

LEXICALIZATION IN AN ANOMIC PATIENT

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Abstract—Following a haemorrhage in the left temporal lobe, a 25 yr-old left-handed male patient presented a word finding difficulty, particularly in confrontation naming. The patient had extensive semantic knowledge of the items that he was not able to name. Several experiments showed that he had a poor phonological image of the target word and was poorly helped by phonological cues. He had a better knowledge of the graphological image, but it remained insufficient to result in word retrieval. On several occasions, when the patient failed to name a picture which happened to be lexicalized by a polysemous word, a residual covert word form could still operate as a link between different meanings of the target word; then, the patient produces a word or a circumlocution related to one meaning which was not the illustrated meaning. This kind of response could be called a parasemia. We postulate that the patient's deficit took place outside semantic treatment and before achievement of lexical (phonological or graphological) output.

INTRODUCTION

MOST APHASICS evidence a reduction in lexical availability [5, 7, 8, 18] “un manque du mot” in the French literature [19, 24]. Most taxonomies of aphasia isolate a particular syndrome called amnesic aphasia or anomia, in which the almost exclusive symptom consists of a word-finding difficulty, particularly manifest in naming tasks. This anomia on visual confrontation contrasts with fluent spontaneous expression which, however, often appears poorly informative and is often described as “empty speech”. Facing an object or a picture, anomic aphasics desperately search for the correct word and use, as palliative strategies, indefinite terms such as “thing”, “do”, or deviate in sentences using expressions such as “there are plenty of those . . .”, “it is used for . . .” or “I know what it is . . .”. Such relatively *isolated* word-finding difficulties may be subsequent to a slight lesion in the left temporal or temporoparietal area [1].

Every normal speaking subject occasionally experiences a similar phenomenon, called the “tip of the tongue” phenomenon [2], but anomic patients apparently suffer from an abnormally severe phenomenon of a similar kind [9]. Why do they not find verbal labels?

To quote WHITEHOUSE *et al.* [28]: “Naming behaviour 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”. Several recent studies dealing with normal subjects or patients address this specific issue [4, 5, 11, 12, 15, 16, 20, 22].

As clearly stated by Gainotti, there are two types of anomia: purely expressive anomia without comprehension disorder and anomia with lexical comprehension disturbances. Each type is associated with a distinct locus of dysfunction: a *phonological impairment* in the first case and a *semantic impairment* in the second. HADAR *et al.* [12] suggest a third type of

anomia in which neither semantic nor phonologic treatments are impaired, but in which the phonological lexicon is partly disconnected from semantic lexicon.

We had the opportunity of examining a patient who, after a haemorrhage in the left temporal lobe, showed a persistent anomia, whereas spontaneous speech was preserved. A 1-yr extensive experimental study led us to conclude that, in the absence of perceptual, semantic or memory impairments, the deficit in this patient was restricted to a lexical stage, essentially a phonological one. Moreover, this anomic patient, confronted with lexical-phonological problems during word retrieval, regularly tried to use graphological coding as a help. Yet this strategy in word-finding tasks was rarely successful. This failure could be seen as a consequence of deficient spelling since the patient had a severe dysorthographia.

CASE REPORT

G.M. was a 25 yr-old male with 3 yr of university education. He was strictly left-handed. He presented a typical Wernicke aphasia with severe dysgraphia after a haematoma of unknown origin in the left temporal lobe. Therefore, language processes were assumed to be located (at least preferentially) in the left hemisphere despite the patient's left-handedness. Most of G.M.'s aphasic disturbances cleared up in a few weeks and the language deficit was then reduced to word-finding difficulty and orthographic dysgraphia.

Several CT scans evidenced a stable hypodensity located in the left temporo-occipital area. A recent MRI (December 1987) showed the lesion to be located along the second temporal gyrus with a fissure in temporal isthmus (Fig. 1). Although the first temporal gyrus was apparently spared, many of its afferences and efferences were obviously destroyed.

G.M. was still leading a very active professional life as a photographer. From the beginning he was handicapped by a persisting slowness as soon as he had to deal with testing procedures, contrasting with his case in speech and conversation in a natural setting.

Neurological examination disclosed only a right superior quadrantanopia. Verbal dichotic testing revealed a clear right ear extinction, which persisted for 18 months after the initial stroke. In five successive dichotic tests using pairs of words (November 1984, April 1985, July 1985, September 1986, January 1987), correct responses for left ear vs right ear were: 100 vs 0%; 95 vs 15%; 95 vs 50%; 98 vs 70%; 95 vs 60%. Listening with his right ear was subjectively different from listening with his left one, as if he had to direct and maintain attention to this side in order to understand. By comparison, conscious attention was not necessary for language decoding on the left side ("with my left ear it is simple and natural"). Yet there was no right hemianacusia since auditory evoked potentials, at all latencies, appeared normal bilaterally, attesting that G.M. was hearing with both hemispheres [21].

A WAIS test performed twice showed the following scores, attesting his good non-verbal performances (Table 1).

Oral language comprehension

Most of the time, G.M. understood oral language without any difficulty. However, the meaning of some words, mainly abstract ones, appeared vague to him, although these words had probably belonged to his former vocabulary.

Syntactic competence was normal as attested by his facility in carrying on a dialogue. His score on the Token test was high: 58/62, with only one error in part V. He had no problem in classifying words by their "part of speech".

Language comprehension was not totally preserved. G.M. had difficulty in understanding or giving definitions. In conversation, G.M. was ill at ease with absurdities, ambiguities and even more with humour, particularly when puns were involved.

