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A VISUAL-SPEECH DISCONNEXION SYNDROME

REPORT OF A CASE WITH OPTIC APHASIA, AGNOSIC ALEXIA AND COLOUR AGNOSIA

BY

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IN a paper entitled "Optische Aphasie und Seelenblindheit," Freund (1889) reported a case (Case 1) of left parieto-occipital—and probably callosal—tumour in which the patient could not name objects he recognized by sight whilst he correctly named objects put in his hand. Although the disorders were not confined to those just mentioned for there were in addition a right homonymous hemianopsia and aphasia and although the case was not extensively studied, the discordance between the abilities to name objects was so striking that Freund identified the disorder by the term "optic aphasia." He went on to propose an explanation by assuming that there were 2 lesions (fig. 1), one which destroyed the left optic radiations and the other which interrupted the associative pathways between the right occipital region and the speech area. Freund, however, did not clearly distinguish disorders of visual recognition from those of denomination. Thus he was led to include cases of visual agnosia in "optic aphasia" and to consider the latter as a third category of aphasia, beside Broca's and Wernicke's aphasias. The assimilation of disorders of visual

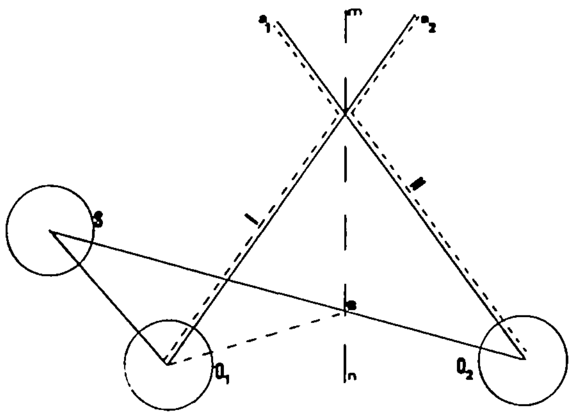


FIG. 1.—Freund's diagram: a_1, a_2: retinæ; 0_1, 0_2: visual cortex. S: speech area; B: splenium. According to Freund, damage to the left occipital region (0_1) together with a lesion of the splenium (B) would determine optic aphasia, i.e. the patient sees and recognizes objects with the right occipital region (0_2) but he cannot name them since the pathway linking 0_2 and the speech area (S) is interrupted.

recognition with optic aphasia was criticized by Freud (1891). In the following years, apparently similar cases were reported. After reviewing these, Wolff (1904) concluded that the available data did not exclude visual agnosia or a disorder of aphasic nature which would have not been confined to naming after visual recognition. Kleist (1916, 1934) shared Wolff's opinion and doubted whether optic aphasia actually existed. Since then, optic aphasia has either been quoted as a matter of historical interest (Nielsen, 1946; Hécaen and Angelergues, 1963) or even omitted, in studies of visual agnosia (Critchley, 1964; Frederiks, 1969; Bender and Feldman, 1972; Geschwind, 1965).

The presence or absence of disorders of naming according to the sensory modality has however been studied in researches about aphasia. Spreen *et al.* (1966) reported a case like Freund's, and studied naming in 20 patients with amnesic aphasia. In 3 "visual anomia" was more marked than "tactile anomia." In 2, the reverse situation was present. Goodglass *et al.* (1968), studied the relationship between naming and sensorial modality in aphasias and concluded that there was "a uniformity of naming ability across modalities of sensory stimulations for the great majority of aphasics."

The case reported in the present paper resulted from an ischæmic accident in the left posterior cerebral artery territory. It exemplifies dramatically the disorder individualized by Freund (1889), a disorder which results neither from visual agnosia nor from aphasia. Therefore we have called it visual-speech disconnexion. This obviously implies a physiopathological hypothesis which seems to us to be supported by a special neuropsychological study which was designed for this particular patient. At least, the present case offers the chance to study intra-hemispheric disconnexion as opposed to interhemispheric (callosal) disconnexions (Geschwind and Kaplan, 1962; Gazzaniga *et al.*, 1967; Geschwind, 1965).

Report of Case

Case 20451.—Jules F, a retired right-handed electrician, aged 68 years, was seen in June 1970. In 1965 he had a heart attack. Mild diabetes mellitus had then been discovered and treated. In January 1970 while driving his car, he suddenly had a right homonymous hemianopsia and pins and needles on the right side of the body; these lasted a few days. Though troubled by his visual defect and by alexia, he resumed his usual life. Some three months later, he became suspicious and aggressive, thinking that his wife was plotting to poison him. This led him to seek medical advice.

Examination showed a normally alert and co-operative patient. Right homonymous hemianopsia without macular sparing was present. There was no neglect for any part of the visual field. Corrected visual acuity was 6/10 on the right, 8/10 on the left eye. The optic fundi showed no abnormality. Disorders of language and memory were present (*v. infra*). No other neurological abnormality was recorded, except that both ankle-jerks were absent, probably due to the diabetes. EEG (9.6.70): the basic rhythm was slower (7 c/sec) on the left side than on the right side (8 c/sec); fast activity was recorded on both frontal regions; photic stimulation elicited normal responses. The heart was clinically normal. BP 160/100 mmHg; ECG normal; blood glucose 156 mg/100 ml; total cholesterol 225 mg/100 ml; lipids 670 mg/100 ml. No glycosuria. Left carotid angiography showed a tight stenosis, about 1 cm long, of the left posterior cerebral artery just beyond the posterior communicating artery.

