cues as prompts or no additional help. For elicitation of the correct name, the over-learned sequences were more effective prompts than the open-ended sentences. The test was then repeated 24 hours later. Words that had not been prompted successfully were no more likely to be retrieved than those that had not been cued at all. Of those that had been prompted successfully, however, words that had been cued by the open-ended sentences were more likely to be named correctly than those that had been cued by the over-learned sequences. Cohen et al. ascribed this difference to a search in semantic memory, which is required in response to open-ended cues, having greater long-term effects than the relatively automatic production of a word in response to a cliché cue.

Patterson, Purell, and Morton (1983) investigated the effects of word repetition and phonemic cueing on the facilitation of naming. When an aphasic patient could not find a picture name, repeating it was an effective naming prompt if the picture was presented for naming again immediately afterwards. By the time that 30 other events (representing a time interval of about five minutes) had intervened, however, all benefit from having repeated the word had disappeared; the aphasic subjects were then no more likely to name the picture than if they had had no opportunity to repeat its name. Phonemic cues were also effective at eliciting names that were otherwise unavailable; but when the patients were asked to name the pictures again 30 minutes later, they were no more likely to name pictures that had been phonemically cued than control pictures for which no cue had been offered. Any facilitation from phonemic cueing had lasted for less than 30 minutes.

In the present study we are interested in the facilitation of picture naming by comprehension tasks that require *semantic* processing of picture names. There is one general reason why we were particularly interested in such tasks. The Patterson, Purell, and Morton experiments involved two techniques that provide the patients with information about the phonological form of the target word; such information produced significant short-term prompting but *not* long-term facilitation. The main reliable long-term effects of which we are aware are those found by Cohen et al., involving a task (open-ended sentence completion) that requires some semantic processing on the part of the aphasic patients. Accordingly this approach seems the most promising one to pursue. Our first experiment concerns the effects on subsequent picture naming of spoken word-to-picture matching. The reason for the selection of this task is purely practical. In the clinic we have often treated aphasics for whom few linguistic functions remain intact; yet

auditory word-to-picture matching may be relatively well preserved in such cases. Since we have often had to rely on auditory word-to-picture matching in our attempt to prompt some successful naming, we wanted to establish whether the technique produces reliable facilitation.

EXPERIMENT 1

This experiment is concerned with the question of whether auditory word-to-picture matching facilitates picture naming by aphasic patients, and whether the effects are stable over a time interval of twenty minutes.

In order to assess these questions we had to control for a number of factors:

1. We had to identify, at the beginning of the experimental session, those pictures that the patient was unable to name. Some of these were to be treated and presented again for naming; others were re-presented for naming as often as the pictures whose names had been treated. Any difference in naming performance between these two sets could be ascribed to the effects of treatment, rather than just a further opportunity for lexical search.
2. We wished to ensure that sufficient items intervened between treatment and subsequent naming to prevent the subjects from simply holding the phonological word form temporarily in episodic memory. We also embedded the target items among other items for auditory word-to-picture matching, so that the patients were, as far as possible, unaware which pictures would be presented for naming again, and which were to play no further part in the experiment. (In other words, we tried to fulfil Weigl's (1961) criteria for de-blocking.)
3. We tried to maintain a reasonably consistent level of success in naming throughout the experiment to control for any effects of task difficulty (Brookshire, 1972).
4. We ensured that the pictures involved could be unambiguously named, by using pictures whose names are agreed upon by normal subjects. Otherwise treatment might simply have shifted the response from one name to another equally possible one that the patient had initially had available, but had chosen not to use.

Design

In the pre-test the subjects were presented with pictures to name until at least 16 had been correctly named and at least 16 failed. The first 16 successes acted as filler items to maintain a reasonable overall rate of correct naming. The 16 failures were assigned to the four experimental treatments (see Table 1):

Pointing and Naming. These items were treated (by pointing on auditory command to one of four pictures) and then, after six intervening events

(pointing to other pictures and naming other pictures), the target pictures were presented for intermediate naming. These were again presented for naming in the post-test.

Pointing and Naming Control. These items were pre-test failures that were re-presented for intermediate naming without prior treatment by auditory word-to-picture matching; they were tested again in the post-test. These items act as controls for additional opportunities for lexical search; any difference in performance on these items compared to *pointing and naming* items will be attributable to the treatment by auditory word-to-picture matching.

Pointing Only. These pre-test failures were treated by auditory word-to-picture matching, were not given intermediate naming practice, and then were presented for naming in the post-test. For *pointing only* items, therefore, there is a delay between treatment by auditory word-to-picture matching and the next opportunity to name the picture.

Pointing Only Control. These items acted as controls for the *pointing only* items. They were pictures failed in the pre-test which then played no part in the experiment until they were presented for final naming in the post-test.

Subjects

The subjects in this experiment were 15 aphasic patients who had suffered left cerebral hemisphere vascular accidents. There were nine men and six women.

All patients participating were assessed on either the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) or the Western Aphasia Battery (Kertesz & Poole, 1974). None had evidence of generalised confusion

TABLE 1
Experiment 1: The different treatments applied to items in different conditions

	Conditions			
Events	*Pointing and naming*	*Pointing and naming control*	*Pointing only*	*Pointing only control*
Outcome on pre-test	failure	failure	failure	failure
Given facilitation?	yes	no	yes	no
			Six item gap	
Intermediate naming?	yes	yes	no	no
			Mean 35 item gap	
Post-test naming?	yes	yes	yes	yes

and all could recognise pictures and point to pictures named by the examiner. On the basis of the assessment, seven subjects could be classified as anomic aphasics, four as conduction, three as Broca's and one as a Wernicke's aphasic. Their ages ranged from 17–84 years (mean 52 years). Testing took place 3–68 months after the onset of aphasia (mean 26 months).

Materials

The pictures were black and white line drawings mounted on 5in by 4in cards. They were selected from the set of pictures used by Patterson, Purell, and Morton (1983), for each of which the same single name was produced by at least 90% of a control group of normal subjects. For each picture there was a pointing sheet with four pictures; the three foils were semantically unrelated to the target, whose position was randomly assigned.

Procedure

Pre-test. Single pictures were presented to the patients until at least 16 had been correctly named and at least 16 had been failed; the order of presentation of pictures was different for each patient. Patients were given up to 30secs to retrieve a picture name; self-corrections and non-word responses that differed from the target by a single phonemic error (i.e., phonemic addition, omission, metathesis or substitution) were accepted, as we were interested in word retrieval rather than the accuracy of phonological realisation. The same criteria for correct naming were applied throughout the experiment. No feedback on success or failure was given, but if patients became frustrated, they were assured that they would have another opportunity to try to name the picture later.