Spontaneous expression

G.M. was very talkative, slightly more than before his stroke according to his relatives. When speaking spontaneously, he used a normal range of words. On average, on the basis of four samples of 3 min of free speech, he produced 150 words/min, with 52 new words the first minute, 30 the second minute, 13 the third minute. There were no phonemic or semantic

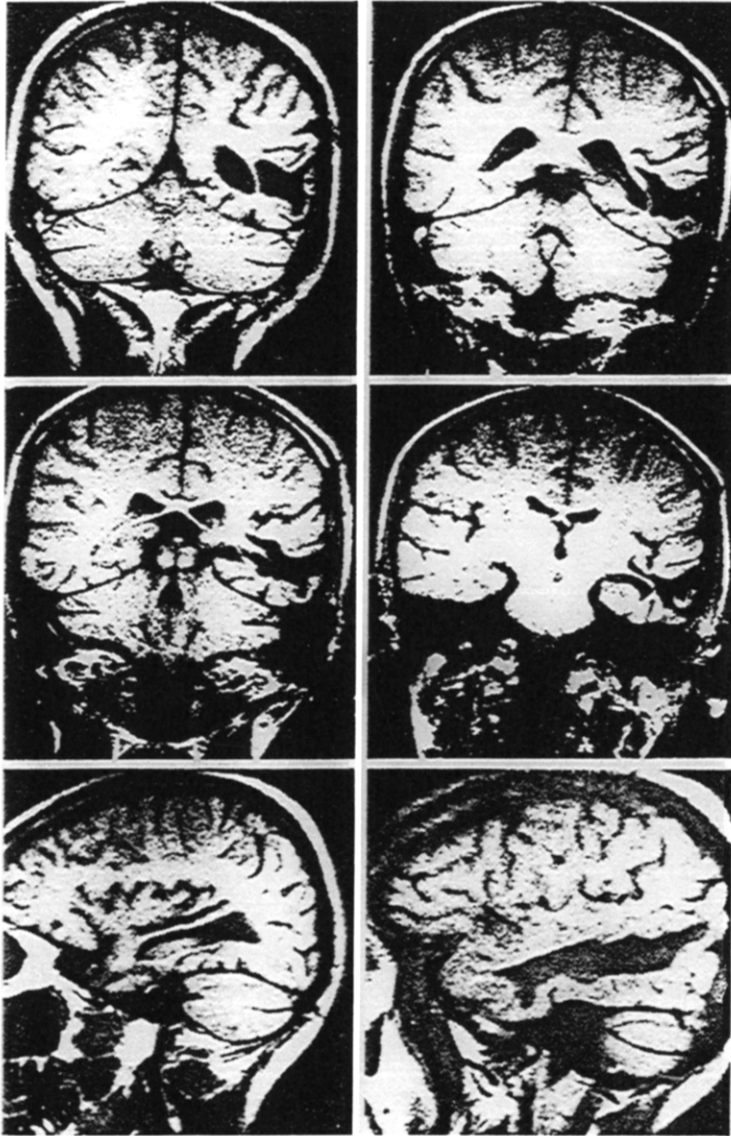


FIG. 1. MRI demonstrating the left temporo-occipital lesion along the second temporal gyrus, cutting horizontally the temporal isthmus.

Table 1

Date	6/85	10/86		6/85	10/86
Information	10	10	Digit symbol	7	Not tested
Comprehension	12	Not tested	Picture completion	13	13
Arithmetic	8	9	Block design	11	11
Similarities	10	16	Picture arrangement	14	14
Digit span	8	8	Object assembly	12	12
Vocabulary	12	10			
Verbal IQ	101	102	Performance IQ	111	109

Performances for PM 47 and Hooper test were in the superior range.

paraphasias. Yet, when G.M. had to refer to precise objects, persons or concepts, he would often search for a long time before finding the correct word. But he was usually skillful at masking this word-finding difficulty by using circumlocutions. Nevertheless, an objective assessment of his word retrieval by tests of verbal fluency or confrontation naming disclosed a serious problem.

Fluency

Three different fluency tests revealed a severe word-finding difficulty since G.M. produced per minute:

—for words beginning with the same letter a mean of 7.2 in 10 trials (percentile range 1–3, i.e. defective, according to Benton and Hamsher's tables)

—for words beginning with the same syllable a mean of 6.5 words in 5 trials

—for words belonging to the same semantic category a mean of 6.2 words in 5 trials.

These three means are far below normal scores for the patient's age and educational level.

Completion of clichés

Clichés or proverbs are normally heard as whole units, and listening to the beginning of a sentence should automatically yield complete phonological chains. G.M. could not complete unfinished sentences such as: *riche comme . . . Cresus* (rich as . . . Croesus); *pierre qui roule n'amasse pas . . . mousse* (a rolling stone gathers . . . no moss). When asked to make the correct choice between three word candidates to finish an open-ended metaphoric sentence like: *il a une santé de . . . fer? d'acier? de bronze?* (he has a constitution of . . . iron, steel, bronze) he made 9 errors out of the 50 triple choice sentences (18%) while control subjects made no errors at all. To sum up, G.M. was strikingly inadequate in these two tasks which rely heavily on auditory memory.

Global features of confrontation naming

G.M.'s word-finding was studied over a period of 1 yr when the patient's verbal behaviour appeared to be relatively stable.

Let us start with two typical naming sequences when G.M., confronted with a picture, was in what has been called a TOT state [2].