Neuropsychological examination showed an intellectual level in keeping with the patient's educational background. Wechsler-Bellevue: IQ Verbal Scale 93; Performance Scale 93. Raven's Progressive Matrices between 50th and 75th percentiles.

An "amnestic syndrome" was present. Recent memories were incomplete. The day, month or year could not be given. The patient was aware that he was in a hospital but could not say where. Routes familiar to him from home to shop or famous monuments could not be recalled. After ten days in hospital he could walk back by himself from the neuropsychological department, in the basement, to his room, on the fifth floor of the same building. Disturbances of memory were disclosed in: (1) Wechsler Memory Scale: MQ=77, lower than the intellectual level; (2) drawing from memory the Figure of Rey in which the score (9) put the patient below the centile 10; (3) Benton's Visual Retention Test in which there were many perseverations; (4) various other tests, such as placing nine pictures in nine subdivisions of a square, learning of series of words and codes (Lhermitte and Signoret, 1972) which showed a severe reduction of learning ability. The memory span was reduced (4 digits forwards, 3 backwards). On the other hand, old memories were comparatively spared although their sequential organization often seemed disturbed (temporal confusions between memories pertaining to distinct periods of the patient's life).

Language was normal except for errors in denomination based upon visual recognition (*v. infra*). In spoken speech, there was no dysarthria, no lack of words and no paraphasias. Repetition of words and sentences, definitions of words, making sentences from given words were normal. Spoken speech was normally understood. Scores for the WAIS Vocabulary Test (standard score 12) and for the Binois-Pichot Synonyms Test (score 106) corresponded with the patient's educational level. Writing was normal (fig. 2) except for a few misspellings, again in accordance with the educational level. A few duplications or omissions of letters or parts of

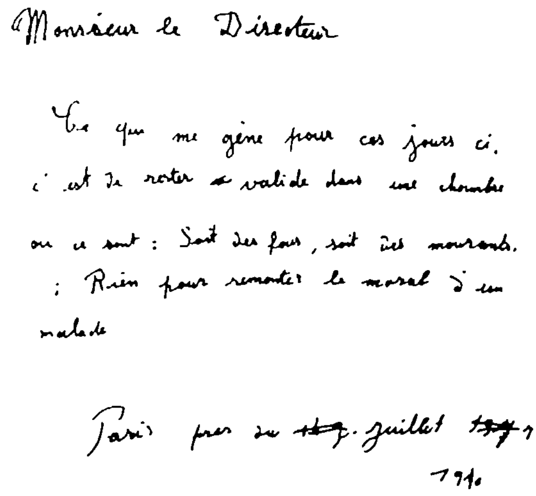


FIG. 2.—Spontaneous writing.

letters could be ascribed to alexia. There was no so-called ideomotor or ideational apraxia. There was no constructional apraxia and in the Wechsler-Bellevue Performance Scale, the block design subtest was carried out best. Drawings were very well executed, either spontaneously (fig. 4) or on spoken request.

The basic abnormalities were revealed by performance tests involving visual-speech activities. Errors in naming objects or pictures of objects were numerous (about 30 per cent in a series of nearly 600 items). When objects were misnamed, the patient very clearly showed by pantomime that he had correctly recognized them. Faces were normally recognized. Relatives, familiar physicians, and psychologists were correctly identified but in giving a name to pictures of famous persons mistakes similar to those noted with objects were present.

A few visual perceptive disturbances were present: Thurstone's Test of Identifical Forms was performed in 30 minutes with 13 mistakes; copying the Figure of Rey gave a type IV result. Copied

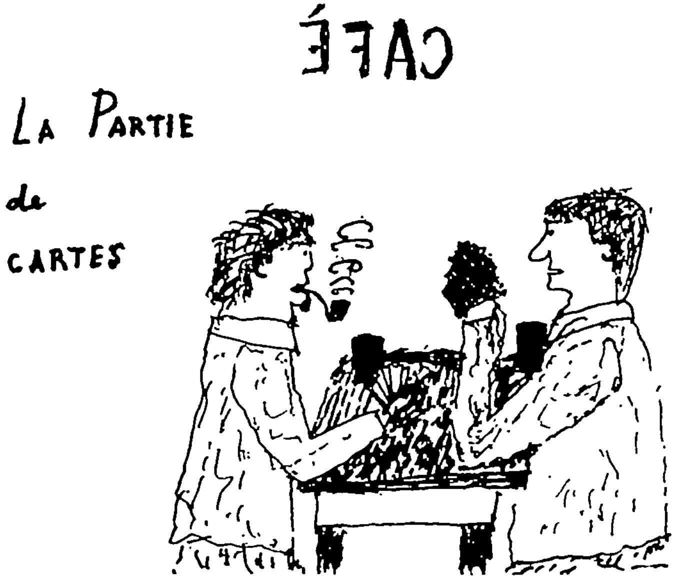


FIG. 3.—Spontaneous drawing. Note the excellent spatial organization (the word "café" is seen from inside).

drawing was slightly disturbed while freely executed drawing was normal (fig. 3). Copied writing was severely disturbed while spontaneous writing and writing to dictation were normal. A very severe agnosic alexia was present. A few letters only could be recognized and the patient was unable to read any syllable or word. No improvement occurred when the observer wrote the syllables or words on the right or left palm of the patient's hands. More frequent recognition occurred however when the patient traced large letters with a finger. Even so no syllable was recognized.