The 16 successes were to act as filler items to sustain a reasonable overall level of success. The failures were assigned to the four experimental groups; the first failure was assigned to *pointing and naming*, the second to *pointing and naming control*, the third to *pointing only*, the fourth to *pointing only control* and so on.

Treatment. This section consisted of four blocks; each of these comprised auditory word-to-picture matching for five pictures (two target items and three fillers) followed by an intermediate naming test for five pictures (one of the target items just treated, one control item plus three pre-test successes). The structure of a block is illustrated in Table 2. Errors in auditory word-to-picture matching were infrequent in this experiment and those that follow, and such errors were ignored for the purpose of the analysis of the results.

Post-test. All 32 experimental items (pre-test successes and the four groups of failures) were presented for naming again immediately after the

TABLE 2
The structure of Experiment 1

Pre-test (to Obtain 16 Successes and 16 Failures)		
Treatment		
	Auditory word-to-picture matching	1. Filler 2. Pointing and naming item 3. Filler 4. Pointing only item 5. Filler
	Intermediate naming	1. Pre-test success 2. Pointing and naming control 3. Pre-test success 4. Pointing and naming item 5. Pre-test success
	Three more blocks of auditory word-to-picture matching and intermediate naming	
Post-test. All 16 experimental items and 16 pre-test successes in the same order as in the pre-test		

final treatment block in the same order and under the same conditions as in the pre-test.

Because of the design of the experiment, the exact number of items intervening between pointing and post-test naming varied, although minimally. The mean total number of pointings and namings intervening between pointing and post-test naming was 39.6 (sd 6.7) for *pointing and naming* items and 40.9 (sd 10.5) for *pointing only* items; and the mean number of events between intermediate naming and post-test naming was 32.6 (sd 6.7) for *pointing and naming* and 33.9 (sd 7.2) for *pointing and naming control* items. For simplicity, we treat the intervals for each pair of conditions as comparable. The lag between treatment and naming is most appropriately measured in terms of the total number of intervening events; for an estimate of the time intervals involved, six events correspond to about three minutes and 40 events to about 20–25 minutes.

Results

The results are presented in Table 3. The proportions of pictures correctly named were subjected to an arcsine square root transformation to increase the homogeneity of variance and analysed with the following results:

Intermediate Naming. The treated items are more likely to be named correctly than their controls (related $t(14) = 2.83$; $P < .01$).

Post-test Naming. An ANOVA on the transformed scores reveals a significant effect of conditions ($F(3,42) = 4.56$, $P < .01$). Pairwise comparisons show that *pointing and naming* items are better than *pointing and naming*

TABLE 3
Experiment 1: Mean probability of correct naming for items in each treatment condition at intermediate naming and post-test (15 patients; 4 items in each condition; untransformed scores)

	Mean Probability of Correct Naming	
Condition	*Intermediate naming*	*Post-test naming*
Pointing and naming	.53	.55
Pointing and naming control	.23	.22
Pointing only	—	.40
Pointing only control	—	.25

controls ($t(14)=2.61$; $P<.01$), *pointing only* are better than *pointing only controls* ($t(14)=2.18$; $P<.05$), and *pointing and naming* and *pointing only* do not differ significantly ($t(14)=1.52$; n.s.).

Discussion

Taking pictures that could not be named in the pre-test, we found that patients had substantially greater success in naming in the post-test, if, in the interval, they had pointed to the picture on auditory command rather than simply having had a second opportunity to try to name it. The effect was numerically greatest if an intermediate opportunity to name the picture followed shortly after word-to-picture matching; but this facilitation was not significantly greater than in the condition without intermediate naming—that is, when 40 events and about 20 minutes intervened between treatment and the post-test.

The significant facilitation of naming by auditory word-to-picture matching appears to be qualitatively different from the effects on naming of repetition or phonemic cueing. Patterson, Purell, and Morton (1983) found that both repetition and phonemic cueing produced *short-term* prompting of naming; but after an interval of the sort employed in the present experiment, there was no measurable facilitation of naming by either technique. By contrast, here, 20 minutes after word-to-picture matching name retrieval was still significantly improved.

How is this effect to be interpreted? In our view, at least two classes of explanation are possible:

1. If a patient had a problem in recognising some of the target pictures s/he would fail to name the item in the pre-test. Then on being told to "point to the —", provided that the patient could recognise the other three pictures involved, s/he would be able to deduce by elimination which picture matched the sought-for name. Pointing, then, could provide the information necessary to enable the subjects to identify the difficult-to-recognise pictures. If a central representation of that picture were then tagged, in

memory, with a pointer to indicate the appropriate name, the patient could use this pointer to retrieve the correct name when the picture was presented for naming again in the post-test. We think this explanation is unlikely to be correct; the main reason is that none of the experimental subjects behaved as if they had difficulty in picture recognition, and we had excluded all patients with obvious recognition problems.

2. The second explanation seems more plausible. Picture pointing requires the subject to retrieve, on the basis of the heard word, a semantic representation of a lexical entry and then to search for a picture whose semantic representation matches it. Any of the components common to this process (auditory word-to-picture matching) and the process of picture naming are candidate loci for the operation of this facilitation effect; all of these common processes are on a semantic level. If, for example, our patients are failing to name pictures due to a semantic breakdown, auditory word-to-picture matching might prime the semantic representation corresponding to a picture name, by using this representation in another task. If, alternatively, the patients cannot access a verbal semantic representation on the basis of a visual semantic representation, auditory word-to-picture matching might prime the operation of a link between the (visual) semantic representation of the picture and the (verbal) semantic representation of the word. In any case, when the patient is later asked to name the picture, operation of the defective process will be improved because of its use in the treatment task; as a result the patient will be more likely to retrieve the correct name for treated items than untreated controls—the treatment has facilitated naming performance.

The next experiment was designed both to replicate the results of the first experiment and to distinguish between the two interpretations of the facilitation resulting from auditory word-to-picture matching—in terms of an effect on the process of picture recognition or as priming at a semantic level.

EXPERIMENT 2

In this experiment we compared three treatment conditions applied to pictures that a subject could not name in the pre-test. The two experimental conditions requested patients to point, on auditory command, either to the failed picture itself or to an associate of that picture. No pointing occurred in the control condition. Pictures were presented for intermediate naming after an interval of six items, and again in a post-test after 41 items, and finally in a second post-test 24 hours later.