Picture of a **bird cage** ("cage à oiseau" or "une volière"): . . . *ça commence par V . . . ils peuvent voler . . . ça commence par voi . . . dans les musées . . . quand les oiseaux peuvent voler à l'intérieur . . . c'est "une", j'en suis sûr . . . ça ressemble à volier . . . il y a peut-être un autre mot qui me vient quand je pense à celui-là . . .*
 [. . . it starts with V . . . they can fly . . . it starts with VOI . . . in museums . . . when birds can fly inside . . . it's

feminine, I am sure of it . . . it sounds like sailing boat [voilier] . . . there is perhaps another word which comes when I'm thinking to this one . . .]

Picture of holly (*houx*) . . . *je sais que l'autre c'est le gui . . . il y a un X dedans . . . il y a un H . . .* (after 55 sec): . . . *c'est du houx*.

[. . . I know the other is mistletoe . . . there is an X inside . . . there is an H . . . (after 55 sec) . . . that's holly].

Globally, G.M. could not name more than 40% of the 400 pictures presented over different sessions.

Soon after his stroke, G.M. had difficulty finding even frequent words (frequency rank lower than 2000), but after a few months, he failed essentially for less frequent words, those which were not in the 2500 most frequent words in French. All subsequent results were obtained with words with a frequency rank belonging to the 2500–4500 interval according to TLF tables.

G.M. knew that only one word would exactly label a presented picture and he did not answer with members of the same category or with hyperonyms. For instance, after an unsuccessful search for the word shrimp [*crevette*] he did not propose Crustacea [*crustacée*] or lobster [*homard*]. He rather did go astray in free associations like: “. . . feminin . . . sea . . . first transparent . . .” moving progressively away from a close semantic field. Semantic and phonemic paraphasias were remarkably rare. When the right word was inaccessible, G.M. waited until he found it or escaped in multiple commentaries.

There was no pictorial effect since it made no difference whether the referent picture was isolated or embedded in a context and represented by a drawing or a photograph. This is in accordance with HATFIELD *et al.*'s observations [13].

Part of speech was not a relevant factor since there was no significant difference between nouns, adjectives or verbs.

G.M. showed no specific deficit for a particular category such as animate or inanimate; body-parts; flowers; fruits; furniture; tools; geographic names; operative names . . . From the beginning he was able to name colours normally, but insisted that he extensively used this particular vocabulary in his professional life. However, proper names were more difficult to retrieve.

Such a deficit in fluency and naming performances could be the result of various types of impairment: semantic, articulatory, mnesic or lexical. Accordingly, we investigated G.M.'s capacities in semantic, articulatory, mnesic and lexical processings.

Semantic representation of pictures and words

When G.M. failed to name a picture, he said: “I know what it is” . . . and he was often able to comment with words pertaining to the target word semantic field. For example, confronted with the picture of a hazelnut [*noisette*] he said “I was thinking of an acorn [*gland*] . . . but it is not . . . you can eat it . . . small animals too . . .”.

In a word-picture matching test, 10 sets of pictures from a different semantic category were selected (fruit, tools, weapons, vegetables, animals, musical instruments, body parts, trees, furniture, flowers), each set containing four pictures illustrating four words of the same category (e.g.: rose, daffodil, violet, daisy). G.M. had to point to the picture corresponding to the word uttered by the experimenter. He failed only once (daffodil) although he was previously unable to name 16 of these pictures.

In an odd word out test, G.M. had to point to the incongruous word among seven semantically related words. To make the task more difficult, half of the time the distractor word was phonologically related to one word of the list. For instance “*côtelette*” [cutlet], close to *côte*, had to be removed from the list:

<i>plage</i>	<i>mer</i>	<i>rochers</i>	<i>marée</i>	<i>côte</i>	<i>vagues</i>	<i>côtelette</i>	<i>île</i>
beach	sea	rocks	tide	coast	waves	cutlet	island

G.M. succeeded in all the 24 lists of the test.

In another test, G.M. had to select the hyperonym from a list of seven words of the same category. For example, clothes (*vêtement*) had to be selected from the list:

<i>chaussette</i>	<i>pantalon</i>	<i>veste</i>	<i>vêtement</i>	<i>complet</i>	<i>jupe</i>	<i>gilet</i>	<i>robe</i>
sock	trousers	jacket	clothes	suit	skirt	waistcoat	dress

G.M. succeeded in 11 out of 12 lists for concrete words, six out of eight for abstract words.

These tests proved that G.M.'s deficit in confrontation naming was not due to a picture or word semantic representation impairment.

Phonological segmentation and repetition

In a task of phonological segmentation G.M. was able to make progressive phonemic stripping as in: *charpente*/ʃaRpât/ /ʃaRpât/→/aRpât/→/Rpât/→/pât/→/ât/→/t/. Two or three syllables words were used, half of them were graphologically regular and half were ambiguous or irregular. He succeeded for 10 words out of 10.

G.M. was able to detect syllables in a phonological chain: required to detect the syllable /**la**/ in sentences like "le bas du **lac**"; "il **a** bu du lait"; il monte à l'**a**ssaut"; il veut **la** paix" mixed with sentences like "j'ai **lu** un livre, he showed 100% correct responses for 30 sentences.

Listening to phonologically close words (as "*poule*" vs "*boule*", "*moule*" . . . pit vs bit in English), he could point exactly to the heard word in a written list.

G.M. repeated correctly isolated words and non-words, series of unrelated words (up to four), of non-words (up to three), and short sentences.