A slight disorder of colour vision (axis of tritanopia very small at Hardy-Hand-Ritter's Test, definite at Farnsworth's 100 Hue Test) was present. Tests of colour matching were normal. Colour agnosia was disclosed by naming errors and, to a lesser degree, errors in designating colours upon spoken request, errors in the choice of the rightly coloured picture of an object, severe errors in colouring his own or other's drawings.

These errors in recognizing and using colours as specific attributes of objects were studied with two tests: (1) pointing to the correctly coloured object amongst 5 variously coloured drawings of the same object, there were nearly 50 per cent of errors; (2) colouring 12 drawings in 6 different experimental conditions, this was designed to study whether errors were related to errors in naming the pictures and/or to errors in naming the colour corresponding to the objects. Errors in colouring were observed in 40 to 50 per cent of the items, while errors in naming objects were observed in 25 to 35 per cent of the items, suggesting that the patient erroneously coloured objects that he had correctly identified. The patient's choice of colour appeared unrelated to the colour of the object corresponding to the erroneous name he had given. Finally, when the observer gave the name of the object presented on the picture and asked the patient to give the name of its colour there were 96 per cent of correct answers (for 24 stimuli), but this did not improve colouring (40 per cent of the pictures remained incorrectly coloured).

In summary, a 68-year-old right-handed man, after an ischæmic accident in the territory of the left posterior cerebral artery, showed: (1) right homonymous hemianopsia; (2) errors in naming objects which were however correctly recognized;

(3) slight disturbances of visual perception; (4) agnosic alexia; (5) colour agnosia. The main disorder involved errors in naming objects. This disorder contrasted with otherwise normal language and with a nearly normal visual perception as judged by the patient's ability to recognize and draw objects. In other words, this disorder could not be ascribed either to aphasia or to visual agnosia. This raised the problem of: (1) the site of the defect in the chain of visual perceptive and psycholinguistic operations; (2) the characteristics of the errors in naming. The study was performed during June and July 1970, the condition of the patient showing no significant change throughout these two months.

SPECIAL NEUROPSYCHOLOGICAL STUDY

I. Naming Errors, Speech and Visual Perception

Misnaming and Language

To disclose language disorders which might not have appeared on standard examination, the patient was asked to name objects when given a spoken definition or tactile clues or auditory clues (Table I).

TABLE I.—TESTS OF NAMING

Stimulus	*No. of stimuli*	*No. of errors*	*Percentage of errors*	*Type of errors*
Visual				
Pictures	100	28	28	Mainly semantic
Objects	30	7	23	
Auditory				
Definition of words	100	4	4	Possible errors (such "errors" may be encountered in normal subjects)
Noises specific for objects	25	1	4	
Tactile				
Objects put in the hand	120	11	9	Possible errors (such morphological confusions may be encountered in normal subjects)

(*a*) *Naming objects from spoken definition.*—One hundred objects were selected for which misnaming had occurred. For each of these, a dictionary-like spoken definition was proposed as a question, e.g. what is the name of the animal which sings at dawn? What is the name of a machine which pulls the carriages of a train? What is the name of the summer shoes consisting of a sole bound to the foot by straps? The 100 questions were asked during a single examination. The patient replied immediately to every question and a new question directly followed each answer. There were 96 correct and 4 questionable answers. Among the 4, 2 were related to 2 fruits for which colour is an important feature, i.e. the patient said redcurrant instead of blackberry and plum instead of apricot. The 2 other questionable responses could be ascribed to imprecise definitions, e.g. what is the white and round vegetable with green leaves which is cooked with breadcrumbs or seasoned with oil and vinegar? The patient said leek or potato instead of cauliflower.

(*b*) *Naming based on tactile clues.*—The patient was blindfolded and asked to name 30 objects serially put first in his right hand, then in his left hand. Thirty other objects were put in both hands in reverse order. This made 120 questions to which 109 correct answers were immediately given. Among the 11 incorrect responses, 7 were related to the left hand, 4 to the right one. Six incorrect responses were at once spontaneously rectified. In every instance, incorrect names showed a morphological relation to the right name, e.g. a marble "a hazel . . . something like that . . . a marble"; a paper clip "a safety-pin." Since it was not possible to know whether the object had been correctly "examined" by touch, the significance of such "errors" is questionable.

(*c*) *Naming based on auditory clues.*—The patient was asked to name 25 items, e.g. car, railway train, bell, piano, typewriter, wind, from their characteristic sounds recorded on magnetic tape. He made only one mistake of doubtful significance, i.e. "Far West locomotive" instead of ship hooter: both sounds are quite similar; the French are currently submitted by television to a hard educational pressure about Far West folklore so that very exotic sounds and expressions are likely to become more familiar than domestic ones. It should also be noted that the two sounds preceding the Far West mistake were that of a railway train and that of a galloping horse.