In the *same* condition, the patient had to point to the picture which s/he had failed to name in the pre-test, out of a choice of four; in this experiment the foils, unlike those used in Experiment 1, were semantically related to the target. So, for example, a patient who had failed to name the picture of

a *tiger* in the pre-test would be asked to "point to the tiger" out of a set of pictures of a *lion*, a *tiger*, an *elephant* and a *giraffe*. In the auditory word-to-picture matching of Experiment 1 only minimal semantic information is needed to perform correctly; in the task used here, rather more detailed semantics must be accessed. This task (apart from the nature of the foils) is essentially the same as that used in Experiment 1, and successful facilitation in this condition could be explained by either hypothesis.

In the *associate* condition, the subject was asked to point to a picture of a *different* object from the *same* semantic category as the picture that s/he had failed to name in the pre-test. The picture alternatives comprised the identical set as in the *same* condition. The associate was the object which we intuitively judged to be the most closely related member of the category of which we had a picture. So the hypothetical patient who failed to name the *tiger* on the pre-test, would be asked to "point to the lion", from the choice of pictures of a *lion*, a *tiger*, an *elephant* and a *giraffe*. Then six items later, again 41 items later and 24 hours afterwards, the picture of the *tiger* would be presented for naming.

There are two rather different reasons why we were interested in the effects of associate word-to-picture matching. Weigl (1970b) claimed that the effects of "de-blocking" would spread to all members of a semantic field[1]; this notion of a semantic field is not precisely defined (cf. Maruschewski, 1975), and, indeed, Weigl (1970b, 1979) suggests that "de-blocking" may provide an empirical test of the extent of such fields. However, it is clear that our associates fall within the limits of the semantic fields; we would therefore expect facilitation in this *associate* condition if, as Weigl claimed, priming extends to all members of the field.

The second reason for our interest in this condition comes from a very different source. Recognition of written or spoken words by normal people, under conditions of stimulus degradation, may be improved by presentation of a semantic associate immediately beforehand. There is, then, associate facilitation of *input* word recognition processes in normal subjects; can analogous effects be found in the facilitation of aphasic naming? This question is particularly interesting because the facilitation we are investigating here might (under our hypothesis 2) be operating at a specifically semantic level.

Under the *control* condition, pictures that had been failed in the pre-test were presented for naming again in each subsequent naming test. These items therefore control for the effects of repeated opportunities to try to retrieve a picture name.

To examine whether facilitation by auditory word-to-picture matching can be explained by our first hypothesis—that pointing provides informa-

[1] Weigl (1970a, 1970b, 1979) argued that de-blocking applied to the whole of a semantic field. Earlier, Weigl had taken a different view; Weigl (1961) claimed that de-blocking was lexically specific—effects were confined to the de-blocked word.

tion that the patient can use to help defective picture recognition—we administered the *picture association* test used by Howard and Orchard-Lisle (1984). This test involves matching a picture to one of a pair of pictures which share a common semantic category on the basis of an association. So, for example, a *pyramid* has to be matched to a picture of a *palm tree* rather than a *deciduous tree*, or a picture of an *Eskimo* to an *igloo* rather than a *house*. Howard and Orchard-Lisle argue that in order to perform with consistent accuracy in this task, patients must, at least, be able to recognise the pictures and retrieve the semantic representations corresponding to them (of course, patients may have to retrieve more information about the pictures than is given by their semantic representations alone). Poor performance is ambiguous: the subject may perfectly well be able to identify the pictures involved but may be unable to make the semantic association, or s/he may simply be poor at picture recognition. (We have, of course, excluded patients with gross problems in picture recognition, but it is likely that patients with more subtle problems will have difficulties in this test.) Good performance, on the other hand, is evidence that the patient can recognise pictures. In this experiment we therefore compare the performance of those patients whose scores on the picture association test were lower than Howard and Orchard-Lisle's non-aphasic, non-agnosic, brain-damaged controls, with those whose scores fell within the control range. If facilitation by auditory word-to-picture matching can be attributed to an effect on picture recognition alone, then there should only be a facilitation effect for those patients with poor scores on the picture association test.

We were also concerned with the question of whether facilitation of naming by auditory word-to-picture matching related to the diagnostic category of the aphasic patients. There is some evidence that separate groups of aphasics produce qualitatively different patterns of naming errors (Butterworth, Howard, & MacLoughlin, 1984), although the effects of different prompts do not appear to differentiate between particular diagnostic groups (Myers Pease & Goodglass, 1978). In one study of diagnostic groups, only conduction aphasics showed convincing ability to guess the first letter and number of syllables of a name they could not find (Goodglass, Kaplan, Weintraub, & Ackerman, 1976); this ability is, of course, known as the tip-of-the-tongue phenomenon (Brown & McNeill, 1966). All current accounts of the tip-of-the-tongue state agree that its existence depends upon having retrieved a reasonably complete and correct semantic representation. If auditory word-to-picture matching facilitates by inducing the retrieval of a semantic representation, then this will provide no new and useful information to conduction aphasics when they are in a tip-of-the-tongue state. On these occasions, then, conduction aphasics should not be aided by auditory word-to-picture matching; we might, then, predict that conduction aphasics should show less facilitation than patients from other diagnostic groups (assuming, of course, that our conduction aphasics behave like the Goodglass et al. patients when they do not name correctly).

TABLE 4
The structure of Experiment 2

Pre-test (to Obtain 15 Successes and 15 Failures)		
Treatment		
	Auditory word-to-picture matching	1. Filler 2. Associate 3. Filler 4. Same 5. Filler
	Intermediate naming	1. Pre-test success 2. Control 3. Pre-test success 4. Associate 5. Pre-test success 6. Same
	Four more blocks of auditory word-to-picture matching and intermediate naming	
Post-test. All intermediate naming items in the same order as in intermediate naming		
Post-test 2. The same post-test repeated 24 hours later		

This experiment, therefore, is intended to differentiate between hypotheses to account for the facilitation caused by auditory word-to-picture matching. We examine the effects of three conditions (*same*, *associate* and *control*) on naming at three intervals up to 24 hours after facilitation. We also investigate whether performance is related to (a) patients' scores in a picture association test, and (b) their diagnosis as Broca's, anomic or conduction aphasics.

Procedure

The general structure of the experiment is illustrated in Table 4.

Pre-test. Subjects were presented with pictures to name until they had named 15 successfully and had failed on 15. The pictures used and our criteria for correct naming were identical to those used in Experiment 1. Each subject had a different order of presentation of pictures.

Of the failures five were assigned to each of the three experimental conditions—*same*, *associate* and *control*. The 15 successes acted as filler items to ensure that subjects enjoyed a reasonably consistent level of naming success.