To sum up, G.M. easily mastered phonological analysis of verbal input. Moreover, he presented no difficulty in articulatory output in spontaneous speech or repetition. His word-finding difficulty can hardly be explained by a deficit of word pronunciation. G.M. did not easily find words in a naming task, but does it mean he was not able to recall or recognize learned words?

Verbal learning capacities

Memory, tested by Signoret's battery 144 was normal.

Oral modality. G.M. showed no difficulty in learning series of orally presented words, as attested by his excellent performance to the Rey auditory-verbal learning test (10-10-13-14-15 words out of 15 recalled the first day; 14 1 week and 3 weeks later; 15 a month and 3 months later). These words were very common ones which he could retrieve easily in a naming task. But G.M. did not perform as well when he had to learn pseudo-words. For instance, we asked him to learn verbatim the French Revolution calendar. It is composed of 12 neologisms built up with a root and a suffix functioning both as phonological and semantic cues, like: "ventose" compound of [*vent*] (wind) and [*ose*] relating to winter season, "fructidor" (October) compound of [*fructi*] (relating to fruit) and [*or*] relating to summer season . . . etc. Despite these two cues, G.M. could never learn the whole calendar, even after 10 sessions of auditory learning.

Thus, although G.M. was able to learn a list of usual spoken words, he had much difficulty with a list of pseudo-words in the same auditive modality.

Visual modality. In a task of picture recognition where the patient had to judge whether or not the picture has been seen before (pictures used during naming sessions), G.M. performed well; in fact, he was even better than the three observers.

We conclude that G.M. is able to learn, to recognize and recall words and pictures. His word-finding difficulty cannot be due to an impairment of word or picture memory. A problem at a lexical level seems more likely, and we will now describe extensively the peculiar features of G.M.'s word-finding difficulty.

Confrontation naming: a specific study

G.M. presented naming difficulties in all input modalities (tactile, auditory and visual items) but we essentially studied his word-finding problem with visual items.

We looked for a possible word length effect on naming by comparing two sets of words having a frequency greater than 3000: the first set of 20 words retrieved at the first picture presentation, the second set of 80 words not retrieved at this first presentation. A *t*-test showed that the two sets: did not differ in word frequency; differed ($P < 0.002$) in the number of letters, long words being more difficult to retrieve than short ones (short words having less than six letters, long words more than seven); did not statistically differ in the number of syllables ($P = 0.06$). What is most striking, in fact, is the difference in significance between the two parameters (0.002 vs 0.06). Overall length is a highly relevant factor for word retrieval whereas number of syllables played a slight role if any. This is evidence that graphological features were more relevant than phonological ones in word retrieval. This point will be discussed later.

G.M. usually guessed some features of the target word.

Its *gender*—G.M. often indicated spontaneously the gender of sought-after words. In a special oriented session, he named only 19 out of 36 pictures but remained able to give the correct gender for 13 of the names he could not find (only 1 mistake).

Its approximate *length and morphology* (compound words, long vs short), but he never indicated the number of syllables, which remained for him an unfamiliar concept.

Its *first letter*, approximately in 60% cases. By contrast, G.M. rarely knew the first syllable or the last one. For example, looking at a lighthouse (*phare*/faR/in French) he said: "it begins with [p], it is masculine". Notice that the first letter is not necessarily a conversion of the word's first phoneme; this showed that G.M. had a better tacit knowledge of the graphology than of the phonology of the inaccessible word.

Some *medial letters* of the written word: in search of the target word [*algues*] (seaweed), G.M. spelled some of its letters: "a...l...g..." but it was not a sufficient prime to reach the whole word. It even happened that G.M. could almost entirely spell the target word and still remain unable to utter it: "h...a...l...b..." for [*hallebarde*]; "ch...e...v...l..." for [*chevalet*]; "c...a...q...u...e...s..." for [*casque*]; "g...o...l...e..." for [*gondole*]; "g...e...y..." for [*geyser*]; "m...y...a..." for [*mygale*]; "h...i...p...o..." for [*hippocampe*]; "h...e...a...u" for [*heaume*]; "c...y..." for [*cymbale*]... G.M. was mentioning medial letters as a series of isolated letters; he did not propose letter clusters or morphemes as normal people would do in a TOT state [25]. This is further evidence of a relatively better availability of graphological rather than phonological information. In fact, G.M. very often had access to first or medial letters and was thus helped in retrieving and producing the word rapidly enough to leave almost covert the search of the word. This tacit graphological knowledge was probably useful as indicated by G.M.'s commentaries about his strategy during word searching.

The number of graphological cues spontaneously mentioned led us to study G.M.'s

written naming. With 40 items of the same lexical frequency rank (around 3000), we observed the same results as in oral naming: 18 (45%) picture names were immediately written, but often with spelling errors; for the other inaccessible names, G.M. sometimes knew the first letter and/or some medial letters. If the response time was limited to 10 sec, G.M. failed in 55% cases; if he was given 1 min or more, he engaged in an anagram search which sometimes eventually succeeded. For example, having to name the picture of an antelope (“*antilope*” in French) he wrote “a...i...o...p”, tried two or three letters after the “a”, wrote an “n”, then said /ã/ and finally wrote “*antilope*”. Because of such a similarity in both strategy and results for the two naming modalities (written and oral), we then limited our investigation to oral naming, leaving G.M. free to occasionally look for a help in writing.