(*d*) *Designating pictures of objects.*—Pointing to 50 pictures of objects, the name of which was spoken, was normal. The only situation which revealed errors of designation was when the patient was asked to point to objects not present in the pictures shown to him. In this case the patient sometimes pointed to a picture of an object bearing a semantic relationship to the name of the object given by the observer. For instance, the patient pointed to a ham and a pipe when asked to point to a sausage and a cigarette.

In conclusion, aphasia could not account for the numerous errors which occurred in naming from visual clues.

Naming Errors and Visual Perception

Visual perceptive operations were studied in: (*a*) drawing from memory objects for which errors in naming had occurred; (*b*) recognition of objects as judged by pantomime and comments spoken by the patient.

(*a*) *Drawing misnamed objects from memory.*—This test was devised to discover whether misnamed objects could have been correctly perceived. A series of 100 pictures of objects (50 black and white, 50 coloured) was used. Each picture was presented during two seconds. When the patient gave an incorrect name, he was asked to draw the picture from memory. Then he was given verbally the correct name of the object and asked to draw it. Finally, the patient was given verbally the incorrect name that he had uttered and asked to draw the corresponding object (fig.4). When shown the 100 pictures, the patient made 31 errors in denomination. Among these 31, in 22 instances, he drew the object fairly well from memory, with significant details. In 6 instances, he began to draw the picture then went on adding features pertaining to the wrong name-object. This led to curious cross-bred drawings (fig. 5). In 3 instances, the drawing was very poor and did not suggest anything definite to us. In short, in more than two-thirds of the errors in oral naming, visual perception had been good enough to allow a fairly correct reproduction by drawing. The graphic quality of most of the drawings was excellent; when asked, the patient always drew correctly the object whose picture he had misnamed, the object corresponding to the incorrect name (fig. 6).

(*b*) *Recognition of objects.*—In everyday life, the patient's behaviour did not suggest visual agnosia. He could describe how to use clothes, razor, comb, fork, knife and usual tools presented to him without touching them. Similarly, spontaneously or upon request, he correctly mimed the use of objects presented to him, although he misnamed some of them. This pantomime suggested that he had recognized the meaning of the object, e.g. when shown a boot, he mimed a man pulling on his boot and said "a kind of head-comforter" ("un genre de passe-montagne"). A similar discrepancy between incorrect naming and correct miming was present for a sandal, a detachable collar, a fan, a glove, a comb, etc. In the whole series of tests no incorrect miming occurred. Therefore it seemed that there was no significant defect in the processes of visual recognition. When shown some complex objects, however, the patient gave answers which suggested that he sometimes did not recognize or at least did not recognize at once the object but he could very well draw or describe it (*v. infra*).

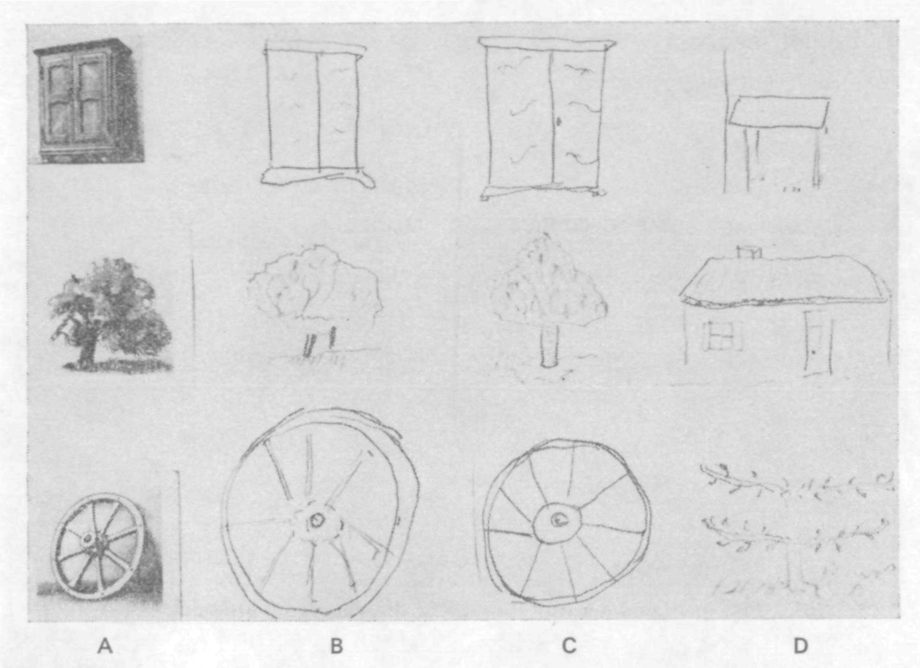


FIG. 4.—From left to right: A, the picture which was misnamed; B, drawing from memory of this picture; C, drawing on request of the object the picture of which had been presented to the patient; D, drawing of the object corresponding to the incorrect name. For instance, when the patient was shown a picture of a tree, he said: "it's a house with a straw roof" (a preceding picture showed a house); however, when asked to draw from memory what he had just looked at, he drew a correct picture of the tree while he maintained that he was drawing "a straw roof"; he was then asked to draw a tree and a house with a straw roof. Names for the other pictures were: wardrobe→ a corner table; wheel→ fruit wall-tree.