Treatment. This consisted of five successive blocks, each of which involved five picture pointings followed by six picture namings. The structure of these blocks is shown in Table 4.

The pointing was conducted in the same way as in Experiment 1, except that the foils came from the same semantic category as the target. In each

block, in the second pointing the subject was asked to point to the associate of the target, and in the fourth to the same picture as the target. Then after six items had intervened the target pictures from the same and associate conditions were presented for naming together with the control picture.

Post-test 1. This followed immediately after the treatment section. All the pictures from intermediate naming were presented for naming again in the same order as they had occurred in intermediate naming. Each picture was therefore presented for naming after an average of 40.0 items (sd 7.1) had intervened, since it was presented in the intermediate naming test. As in Experiment 1, this interval of 40 items corresponds to about 20 minutes.

Post-test 2. The identical post-test was re-presented 24 hours later. This was to establish whether facilitation would be stable and long-lasting.

Subjects

The subjects were 20 adult aphasics who had suffered a cerebro-vascular accident. They were assigned to diagnostic groups on the basis of their performance on either the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1972) or the Western Aphasia Battery (Kertesz & Poole, 1974). Seven subjects were classified as anomic aphasics, seven Broca's and six conduction aphasics. Eight of the subjects had already participated in Experiment 1. A minimum of three months intervened between the experiments.

On Howard and Orchard-Lisle's picture association test, nine subjects (two anomic, four Broca's and three conduction) scored within the range of the brain-damaged controls (mean score 18.9/20, sd 1.2). The remaining eleven subjects (five anomic, three Broca's and three conduction) scored below the control range (mean 13.0/20, sd 2.7).

Results

The results for three conditions, three naming tests (time), three diagnostic groups and two categories of scores on the picture association test were

TABLE 5
Experiment 2: Analysis of results

Source of Variance	*Chi²*	*Degrees of Freedom*	*Probability*
Within cells	35.7	14	
Aphasic groups	8.4	2	.0150
Picture association	6.5	1	.0108
Treatment conditions	95.8	2	<.0001
Tests	7.6	2	.0224
Groups × association	8.8	2	.0123
Conditions × groups	10.3	4	.0357
All other interactions $P > .1$			

analysed using a logit-linear model and parameter values were estimated using the GLIM programme. The results of this analysis are shown in Table 5. All interactions not shown in the table are not significant.

The effect of the conditions was highly significant; this is illustrated in Fig. 1. The probability of correct naming was raised to 52% in intermediate naming in the *same* condition; in contrast, performance in the *associate* condition was statistically indistinguishable from the *control* condition. Facilitation, therefore, is word specific; pointing to an associate from the same semantic category has no facilitatory effect, giving no evidence of any spread of activation. The lack of an interaction between tests and conditions shows that facilitation in the *same* condition was maintained at an equally high level after 24 hours.

There was a significant main effect of scores on the picture association test, and an interaction of this with diagnostic groups but not with conditions. Patients who did badly on the picture association test had lower overall naming scores (mean probability of correct naming, collapsed over tests and conditions, .25), than those whose scores are in the normal range (mean .33). Picture association scores (poor vs. normal) did not interact with conditions; that is patients who were able to recognise pictures well benefited from facilitation as much as patients with poor picture association scores. This result makes it unlikely that the effects of facilitation are attributable to assistance with picture recognition (our first, but less preferred, hypothesis 1).

The main effect of diagnostic groups is illustrated in Table 6. Overall, conduction aphasics had lower naming scores, and this is principally due to poor performance in the *same* condition, where they were significantly

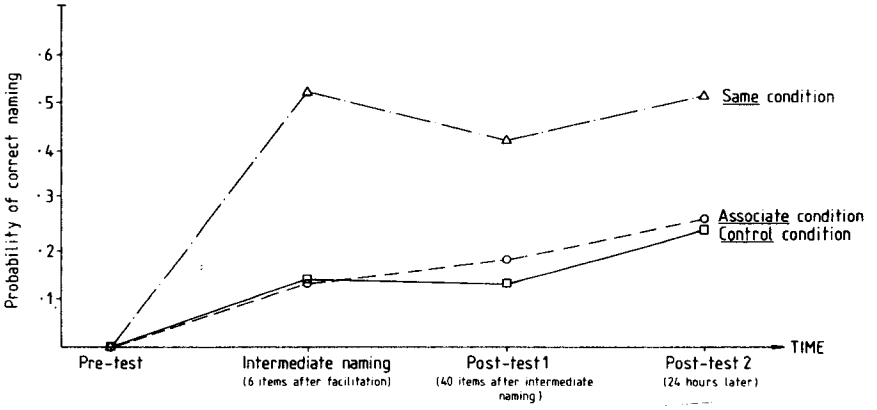

FIG. 1 Experiment 2: The mean probability of correct naming of pictures in each condition at three intervals after treatment.

TABLE 6
Experiment 2: The performance of patients from different diagnostic groups under different treatment conditions (mean probability of correct naming collapsed over tests and picture association scores)

Diagnostic Group	*Treatment Condition*			
	Control	*Associate*	*Same*	*Total*
Broca's	.26	.15	.50	.29
Conduction	.10	.21	.34	.22
Anomic	.18	.21	.58	.33
Total	.17	.19	.48	.28

worse than both Broca's aphasics ($z=2.25$, $P<.05$) and anomic aphasics ($z=3.27$, $P<.01$). In the *associate* condition the groups' scores did not differ significantly; but in the control condition, the Broca's aphasics were just significantly better than the conduction aphasics ($z=2.19$, $P<.05$). Comparison of the performance of different groups of aphasic patients is a notoriously unreliable procedure, and, in this case, it is not clear that any conclusions can be drawn. Conduction aphasics show lower overall levels of success in naming the experimental items than patients from other groups, but the absolute difference in the probability of correct naming between *same* and *control* items is equivalent in all groups. It is evident that the particular patients classified as conduction aphasics in this experiment are facilitated in their naming by auditory word-to-picture matching.

Discussion

The results of Experiment 1 showed that auditory word-to-picture matching resulted in significant facilitation of naming. This experiment confirms and extends that conclusion: auditory word-to-picture matching has an effect that is stable for at least 24 hours. Experiment 2 allows us to eliminate one possible explanation of the effect. Those aphasics whose performance is normal in a non-verbal test of picture association benefit as much from facilitation as those whose scores in the association test are poor; for those patients with normal picture association, facilitation by auditory word-to-picture matching cannot be operating by aiding any process of picture recognition.