We studied *polysemic words* in a special naming session with 42 pictures corresponding to 21 words (i.e. a same word for two pictures as: “*avocat* [avocado pear]” or “*avocat* [lawyer]”). G.M. found 10 words as labels for both pictures, 7 words as labels for one picture only, and failed to find 4 of the 21 words. When G.M. had access to a word for the first picture, he was quite reluctant to use it as a label for the second picture when it had a different gender. For example he found “*la moule*” [mussel] for ‘shell fish’, but did not accept the word “*moule*” (without article) offered by the examiner for “cake dishes” [mould] because this time it was masculine (*le moule*).

When G.M. was searching for a target word which happened to be a polysemic word, we could observe a quite remarkable phenomenon. Required to name the picture of a ruff* (“*fraise*” in French) G.M. did not find the target word but insisted that this (unavailable) word was also a fruit name (“*fraise*” in French usually refers to [strawberry]). When confronted with the picture of a “*baleine*” [rib of an umbrella], G.M. again did not find the word but added that it was also a big animal (“*baleine*” usually refers to [whale]). Thus G.M. was slipping from the rare meaning of a polysemic word to a more common meaning, without being able to produce the phonological or graphological form of this word.

The phonological/graphological lexical unit of the polysemic word was the only link between the two referents since they are both visually and semantically different. In other words, G.M. had access to two separate semantic fields while the phonology and graphology of these two homophonic/homographic words were unavailable. We propose to call this very unusual phenomenon *parasemia*.

The other examples are: unable to utter the word *une coccinelle* [ladybird], G.M. referred to the popular German Volkswagen car which, in familiar French, is called *une coccinelle*; to name *lentille* [lens] as an optical tool G.M. said “it has something to do with a vegetable”: *lentille* also refers to [lentil]; confronted with *une grenade* [pomegranate] picture he said “it reminds me of Napoleon . . . a soldier”, referring to the word *un grenadier*; to name *marguerite* [daisy] he said “I think it is a first name too”; to name a picture of *un creneau* [crenellation], G.M. commented “something to do with a car, a driving manoeuvre, may be”: *un creneau* also refers to a driving manoeuvre; for *un cochonnet* [small ball or bowling jack] picture he said “there is something with an animal”: *un cochonnet* also refers to a piglet (in this case he recognized “*cochon*” [pig] in a multiple choice of animal names and eventually deduced the target word “*cochonnet*”); to name *un trombone* [wire paper-clip] picture he said “there is some music . . . musical instrument”. Looking for the word *une perche* [perch fish] he mentioned a jumping accessory *une perche* [pole] in French; to name *une quille* [keel]

*Ruff is a kind of collaret worn in the 16th century.

picture G.M. said “it reminds me of a game”: *une quille* is also a [skittle]; to name a rifle hammer, *un chien de fusil*, he said “that’s an animal, I think”: the common meaning of *un chien* is [dog]; to name *une punaise* [bug] he said “it is the name of a kind of pin”; *punaise* is also a [drawing pin]; for a *caravelle* [Christopher Columbus vessel] he commented on an airplane [a type of French aircraft].

It must be mentioned that these paresemias occurred in the course of numerous naming sessions, once in a while, and that in these conditions it cannot be considered as a deliberate strategy. We also observed that parasemias occurred for polysemic words which were both homographs and homophones, and all but “grenade” were of the same gender in the two meanings. G.M. never produced parasemias for homophonic non-homographic words (like *chaîne* [chain], *chêne* [oak]) but it is difficult to state this point with confidence because of the rarity of such words (if one requires that they be unfrequent and picturable).

It should be realized that it is difficult to study parasemias in an experimental way. Indeed, if we propose in a same session many polysemic words to name, the patient would become rapidly conscious of the experimenter’s expectation, becoming quickly aware that the target word is a polysemic word. The patient would be inclined to comment on a second meaning of the target word. For example, we tried to test the parasemia phenomenon in another anomic patient with a set of pictures corresponding, for half of them, to polysemic words. We quickly realized that in these conditions parasemias were induced too often. However, although parasemias could be easily elicited in some anomic patients, it was not true for many of them.

Attempt at naming facilitation by four different methods

Prompting with the first phoneme, the first or the last syllable of the target word was no help. Uttering aloud the word’s vowel sequence (like “/i/.../o/.../o/...” for “diosaure”) did not facilitate naming; the word’s consonant sequence with a wrong vowel (like “/danazaR/” for “diosaure”) was only slightly helpful. Thus, phonologically close gestalts were inefficient.

By contrast, naming was facilitated by graphemic cues. Indeed, word-finding was facilitated when the first letter was provided, even when this first letter gave an incorrect phonic cue as “p” in “phare”. In several naming sessions, we deliberately wrote the first letter of the target word. This prompting facilitated correct naming in 22 out of 40 presentations which were until then unsuccessful (in those cases the patient did not know the first letter of the target words). With respect to this first letter facilitation, G.M.’s insight is interesting: “sound does not help me; if you give me the first letter, I have the impression of seeing the word although I do not hear it . . .”.

On the other hand, it was very clear that most semantic and pragmatic information accompanying picture presentation was unable to facilitate word retrieval. This was not a surprise since, when G.M. was searching for a word, he was not helped by his own commentaries and periphrases, even pertinent ones.

We then adopted a more experimental approach similar to the one used by HOWARD *et al.* [14] to specify which kinds of facilitation could help the process of word retrieval.

METHOD

Four facilitation methods were used.