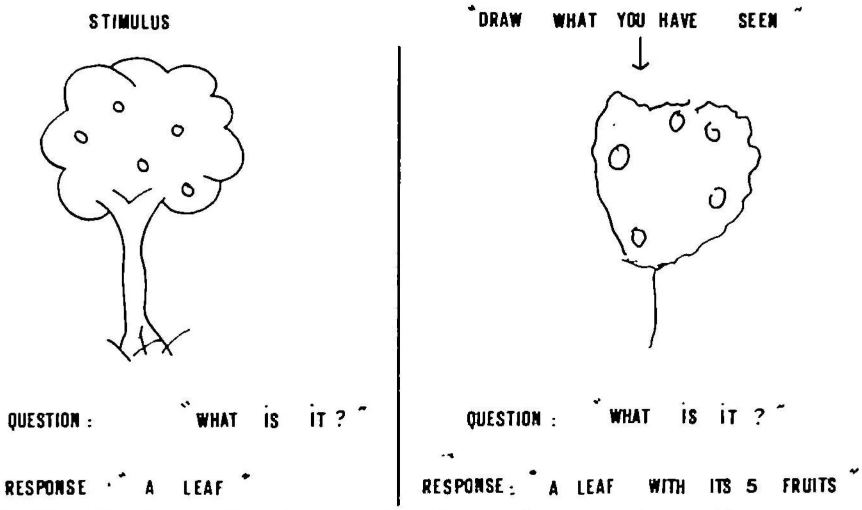


FIG. 5.—Drawing intermediate between the picture-stimulus and the object corresponding to the incorrect name.

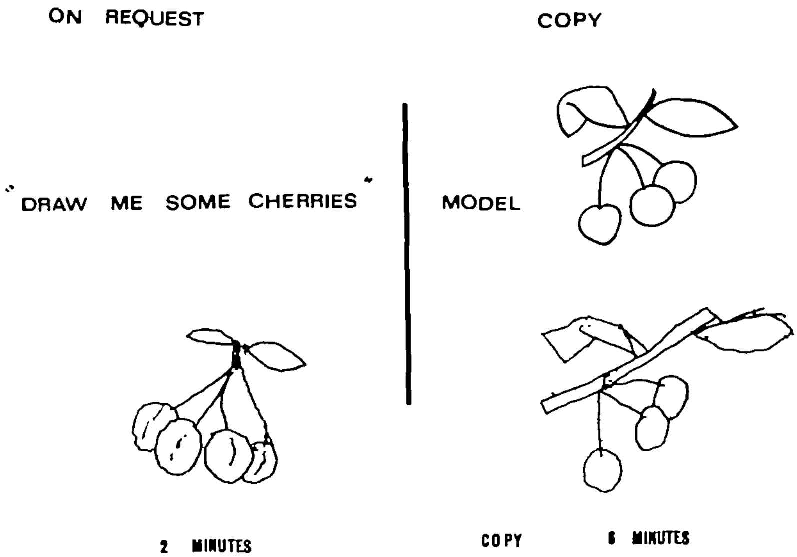


FIG. 6.—Drawing on request and drawing from a model.

II. Analysis of Naming Errors

Errors in naming showed the following characteristics:

(1) using many various stimuli (objects, black and white or coloured pictures) errors constituted about 30 per cent of the responses; (2) when time was allowed to rectify an error in naming, the correct name was often given after successive attempts, even when the stimulus had been seen for only a short time; (3) when a stimulus was presented at a subsequent examination responses might be either correct or incorrect.

When incorrect, the errors varied from one examination to another, e.g. when shown a knife at successive examinations, the patient said "a fork," "a cat," "a leek"; (4) there was often an apparent semantic relation between stimulus and incorrect name, e.g. a ham was called a pancake or a beefsteak, a slug was called a grasshopper, trousers were called shoes. Occasionally naming was peculiar, e.g. when shown the picture of a snail, the patient said "a lion with a snail in front of its nose"; for a carafe, he said "a stopper for a carafe"; for a tie, he said "a head with a tie." A morphological relationship between the presented object and the object corresponding to the incorrect name was rare, e.g. when shown a banana, the patient said "a chistera" (i.e. a kind of racket used for pelota); for a broom, he said "an oar"; (5) perseverations were frequent and of several kinds (Table II): some were correct or incorrect responses pertaining to the preceding stimulus or to stimuli presented previously (Table II, a, b); some were a name the patient should have given to a previously proposed object; this correct name had not been given at the right time (Table II, c); some were perseverations either of a correct or of an incorrect name but perseveration of semantic features related to one or the other (Table II, d); it was infrequent that names bore no apparent relation to the object, e.g. a carafe: "a child"; a cat: "a knife"; (6) when giving a wrong name, the patient was apparently not aware of his mistake. He did not complain of trouble in finding names. When asked immediately after a wrong response, he was convinced that he had given the right name. When uninterrupted after an incorrect naming, however, he often continued talking gradually approaching the right name. When asked to write down the name of objects the patient behaved differently. He refrained from writing until he had found the correct name. Thus incorrect names were absent in written tests of naming.