We are left, therefore, with our second class of explanation: that the facilitation is a result of priming of a representation or process at a semantic level. But which elements of the treatment procedure are necessary to produce the facilitation effect? In pointing to the picture in Experiments 1 and 2, the patients heard the name of the picture and had to match this to one of the array of four pictures in front of them. Facilitation might then be due to priming of some associative link between the visual semantics of the

picture and the verbal semantics of the word; alternatively, it could be due to priming of access to the verbal semantic representation itself. In our next experiment we, therefore, investigated whether facilitation depends crucially upon presentation of either the picture or its spoken name.

EXPERIMENT 3

Design

This experiment uses essentially the same design as Experiment 2. The experimental items were selected in a pre-test where aphasic subjects were presented with pictures to name until at least 18 had been named correctly and 18 failed. The failures were then subjected to one of three experimental conditions.

Some were treated by matching the written word to one of a choice of four pictures (*word* condition). This condition parallels the *same* condition in the previous experiment, the only difference being that presentation of the target word was auditory in Experiment 2 and visual in this experiment. Subjects were discouraged from reading the word out loud.

The second condition involved treatment by semantic *judgements*. The subjects did not see the pictures; they simply had to answer a yes/no question which required access to the semantics of the name of a picture failed in the naming pre-test. So, for example, an aphasic patient who could not name a picture of a *cow* in the pre-test would be asked "Does a cow eat grass?"; one who could not name a *roof* would be asked "Is a roof part of a house?".

In the *control* condition there was no treatment.

All the experimental items were presented for intermediate naming six items after treatment, and again in a post-test immediately afterwards, which was repeated two weeks later.

If facilitation requires *seeing* the target picture, then we would expect effects only in the *word* condition. If it requires *hearing* the picture name, effects would be confined to the *judgement* condition. If facilitation requires only access to the semantic representation of the picture name in a comprehension task, we would expect facilitation in both conditions. If facilitation involves priming of a specific link between a semantic representation for the picture and the *spoken* picture name, then significant facilitation should not be observed in this experiment at all.

Procedure

Pre-test. Subjects were presented with pictures to name until they had named 18 successfully and failed on 18; the order of presentation of pictures was different for each subject. Our criteria for correct naming were the same as in Experiments 1 and 2.

Of the failures, six were assigned to each of the three experimental conditions—*word*, *judgement* and *control*. The 18 successes acted as filler items to ensure a fairly consistent success rate for each subject.

Facilitation. This consisted of six blocks each of which comprised five treatments followed by six namings. Blocks of treatment by visual word-to-picture matching (*words*) alternated with blocks of treatment by semantic *judgements*; half the subjects began with *words* and half with *judgements*.

Within each block of treatments, the first, third and fifth were dummy items which played no further part in the experiment. In the *judgements* condition, these were all questions with the answer "no", e.g., "Does a tree eat grass?". All judgements on target items were questions requiring a "yes" answer, and occurred as the second and fourth items in the block.

Then six pictures were presented for intermediate naming. The first, third and fifth were pre-test successes; the second was a control picture and the fourth and sixth were pictures whose names had just been subjected to the treatment procedure.

Post-test 1. This followed immediately after the treatment section. All 36 pictures from the intermediate naming test were presented again in the same order. Each picture was therefore presented for naming again when an average of 47.5 events (sd 8.5) had intervened since its appearance in intermediate naming. This represents a time interval of about 20–25 minutes.

Post-test 2. The same post-test was repeated two weeks later.

Subjects

The subjects were nine aphasics, all of whom were either Broca's or anomic aphasics. Conduction aphasics were excluded because of the evidence in the previous experiment that they might benefit less from treatment. The subjects were screened for their ability to match written words to pictures and to answer yes/no questions. One subject had participated in both the previous experiments; four more had taken part only in Experiment 2. At least three months intervened between a patient's participation in different experiments.

Materials

Pictures used were drawn from the same set as used in the two previous experiments.

Results

The results are shown in Fig. 2. The arc-sine square root transformed proportions were analysed with a three (conditions) by three (tests) analysis of variance; the transformation is used to increase the homogeneity of variance.

There was no main effect of tests ($F(2,16)=0.17$, $P>.8$), but there was a significant main effect of conditions ($F(2,16)=11.04$, $P<.001$) and a significant interaction between tests and conditions ($F(4,32)=2.84$, $P<.05$).

There was substantial facilitation both from written word-to-picture matching and semantic judgements, and the magnitude of the effects was comparable to those found in the previous experiments. In no test was there a significant difference between the two experimental conditions; but in intermediate naming and the first post-test, performance in both experimental conditions was significantly better than with the controls. Facilitation, therefore, persisted over at least 20 minutes, but at the second post-test two weeks later the effect had diminished to the point where there were no longer any statistically reliable differences.

In this experiment, as in Experiment 2, there is a suggestion that performance with the control items is gradually improving with each presentation. On statistical testing this trend failed to reach significance, but it is possible that there are genuine, but small, benefits from repeated opportunities to try to retrieve the picture names.

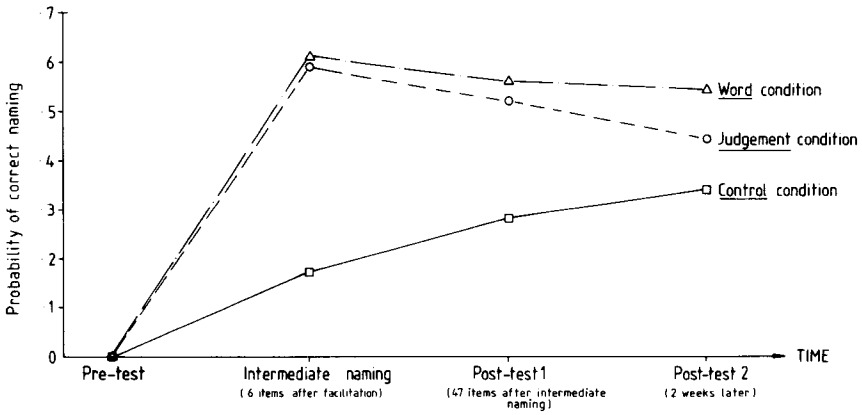

FIG. 2 Experiment 3: The mean probability of correct naming of pictures in each condition at three intervals after treatment.

Discussion

Both semantic judgements and written word-to-picture matching resulted in effective facilitation of naming which persisted for at least 20 minutes. Because the effect is of comparable magnitude to facilitation by auditory word-to-picture matching, it seems a reasonable working assumption that all of these effects reflect priming at the same level. Facilitation is found in the judgements condition, where the patients did not see the picture; we take this to confirm our earlier conclusion that facilitation is not due to priming of any process in picture recognition.