(1) Phonological cueing: one picture (an aubergine as an example) was presented to the patient while the observer said, successively: the first syllable of the word (“it begins with /o/”); 10 sec later, the last syllable (“it ends like /āzin/”

(*angine*)); 10 sec later, number of syllables ("it has three syllables"); 10 sec later the word itself ("it is /obèRzin/"); and finally asked the patient to repeat the word ("repeat it").

(2) Semantic cueing: one picture and six printed words (but not the picture name) were simultaneously presented; the patient had to select among the six words those which had a strong semantic relationship with the picture representing the target word to learn. For example, a picture of "insects" was mixed among six words: "*tard*" (late); "*moustique*" (mosquito); "*tricoter*" (to knit); "*moulin*" (mill); "*vent*" (wind); "*ailes*" (wings). The patient's choices were possibly corrected and he was asked to explain the semantic relations between the picture and the words he selected. If necessary, these relations were explained by the observers, who carefully avoided pronouncing the target word, in order to ensure a purely semantic facilitation without any phonological cue.

(3) Sentence completion cueing: the target word was the last word of a sentence which would almost inevitably induce it. The sentence was read aloud without this last word and the patient had to finish the sentence. For instance: "*j'ai mal au dos, j'ai du me déplacer une . . .*" to prime the target word "*. . . vertèbre*" ["my back hurts, I've probably slipped a . . .] to prime [*. . . disc*"].

(4) Oral reading and writing: a picture was presented simultaneously with its printed name and the patient had to read the word aloud and then write it.

Stimuli

Stimuli were pictures selected in a pre-test naming session. They had the same typography. During the pre-test session, we presented, for no more than 15 sec each, 200 pictures corresponding to relatively rare words (frequency-rank around 3000); 95% of these pictures were correctly named by a control group. From this set we selected 140 pictures which the patient clearly recognized but could not name and 40 pictures which he recognized and easily named. These latter 40 pictures were to be used as fillers to avoid too many failures during testing.

PROCEDURE

One week after the pre-test selection, we carried out both training and testing of 80 pictures, in 2 sessions each with a set of 40 words, according to the following procedure. (1) First a training of five items failed in the pre-test session; (2) 10 min later picture naming of a 10 item mixed set: the 5 items which had just been trained; 2 (or 3) items which had been failed in the pre-test (control 1); 3 (or 2) items (the fillers) which had been successfully named in the pre-test.

These two steps were successively carried out with each of the four facilitation methods: phonological, semantic, sentence completion and reading-writing cueing.

(3) Then followed a second identical session with 40 new words.

(4) Finally, G.M. was required to name the complete set of 2×40 pictures (40 facilitated and 40 unfacilitated) plus 10 new control pictures failed in the pre-test (these will be "control 2"). They differ from control 1 because they have never been presented again after the pre-test).

The next day, the same experiment was carried out with 90 different pictures.

One week later and 3 weeks later, G.M. was required to name all the pictures, i.e. 20 facilitated by phonological cueing, 20 by semantic cueing, 20 by sentence completion cueing, 20 by reading and writing cueing, 40 "control 1", 20 "control 2", 40 fillers.

It must be emphasized that G.M. was never helped in the course of the experiment when he failed to name a picture.

RESULTS

Results (Fig. 2) for each 20 item category show various effects analyzed statistically by comparison with control words (χ^2 tests). Naming was only slightly facilitated by phonological training, less than we expected. It was not facilitated by semantic training. This is less of a surprise since G.M. was usually not helped by his numerous semantic commentaries when searching for a target word. Naming was not facilitated by sentence completion training although this type of training involved both semantic and phonological (when patient found the word) facilitations. Finally, naming was significantly facilitated by reading-and-writing training ($P < 0.001$) which involved both phonological and graphological processes; moreover, naming of this set was not statistically different from naming of fillers. One may suppose that G.M., thanks to his excellent visual memory, was helped by visual memorization of written words. Unfortunately we did not test reading without writing for comparison with reading-writing facilitation.

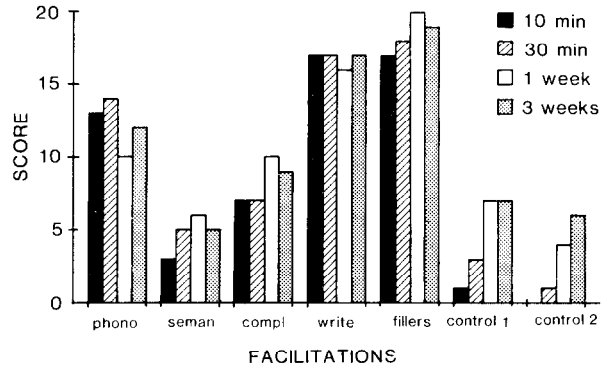


FIG. 2. *Facilitation of picture naming*: number of words successfully named (out of 20) across four facilitation methods (phonological, semantic, sentence completion, reading-writing) and sessions (10 min, 30 min, 1 week, 3 weeks).

We do not confirm for this particular patient HOWARD *et al.*'s [14] report that semantic facilitation is the most efficient one (up to 1 week after the facilitation session). We may object that semantic facilitation, in these author's experiment, is at the same time a phonological facilitation since the patient heard the target word.