TABLE II.—EXAMPLES OF PERSEVERATIONS

a.	kite balloon	→	a kite balloon
	parachute	→	another kind of kite balloon
b.	carafe	→	it's *a child*
	daisy	→	a flower
	cock	→	the head of *a child*
c.	strawberry	→	a cherry
	acorn	→	a fruit, an acorn
	nut	→	a nut
	tomato	→	a strawberry
d.	pencil	→	it's a pencil
	match	→	isn't it a brush?
	knife	→	now it's a pen

To analyse qualitatively and quantitatively errors in denomination and to study the role of some variables in the production of errors, 3 tests were used: (1) naming 100 various pictures (with a limited time to answer); (2) naming 320 pictures with a limited time to answer, the characteristics of which had been selected *a priori* to study the role of 4 variables; (3) naming (with free time to answer) 50 various pictures to study the verbal approach to the correct answer.

Naming 100 Pictures of Objects and 30 Objects

One hundred pictures of objects, dissimilar in perceptual complexity and significance, were used. Each picture or stimulus was presented during two seconds. As soon as the patient had given a name, the following picture was presented. Thus answers could not be altered. Errors were analysed according to 2 criteria: (*a*) relationships between stimuli and incorrect names (horizontal errors or HE); three subgroups were distinguished, namely: (1) horizontal semantic errors (HSE), characterized by a semantic relationship between stimulus and incorrect name, e.g. "hat" for shoe; (2) horizontal morphological errors (HME), characterized by a morphological relationship between stimulus and wrong name, e.g. "hazel nuts" for coffee-beans; (3) horizontal morphological and semantic errors (HMSE) characterized by a combination of both kinds of error or by an error for which it was deemed impossible to decide which of the two types of errors was significant, e.g. "lemon" for orange, "cucumber" for aubergine, "napkin" for dish cloth. Examination having clearly shown the predominance of semantic errors, we made a point not to underestimate morphological ones. Therefore HMEs and HMSEs have been overestimated at the expense of HSEs. (*b*) Semantic relationship between incorrect names and stimuli or names presented previously in the course of the test (vertical semantic errors or VSE). Only errors in which an obvious semantic relationship was present were taken into account. Some of them resulted from the perseveration of a previously uttered name, others bore a close relationship to a precedent stimulus or to a precedent name given by the patient.

In the series of 100 pictures, 28 errors in naming occurred. The mean time between the beginning of the presentation of the picture and the response was 2·9 seconds for correct names, 5·7 seconds for incorrect ones. This mean time is significantly longer than that required for responses in normal subjects, i.e. 0·47–0·80 second (Fraisse, 1964). The 28 errors were (Tables III, IV and V): 17 horizontal errors (60 per cent) (9 HSEs, 2 HMSEs), 8 VSE (28 per cent) and 3 mixed horizontal and vertical errors. As can be seen in Tables III, IV and V, most of the incorrect names bear a semantic relationship to the object. This is obvious for HSEs. It seems likely for HMSEs where the semantic kinship may be most significant. VSEs (Table IV) may be simple or complex. A striking example is found in the name "Pierrot" given in response to stimulus No. 73, when stimulus No. 71 had been a crescent moon. ("Au clair de la lune, mon ami Pierrot. . . .")

The patient was asked to name 30 objects to see if there was a significant difference in the frequency and nature of errors, depending on whether the stimulus was an object or a picture of an object. Time exposure and timing of sequential presentation of objects were similar to those used with pictures (*v. supra*). The patient made 7 errors (23 per cent/30), a non-significant difference with 28 per cent/100 pictures (*v. supra*). The 7 errors were: 5 horizontal errors (3 HSEs, 1 HME, 1 HMSE) and 2 VSEs.

TABLE III.—HORIZONTAL ERRORS

(1) Horizontal semantic (HSE)
- bottle → glass
- cap → jockey
- container → head of carafe
- helmet → cassock
- shoe → hat
- wardrobe → arm chair
- red poppy → bunch of flowers
- glass → carafe
- comb → tooth brush

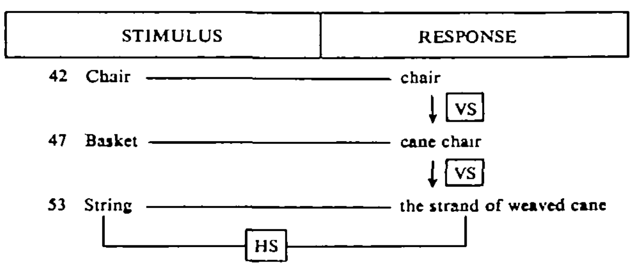
(2) Horizontal morphological (HME)
- tea pot → cube with 8 sides
- coffee beans → hazels

(3) Horizontal morphological and semantic (HMSE)
- orange → lemon
- mug → ice bucket
- salt box → pepper pot
- aubergine → cucumber
- wash basin → sink
- dish-cloth → towel