In performing semantic judgements the subjects did not see the object picture; in picture pointing with written words they did not hear the picture name. It is therefore unlikely that facilitation results from priming either of an association between a visual semantic representation and a verbal semantic representation, or of an association between the verbal semantic representation and the phonological word form. There is one common factor between all of the tasks which, in our studies, resulted in substantial facilitation lasting for at least 20 minutes: they were all comprehension tasks requiring the subjects to access a semantic representation corresponding to the picture name.

All three experiments reported thus far have used essentially the same experimental paradigm. Pictures that could not be named in a pre-test were treated by one of a variety of treatment techniques that emphasised semantic processing in comprehension; shortly afterwards, the subjects were presented with the pictures to name again, and a set of post-tests followed. This paradigm is somewhat different from that used by Patterson, Purell, and Morton (1983) in the study of repetition and phonemic cueing—two tasks which provide the subjects with information about the phonological characteristics of the picture name. Our final experiment is a partial replication of their results; using an experimental paradigm similar to Experiments 1-3, we investigated the effects of three techniques that provide information about the phonological form of picture names: repetition, rhyme cues and rhyme judgements.

EXPERIMENT 4

Design

In this experiment there were four conditions. *Controls*, as before, were pictures which had no treatment but were presented for naming as often as the treated pictures. *Repetition* involved simply repeating the name of a picture that could not be named in the pre-test. *Rhyme judgements* required the patient to judge whether the picture name rhymed with another word (e.g., "Do these rhyme: tent, bent?"); for all of the experimental items the correct answer was "yes", while filler items were non-rhymes. In the *rhyme*

cue condition the aphasic patient was presented with the picture (for example, of a *tent*) and told a rhyme (for example, "This rhymes with bent"); the patient then had five seconds to attempt to retrieve the picture name.

Procedure

Pre-test. Subjects were presented with pictures to name until they had named 27 successfully and had failed on 27; the order of presentation was different for each subject. Our criteria for success were the same as in the previous experiments, except that the subjects were allowed only 5 seconds rather than 30 seconds to retrieve the picture name; this was to make our procedure more closely parallel to that used by Patterson, Purell, and Morton (1983).

Of the failures, six were assigned to each of the three treatment conditions—repetition, rhyme judgement and rhyme cue—and nine to the control condition. The 27 successes were filler items as before.

Treatment. This consisted of nine blocks each comprising a block of five items treated by one of the three methods, followed by six intermediate namings. Each subject had the three conditions in the same order three times; subjects were allocated at random to different orders of conditions.

As before, in each block of treatments, the first, third and fifth were filler items (in the rhyme judgement condition these were all non-rhymes), while the second and fourth were experimental items.

Following a treatment block, six items were presented for intermediate naming; the first, third and fifth were pre-test successes. The second was a control item and the fourth and sixth were the two experimental items whose name had just been treated.

Post-test 1. This followed immediately after the end of the blocks of treatment. The 54 pictures tested in intermediate naming were presented for naming again in the same order. Each picture occurred after an average of 73.0 items had intervened (sd 12.9) since intermediate testing. Because of the shorter time allowed for naming in this experiment this represents an interval of approximately 10–15 minutes.

Post-test 2. The same post-test was repeated after an interval of 30 minutes.

Subjects

There were eight subjects in this experiment, all of whom were aphasic following left hemisphere cerebro-vascular accidents. Two subjects had previously taken part in both Experiment 2 and Experiment 3, one in Experiment 2 only, and four in Experiment 3 only. The one remaining subject was

new to the experience. Again at least three months intervened between participation in experiments.

Results

The results of this experiment are illustrated in Fig. 3. The arc-sine square root transformed proportions were analysed using a four (conditions) by three (tests) analysis of variance. There was a main effect of tests ($F(2,14)=10.84$, $P<.005$) but no effect of conditions ($F(3,21)=0.14$, $P>.9$), and no significant interaction ($F(6,42)=1.84$, $P=.11$).

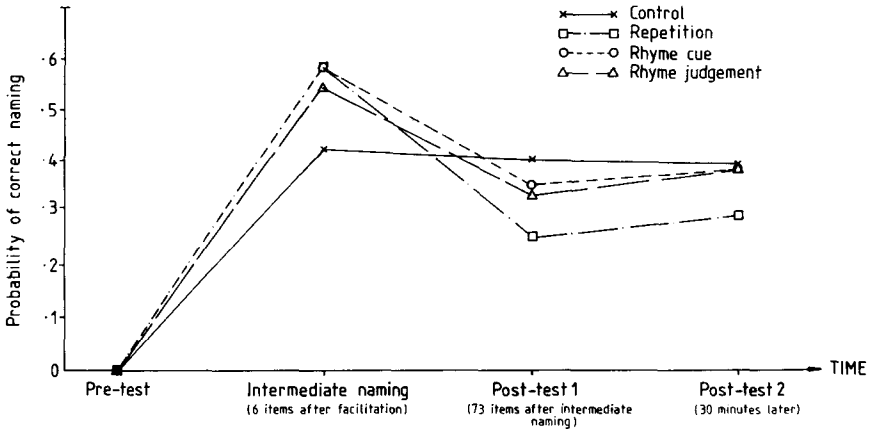

FIG. 3 Experiment 4: The mean probability of correct naming of pictures in each condition at three intervals after treatment.

The main effect of tests is due to good overall performance in intermediate naming, six items after treatment. The fact that the control level was relatively high (which is partly attributable to the stricter five second limit) presumably prevents the interaction between tests and conditions from reaching significance. As it is, we can only claim a trend towards improved naming as a result of these techniques which provide the patients with information about the phonological form of the target word; furthermore, this small trend is confined to the intermediate naming test. In any case, this contrasts strikingly with facilitation by semantic treatments, whose effects were large and lasted for at least 24 hours.

The results of this experiment essentially corroborate those of Patterson, Purell, and Morton (1983). Cueing techniques that only provide phonological information about difficult-to-retrieve names may have a brief beneficial effect on aphasics' naming performance; but this effect dissipates rapidly.

GENERAL DISCUSSION

Theoretical Implications

Half an hour after successfully producing a picture name in response to a phonemic cue an aphasic patient is no more likely to be able to name the same picture than if it had not been cued (Patterson, Purell, & Morton, 1983). If, on the other hand, the patient is simply asked to point to that picture out of a choice of four, then s/he is substantially more likely to be able to name the picture half an hour later (or, indeed, 24 hours later) than if he had not been given this treatment.