Reading

G.M. was fond of reading before his stroke but he often complained that reading was no longer the hobby it used to be. He experienced difficulty in reading more than a few pages, though oral reading of isolated words and non-words was good, both in natural and tachistoscopic presentations. Out of 80 items of 1, 2 or 3 syllable words (20 regular words, 20 ambiguous words, 20 irregular words, 20 non-words), he made only one error, for the irregular word "asthme" (instead of the correct phonetic transcription /asm/, G.M. said /astme/). In tachistoscopic presentation, in a task of oral reading used to study spatial attention, he did not differ from a normal population. Reading of sentences was apparently normal; yet, oral or even silent reading of texts was definitely slow. The scanning deficit due to his upper quadrantanopia could hardly account of this reading slowness.

We studied G.M.'s reading in liminal conditions, i.e. in tasks of lexical decision (discrimination between words and pseudo-words) with tachistoscopic presentation of isolated items. We computed reaction times and error rates according to various parameters. The same lists of words, equilibrated in frequency, were presented several times along a year of observation.

Reaction times were strikingly slower for abstract words than for concrete ones ($t = 2.380$, $df = 129$, $P < 0.02$) while error rates were not significantly higher. By contrast if reaction times were not significantly different for function words and content words, errors were twice more numerous for function words (Table 2).

Overall, G.M. had evidently slower RTs and higher error rates than controls. This could partly be due to an apparent necessity for G.M. to utter more or less silently presented items. But his particular difficulty with abstract words could not be explained by time spent in covert uttering, since these words were no less pronounceable than concrete ones and had similar length or frequency.

His particularly poor performance with pseudo-words could be explained by his spelling

Table 2

Word type	N	G.M.		Controls (N = 15)	
		RT median msec	Errors %	RT msec	Errors %
<i>Concreteness:</i>					
Concrete	8 × 40	831	10	521	2.5
Abstract	8 × 40	1041	13	521	1.5
Pseudo	8 × 80	1040	16	602	3
<i>Part of speech:</i>					
Function	13 × 37	776	18	542	1
Content	13 × 37	789	9	545	1
Pseudo	13 × 80	1026	25	626	1

problem which made it difficult for him to decide if homophones—"jамет" for "jamais"—, purposely numerous in the pseudo-word lists, were non-words or real words. Although G.M. had, after many sessions, learned words and pseudo-words of the lists and could recognize them among distractors, he retained the same difficulty for quick and accurate lexical decisions.

Writing

As attested by old university notes G.M.'s spelling was good. During the 3 months following the stroke, it was disastrous as evidenced by this letter from January 1985 (right spelling in brackets): *Je suis tombé le 6 novembre 1986 . . . 1984 à 5 hr du soir, emmené (emmené) à l'opital (hospital) à 7 hr du soir. Ils m'ont ouver (ouvert) le 8 novembre à 12 hr. Quait-je (qu'ai-je) fait depuis vendre (vendredi) dernier?* This severe dysgraphia had only partly resumed and writing with a correct orthography remained a real problem 2 yr later. Difficulties were rarely syntactic (plurals, inflexions) but mostly lexical. Here are typical errors: *fusis* (fusil), *creu* (creux), *thom* (thon), *dolard* (dollar), *enfan* (enfant), *se pendant* (cependant), *adollessens* (adolescence) *chandaille* (chandail) . . .

A more systematic investigation in December 1986, when dysorthographia had partly resumed, revealed the following: out of 35 regular words, 5 errors (14%); out of 45 ambiguous words, 18 errors (40%); out of 60 irregular words, 31 errors (50%); out of 15 non words 0 error. The errors always respected the phonological code, but the spelling was not always the simplest one (explaining the errors in regular words). The spelling errors reminded those of normal writers with a poor spelling and were not sufficiently characteristic to classify this acquired dysgraphia as a surface dysgraphia, although it presented some of its features.

When he had to select the correct spelling in a multiple choice exercise G.M. hesitated and often failed. He could not use the common strategy of normal subjects, i.e. to write the word and look at it before deciding on the correct spelling. He still used to play Scrabble a lot, but was often obliged to check in a dictionary.

Narrative written discourse was not fluent at all. Required to summarize "Little Red Riding Hood" story, he wrote only four lines in a quarter of an hour. Spelling errors were of the same kind as those observed during dictation, i.e. involving essentially irregular and ambiguous words.

In conclusion, G.M.'s writing showed both a word-finding deficit and a poor spelling.

DISCUSSION

Following a haemorrhage in the left temporo-occipital area, patient G.M. presented an anomia and a surface dysgraphia which contrasted with normal spontaneous expression and quasi normal oral or written comprehension. This set of deficits represents an example of the classical syndrome called amnesic aphasia or pure anomia.

There is no doubt that G.M.'s language was predominantly lateralized in the left hemisphere since after the cerebral haemorrhage he exhibited a prototypical Wernicke's aphasia. Recovery of oral language (apart from anomia) was rapid, perhaps thanks to his left-handedness. But one may observe that what is classically considered as the Wernicke area was spared, since the lesion did not involve first temporal and supramarginal gyri.

Although G.M. could not name pictures it was certainly neither due to a visual recognition problem, nor to an impairment of semantic knowledge; it was a lexicalization problem. With regard to the well established dichotomy of semantically and phonologically based anomias [5, 6, 7, 16], G.M. clearly belonged to the second type of anomia. He often presented a mental state familiar to everybody, that is a tip of the tongue state (TOT) in which recall of the sought-after word is impossible but seems to be imminent. In such a state, normal subjects display a partial knowledge of the inaccessible word (first and last letter, number of syllables, similar sounding words, place of stress) i.e. they have at their disposal both phonological and graphological information. When G.M. was in a TOT state, he correctly guessed the first letter of the sought-after word in 60% cases. This percentage is similar to the percentage observed in a normal population by BROWN and MCNEIL [2]. But G.M. did not evoke the phonological information usually available to normal Ss: he did not know the number of syllables and rarely gave other similarly sounding words. He sometimes had an approximate auditory image. But this image was useless whereas it would almost inevitably enable normal subjects to reach the target word. Phonological prompts provided by the observer were usually ineffective. Further, in the facilitation experiment (see above), phonological help was far from being as effective as reading-writing help which provides an additional visual facilitation.