TABLE IV.—VERTICAL SEMANTIC ERRORS

Stimulus	*Response*	*Presumed origin of error*	*Distance*
10 Knife	A child	9 S and R a baby	1
27 Scissors	A wrist watch again	26 S and R wrist watch	1
36 Fork	A comb again	34 S and R comb	2
45 Case	Two books	44 S and R a newspaper	1
47 Basket	Cane chair	42 S and R chair	5
51 Workbench	Cane back of a seat	42 S and R chair (then 47 R chair)	9 or 4
73 Coffee-pot	Pierrot	71 S and R crescent of moon	2
86 Chariot	Garden armchair	42 S and R chair (then 47 R and 51 R)	44 or 35

TABLE V.—COMBINATION OF HORIZONTAL AND VERTICAL FACTORS



The erroneous response "chair" to item 47 resulted from a perseveration of stimulus 42 and from the response to this stimulus. Cane is used to make baskets and chair. Item 53: "strand" bore a semantic relationship with "string." "Cane" was a perseveration of the response to stimulus 47. "Weaved" might be applied to string as well as to cane.

The results of these tests show the predominance of semantic errors, this being true for horizontal (9/28 for images, 3/7 for objects) as well as for vertical (8/28 for images, 2/7 for objects) errors. Moreover, it should be remembered that in the present work the number of HSEs has been underestimated (*v. supra*). Non-intelligible responses, e.g. "knife" for cat, were not encountered as they had been during clinical examination. This may be due to the fact that in the latter situation they were perhaps unrecognized perseverations.

Some Possible Variables Influencing Errors in Naming

Four such variables were studied: (1) semantic relationship between stimuli; (2) morphological relationship between stimuli; (3) structural complexity of pictures of objects; (4) time elapsed between a response and the following stimulus. These variables were selected, bearing in mind the frequency of the semantic relationship, the rarity of morphological ones and the importance of perseverations in the patient's performances. A factorial design with 16 experimental situations was devised so that any variable could be studied independently of the 3 others (Table VI).

TABLE VI.—EXPERIMENTAL CONDITIONS AND PERCENTAGE OF ERRORS

		Immediate		*Delayed*	
		Coloured pictures	*Black and white drawings*	*Coloured pictures*	*Black and white drawings*
Semantic proximity	Morphological proximity	Round vegetables and fruits (50%)	Four-footed animals (35%)	Round vegetables and fruits (65%)	Four-footed animals (40%)
	No morphological proximity	Clothes (85%)	Various animals (55%)	Clothes (85%)	Various animals (30%)
No semantic proximity	Morphological proximity	Round objects (55%)	Long objects (60%)	Round objects (55%)	Long objects (55%)
	No morphological proximity	Various pictures (50%)	Various drawings (60%)	Various pictures (40%)	Various drawings (60%)

Each experimental situation comprised 20 stimuli which were successively presented for two seconds. In the "immediate" test a new stimulus was presented as soon as the patient had given his response. In the "delayed" test, a new stimulus was presented sixty seconds after the response. During these sixty seconds, the observer maintained an uninterrupted conversation with the patient. In both conditions, the same series of pictures (160) were used. The "delayed" test was given one week after the "immediate" one to avoid risk of learning correct answers and of perseveration of incorrect ones. The role of each variable was studied using the $\chi 2$ test (Table VII). The repartition of each type of error was also studied but it was not possible in every case to treat it statistically as some types of error were rare and there were also errors of mixed types.

The number of erroneous responses varied considerably, according to the experimental situations. The range of variations was from 6 to 17 in a series of 20 images (from 30 to 85 per cent). This number, however, was strictly determined by the nature of the stimuli. It was remarkably constant in each of the series of 20 pictures presented twice with a week's interval (Spearman's rho$=0{\cdot}56$, $P<0{\cdot}01$), although errors did not necessarily result from the same stimuli, and erroneous responses were not similar. The number of errors (about 50 per cent) which could be ascribed to perseverations of words or to semantic perseverations did not vary much from one experimental condition to the other. Results are as follows (Tables VI, VII): (1) when stimuli were coloured complex pictures of objects the number of errors was significantly greater than when pictures were black sketches upon a white background. This, however, did not show a similar influence upon every type of error: perseverations were unchanged; morphological errors tended to be less frequent (from 7 to 4). The increase in the number of errors resulted only from the increase in the number

TABLE VII.—NUMBERS OF ERRORS IN RELATION TO EXPERIMENTAL CONDITIONS

	Delay		*Complexity*		*Morphological relationship*		*Semantic relationship*	
	+	−	+	−	+	−	+	−
Number of errors	86	90	97	79	83	93	89	87
χ^2	NS		$\cdot 10 < P < \cdot 05$		NS		NS	

of HSEs. This might seem unexpected as perceptual complexity could have increased the number of morphological errors. In fact this result is in accordance with the whole neuropsychological picture: most of the errors were of a semantic nature and they became more numerous when proposed tasks were more difficult; (2) when objects were morphologically akin, the number of errors did not significantly differ from that which obtained with morphologically dissimilar objects. However, the number of morphological errors increased and that of HSEs decreased; (3) when objects belonged to the same semantic category, the number of errors did not differ from that which obtained with objects not belonging to the same semantic category, but morphological errors completely disappeared and HSE increased slightly; (4) when stimuli were semantically and morphologically akin, 90 per cent of errors kept a semantic and morphological kinship with the stimulus, e.g. in the series of four-legged animals, errors were almost exclusively names of four-footed animals; (5) when stimuli were complex and closely related semantically, the number of errors increased considerably; it is in this particular situation that it rose to 85 per cent of responses; (6) the sixty seconds' delay between response and presentation of the next stimulus did not change either the number of errors or their distribution in the different categories (Spearman's rho$=0{\cdot}67$, $P<0{\cdot}05$). In particular it did not change the number of perseverations (pure VS$=13 \longleftrightarrow 14$; VS mixed with other types of errors$=49 \longleftrightarrow 53$).