In phonemic cueing, the information given to the patient is the initial phoneme of the word. There can be no doubt that this is a successful method of eliciting picture names from aphasic patients (Patterson, Purell, & Morton, 1983; Myers Pease & Goodglass, 1978; Love & Webb, 1977). By itself, of course, a phonemic cue does not uniquely specify a word; in conjunction with the appropriate picture, however, it does so. Given a picture of a *camel* and the cue "/kə/", aphasics typically say "camel" and do not produce a semantically unrelated word such as "cup", "cartridge", "kipper", "cold" or "concertina". They must, then, be using some semantic information from the picture to specify the word; the combination of the phonemic cue and this semantic information are sufficient to address, uniquely, the lexical entry for the phonological word form "camel".

This introduces a puzzle: if the aphasic patient already has the semantic information to address the phonological word form "camel", why is this alone not sufficient to produce the word?

One possibility is that, in aphasic patients, thresholds for eliciting words are raised (Rochford & Williams, 1963); although the semantic information received by the output lexicon is correct, this information alone is not sufficient to raise the level of activation of the lexical entry to the level required for output. Only when additional phonological information is provided by the phonemic cue, does the "camel" entry reach its threshold. A second possibility is discussed by Howard and Orchard-Lisle (1984); they showed that with one patient, correct phonemic cues could be used to elicit correct picture names, and incorrect cues could elicit semantic errors. Given a picture of a *camel* and the cue "/ɛ/", the patient, JCU, said "elephant". For this patient, at least, the picture apparently yielded a semantic specification inadequate to identify the correct phonological word form, but sufficient to specify a range of semantically related responses.

Irrespective of exactly how phonemic cues operate, it is clear that, in response to them, the correct picture name must be produced from the correct entry in the lexicon of phonological word forms (or, in Morton and Patterson's, 1980, terminology the phonological output logogens). Now, we assume that the use of this lexical entry will result in its being

"primed"—that is, the activation threshold needed to produce the word will be temporarily lowered, making it easier for the patient to name the picture. We also assume that the time course of such priming is a specific characteristic of each lexicon (or level of lexical representation). Having successfully used an output lexicon entry in response to a phonemic cue and given the same picture to name again, the patient should have a raised probability of doing so (compared with a control condition in which no cue had been given) for as long as output lexicon priming is effective. Results from Patterson, Purell, and Morton (1983) (and the present Experiment 4) allow us to conclude that the effects of priming in the phonological output lexicon last less than half an hour, and probably less than five minutes.

Spoken word-to-picture matching (Experiments 1 and 2), written word-to-picture matching and semantic judgements (Experiment 3), on the other hand, produce facilitation lasting at least 20 minutes; indeed, in Experiment 2 the effects had not diminished significantly over 24 hours. All these tasks require the patient to retrieve the semantic representation corresponding to the picture name. Comparison between Experiments 2 and 3 shows that the facilitation effect depends neither on seeing the picture nor on hearing the picture name; the effect is not, therefore, to be explained in terms of facilitation of an "association" between the visual semantic representation of the picture and a verbal semantic representation of the word, nor of an association between an "auditory image" of the word (i.e., auditory input logogen entry) and its semantic representation.[2]

In general, we would expect facilitation only at a point in the naming process where the subjects were operating with inadequate information (at least where we are measuring effects on accuracy rather than latency). And we would not expect to find facilitation effects where patients were operating with incorrect information; if our treatments/techniques had resulted in priming of the correct entry, and the patient was addressing a different, incorrect, entry, there would be no additive effect between them. Therefore, to argue that these experiments demonstrate facilitation operating at a specifically semantic level of representation entails the proposition that aphasics are often using an inadequate (but not incorrect) verbal semantic representation in the process of picture naming. Is there any evidence to justify this claim?

This description certainly seems appropriate to the single patient, JCU (Howard & Orchard-Lisle, 1984). Phonemic cues could elicit both correct

[2] The argument produced here—that facilitation cannot be due to priming of a link between a visual semantic representation and a verbal semantic representation, because the effect remains in verbal semantic judgements, which do not involve the picture— assumes that such judgements do not involve the routine consultation of visual semantic information. As Beauvois (1982) points out, this may not always be the case: in deciding whether, for example, cows eat grass, one might use visually based semantic information.

picture names and semantic errors; this could only happen if JCU was using a semantic representation to address her phonological output lexicon that specified several semantically related names. This proposition also provides a natural account of the observation that semantically related names are a characteristic error of aphasics in picture naming (Howard et al., 1985; Butterworth, Howard, & McLoughlin, 1984); and of the evidence that aphasic patients often use incomplete semantic information in word comprehension (Pizzamiglio & Appicciafuoco, 1971; Butterworth, Howard & McLoughlin, 1984).

If there is facilitation at a semantic level, what is the representation that is primed? We will consider how this question might be answered by two varieties of lexical theory: the 1980 revision of the logogen system, and a related theory that incorporates a semantic lexicon. Either model can account for these data, but, as we shall show, they do so in rather different ways.

In the logogen model (Morton, 1979; Morton & Patterson, 1980) written words are recognised by visual input logogens and spoken words by auditory input logogens. On the basis of activation of an input logogen unit, a set of semantic features corresponding to the stimulus word is activated in the cognitive system.[3] In output, these semantic features from the cognitive system are used to address a phonological output logogen, which contains an abstract phonological specification of the articulatory word form. Within this system the obvious candidate for the locus of the priming effects is the semantic representation of the picture name in the cognitive system.

There are two apparent problems with this account in terms of the logogen system. First, semantic representations in the cognitive system are not, in the version described, specific to lexical processing. In Experiment 2, however, those subjects who scored normally in the (non-verbal) picture association test benefited from facilitation as much as those that did not. We believe that the former group of patients must have been able to retrieve reasonably full and complete information from pictures in order to perform consistently well in the picture association test. As Howard and Orchard-Lisle (1984) argued, partial semantic knowledge may be sufficient to make some of the associations, but consistent performance will only be possible if the patient can always access the relevant semantic information for the association. Thus we are faced with an apparent contradiction: some (if not all) of our patients have access to a (more or less) complete semantic

[3] In talking about semantic representations in terms of "features", we do not mean to suggest features in the form conceived by Katz and Fodor (1963). All that we mean is that these representations are (1) in some way, componential, and (2) consist of elements that are not specific to particular lexical items. The occurrence of semantic errors in comprehension and production convinces us that there are componential central representations. We are, in fact, less convinced that these central representations are, in any simple way, semantic.

representation from the pictures—and yet they are aided by facilitation at a semantic level.[4]

The implication is that there must be at least two distinguishable levels of semantic representation. We might suggest, much as Warrington (1975), Beauvois (1982), and Morton (1985) argue from a variety of rather different view-points and evidence, that there must be specifically visual or pictorial semantics which is at least partially independent from the verbal semantic system. If our patients can retrieve correct and complete visual semantic representations but lose some semantic specificity in accessing the verbal semantic representations needed for word retrieval, then verbal semantic facilitation by auditory word-to-picture matching might operate by priming access to the complete verbal cognitive codes corresponding to the picture name.