To overcome inefficient phonological processing G.M. apparently resorted to a visual strategy. He tended to initiate retrieval by starting from the first letter usually automatically accessible and guessed some other letters inside the target word. These letters did not necessarily correspond to the regular phonology, as "p" [p] in "phare" [far], "y" [i] in "cymbale", "ey" for [è] in "geyser" However, these letters were randomly enumerated, i.e. not in clusters, or morphemes as reported by RUBIN [25]. G.M. was not generating a phonological form out of this incomplete and sometimes disordered graphological outline. Besides, G.M. did not feel phonologically prompted by the first consonant, which has been shown to have a particular role in speech production [26]. This shows that G.M. was reporting visual rather than phonological information.

In addition, in naming tasks, the number of letters was a critical factor of word retrieval: the more the letters in the target word, the more difficult it was for G.M. to retrieve it. By contrast, the number of syllables was not a relevant parameter. Obviously, while both parameters are, to some extent, correlated, the first is essentially visual while the second is essentially phonological.

We mentioned that G.M.'s writing presented features of surface dysgraphia. This suggests an impairment of the graphological forms of the graphemic output lexicon, impairment which could explain both difficulties in writing under dictation and in written naming.

During the naming facilitation experiment, G.M. was mostly helped by reading–writing target word, i.e. by an essentially graphological prompting. The effectiveness of this prompting strengthens the hypothesis of graphological impairment.

Although G.M. evoked more graphological features than phonological ones when he was searching for a word, he was not more successful in writing than in uttering the target word. Considering that he did not show any impairment at a semantic level nor any deficit when speaking spontaneously or repeating, we may postulate three hypotheses to account for his word-finding deficit: a double impairment, i.e. access to each lexicon (phonological and graphological); a double deficit, one inside each lexicon; and a deficit located in a pre-phonological step which could be common to both modalities.

G.M. cannot be readily compared to the 9 anomic patients in the aphasic population studied by Goodglass *et al.* [9]. He actually had more failures (60 vs 16%) and among these failures he presented more TOT states (60 vs 26%). One may suppose that the two picture sets used in Goodglass's experiment and the present one, are not equally demanding.

G.M., as Kay and Ellis's patient, presented the three features characterizing impairment at a phonological level: good semantic knowledge, poor effect of phonemic cue and tip of the tongue responses.

In the course of multiple sessions, when the patient was in an effortful search for a target word which happened to be a polysemic word, he produced an unexpected type of response: for instance, required to name a picture of a ruff [*fraise* in French], he said "I cannot find the word . . . but it has something to do with a fruit name"; the common meaning of [*fraise*] is strawberry.

This type of response suggests that G.M. had access to two separate semantic fields of those two homophonic and homographic words, while at the same time phonology (/frez/) and orthography remained inaccessible. We have called this peculiar type of paraphasia, which results in a jump from one meaning to another, verbal parasemia.

How can we interpret such a jump from one meaning to another while words forms remain unavailable for uttering and writing?

A first hypothesis would be the possibility of a link between two referents inside the semantic representation system. Such a link through common semantic features may give rise to the production of semantic paraphasias (tie taking the place of ruff): meaning makes the link. A similar link is very unlikely in verbal parasemia for which both referents (strawberry vs ruff) do not share any semantic feature. The semantic link could be of another kind, a pragmatic link, elaborated by previous associations of the two meanings of the polysemic word.

A second hypothesis is to consider that some lexicalization process occurs and unifies both senses of the word but remains insufficient to activate the phonological or graphological word forms. This unification could allow a return to the semantic representations as well as an activation of these semantic features pertaining to the second meaning (often an hyperonym: a [fruit] for [*fraise*]). This leads us to consider two lexical steps in word retrieval: a first step would appear to produce a kind of phonological form (frame or outline or gestalt . . .) allowing the unification of the different meanings of a polysemic word: such a primary (uncompleted) form might be linked to semantic representations and vice versa; a second step apparently processes this primary form into a complete phonological form before spoken output. This formalization is consistent with KEMPEN and HUIJBERS's [17] model of lexicalization process divided into two stages: a first "L1" stage which accedes to a dictionary of abstract pre-phonological lexical items which are syntactically specified, and a

second stage retrieving phonological shapes of items. G.M.'s knowledge of gender for a lot (60%) of failed items gives support to this model since gender is a syntactic feature of the word. Parasemia could be interpreted as a good processing of the first stage which, since it is a lexical stage, will make the link between two meanings of a polysemic word.

The problem for G.M. would seem to lie in going from the first step to the second step. The functional locus of impairment is therefore located between the semantic system and the phonological (or graphological) lexicon. It could hardly be within the semantic lexicon [3] which is semantically organized, for two reasons: first, G.M. did not produce semantic paraphasias, and secondly, the rebound operating in verbal parasemias is articulated around phonological similarity.

In conclusion, G.M. exhibited a deficit in oral and written confrontation naming which was the result of an impairment functionally located after semantic processing and before achievement of phonological or graphological processings.

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