The second problem for an account of this facilitation in terms of the logogen model lies in the question of lexical specificity. The only levels at which words (or more correctly morphemes) are represented as discrete units are in the four logogen systems—two input and two output systems. Within the cognitive system itself, semantic representations are not word-specific units, but information structures that can be used in a vast number of different cognitive tasks. So the set of cognitive codes corresponding to *cat* would include a subset which were also a subset of the codes for *dog*, and another subset that apply to *cat* but not *dog*. These sets of codes are not units except in the sense that a particular set of them can be used to address precisely one logogen unit for output.

Facilitation at a semantic level would have to amount to facilitation of these cognitive codes. We would then expect that, to the extent that *cat* and *dog* share cognitive codes, auditory word-to-picture matching of *cat* should facilitate the naming of *dog*. In Experiment 2, however, there was no trace of an associate priming effect. One possible explanation is that the elements of the semantic representation for the word *dog* which are not shared with

[4] An anonymous reviewer suggested that it might be possible to perform the picture association test with semantic information less specific than that needed for name retrieval, and thus we might avoid the need to postulate two different levels of semantic representation. At present we know little, in detail, of the nature of the semantic representation used to address the output lexicon; minimally, however, we must require that the representation is sufficiently elaborated to differentiate the correct name from any other (cf. Howard & Orchard-Lisle, 1984). Of these others the most likely confusers are semantic co-ordinates. The picture association test, in a rather similar way, requires the patient to use a semantic representation sufficiently detailed to choose between co-ordinates. Thus, we would argue, there are some significant similarities between the semantic requirements of the picture association test and picture naming.

The same reviewer suggested that the presence of related pictures in the picture association test might enable the patients to retrieve more detailed semantics than they could get from a single picture presented for naming. This we think unlikely as neither the presence of pictures of semantic co-ordinates, nor a semantically appropriate visual context has any effect on aphasic name retrieval (Peuser, 1977; Hatfield et al., 1977).

cat effectively inhibit the activation of the codes that are specific for *cat*; Podraza and Darley's (1977) result (inhibition from "prestimulation" by associated words) would support this view. In this account then, there is associate priming (of the shared meaning between associate and target), but its effects are masked by inhibition from the elements of meaning that distinguish between associate and target.

There is a second way in which lexically specific facilitation can be explained in terms of the logogen model. Priming of the codes common to *cat* and *dog* may simply be priming of the semantic information that the aphasic patient has already. The most common sort of semantic error aphasic patients make in picture naming is a co-ordinate—that is, an error of the form *cat*→"dog" (Butterworth et al., 1984). This suggests that the semantic information that the patient is able to use in the process of name retrieval is a subset of those codes common to *cat* and *dog*. We would not, therefore, expect priming by associates, as this would fail to provide any of the additional semantic information that the patient needs.

The logogen model can, therefore, explain the absence of an associate facilitation effect in either of two different ways, without having to postulate any lexically specific semantic representations.

Butterworth (1979, 1981) has proposed a different, but related, lexical theory that incorporates a lexically specific semantic level of representation; this permits a different account for the lack of an associate priming effect (see Butterworth, Howard, & McLoughlin, 1984, for a review of lexical theories and semantic deficits). To account for semantically related speech production errors by normal people, Butterworth argues that there is a "semantic lexicon" which intervenes between non-lexical semantic specifications and the rest of the lexical system, and which is involved both in word comprehension and word production. Facilitation in the semantic lexicon will have a characteristic time course like priming at the level of the input and output lexicons. Butterworth, Howard, and McLoughlin (1984) argue that many aphasic patients have defective processing in the semantic lexicon, resulting in effective loss of semantic information. In comprehension, even when the word is correctly categorised by the input lexicon and the correct entry in the semantic lexicon is accessed, only partial semantic information may become available in the cognitive system; semantic errors of word comprehension result. Even where aphasic patients make such errors, however, the correct entry in the semantic lexicon will have been accessed and, consequently, it will be primed. When, after such a word comprehension task, the patient is asked to name a picture, the semantic lexicon may be addressed by only partial semantic information from the cognitive system; of the range of entries specified by this information, only the entry corresponding to the name used in the comprehension task will be primed—as a result it is more likely to be produced.

Facilitation of aphasic picture naming at a semantic level is then seen as a natural consequence of a deficit that results in the loss of semantic infor-

mation in processing in the semantic lexicon. Facilitation is lexically specific because the semantic lexicon entries are lexically specific, and these are the representations that are primed.

Implications for Aphasia Therapy

Many schools of aphasia therapy assume that eliciting a response from an aphasic patient makes it more likely that the patient will subsequently be able to produce that response without the help of a therapist (see Howard & Hatfield, in press). The results of these experiments suggest that the true picture is more complex; it is crucially important *how* responses are elicited.

There are a variety of prompts which can effectively enable aphasic patients to produce a picture name which is otherwise unavailable. Of these, phonemic cues are perhaps the most powerful in their immediate effects (Myers Pease, & Goodglass, 1978), yet, as has been established, they have no lasting effect (Patterson, Purell, & Morton, 1983). In other words, techniques that are effective prompts may not be effective facilitators. We have argued that this description applies to all of the treatment techniques which provide information about the phonological shape of names. Repetition, phonemic cues, rhyme cues and rhyme judgements work as prompts, but are not facilitators in any lasting sense.

On the other hand, techniques that require patients to access the semantic representation corresponding to the picture name—word-to-picture matching with either auditory or visual presentation, and semantic judgements—result in dramatically improved accessibility of the name that lasts for at least 24 hours, even though such techniques do not involve the patient in articulating the picture name. This does not, of course, imply that using these techniques repeatedly will result in long-term therapeutic improvement; just as a prompt may turn out not to be a facilitator, so too a facilitator may not be effective in therapy. Nonetheless, a technique with effects that are durable for at least 24 hours seems a hopeful candidate on which to base and evaluate therapy.

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