Naming 50 Pictures of Objects with Unlimited Time

Fifty pictures of objects were successively presented, each for two seconds. The time allowed for the response was not limited, i.e. the following picture was presented when the patient no longer wished to alter or complete his response.

Taking into account the first response to each picture, there were 14 errors (28 per cent), but in 11 instances the patient subsequently found the right name. To demonstrate the gradual approach to the correct name, some responses may be reproduced here *in extenso* (some of the patient's words and sentences were difficult to translate because they were already peculiar in French. In such cases French words or sentences have been included:

A syringe: "a dropper, unless it might be a hypodermic syringe, but I do not think so!"

A grass-hopper: "a cricket, not a cricket, a grass-hopper."

A mussel: "it looks like 2 snails, 2 slugs, it is a shell-fish, not an oyster, it should be mussels then."

A waste-paper basket: "a kind of andiron (a preceding picture had been named 'log') made of cane, of osier, a basket."

A cup (the preceding stimulus, a cork screw, had been rightly named): "the cork screw too . . . there is a porcelain handle . . . or a fancy cork . . . there is the reflection . . . then I should see only a cork unless it could be a cup."

A bus: "a wagon . . . public transport since there is a back door . . . a stage coach . . . it would be . . . no . . . a city cab . . . not a cab but a city bus."

A window-blind: "a parasol, metallic curtain rods . . . the cloth roof . . . surrounding sails . . . (de la voilure autour . . .) it could be a parasol . . . there are rods, but isn't it a shelter? a window-blind . . . not a window-blind, the window-blind is rolled up, there is no device to roll, a sunshade ('pare soleil') . . . it should be a window-blind which does not roll."

An aquarium: "a bird-cage, unless it is a pot for flowers, a container, a tank, the four aspects . . . the walls made of glass or wood . . . it could be an aquarium if it is made of glass."

A mediæval crown: (a preceding picture had been rightly named: "a basket") : "a kind of foot of metallic basket ('une espèce de pied de corbeille métallique') a basket for flowers, a basket for a table. There are 4 hoops above which make 6 or 8 hexagonal parts while there are only 4 cross-shaped rods . . . a basket . . . it cannot be a basket for decoration on a table . . . it is not a decoration, I do not know what it could be. A basket with 4 feet, no with 4 crossed hoops . . . it cannot be worn as clothing, it would be . . . a hat. It would be a very fancy hat to look like that . . . it is not even closed on top. . . . The ribbons do not correspond with the hoops. If there was a ribbon, it would be a hat, it would be very fancy. I do not know of a fashion that . . . a fancy carnival costume yes."

FIG. 7.—This picture determined answers which are reported in the test.

In these examples, all errors were HSE, HSME or perseverations, e.g. responses for paper basket, cup and crown. Apart from the latter errors, the first responses were nearly always characterized by the presence of semantic features belonging to the object shown by the picture, e.g. responses for syringe, grass-hopper, mussel, bus, window-blind and aquarium. Two processes could therefore be identified. The first one was a semantic approach reminiscent of that displayed by some aphasic patients. This was exemplified by the responses for mussel (notion of shell-fish), for bus (notions of means of transport), for window-blind (notion of cloth roof sheltering from the sun), for aquarium (notion of cage, pot, container) which showed that the deficit lay in the search for the adequate word in a semantic field. The second kind of approach, which was mixed with the first one, consisted of an analysis of the morphological features of the object inside a semantic field. This was exemplified when the patient at first said "parasol" for window-blind then went on with "metallic curtain-rods," "surrounding sails," then returned to "parasol" followed by "rods," and finally reached the correct response. A similar process was observed with "aquarium." By gradually taking into account the morphological features of the object, the patient reached the correct word, as if such an analysis had a facilitating effect upon verbal evocation. The difference between perception of the fundamentals of the picture (forms and colours), and the appreciation of their significance should be stressed here. The first process was normally carried out (the patient could not have given the word "aquarium" if, during the short presentation of the picture, he had not seen goldfishes behind the transparency of the glass walls). The second process was necessary for a correct answer in response to some items. As more and more morphological features were taken into account, the probability of elicitation of the right word in a field of "possible" words became more and more focused up to the point of reaching the correct response. Such a process which is normally almost instantaneous appeared to be carried out progressively so that the patient as it were displayed its mechanism. Doubtless such a process is not akin with the "gradual approach" seen in aphasic patients. It is reminiscent indeed of the operations in patients with visual agnosia when they are asked to describe a picture that they have looked at for a long time without being able to recognize it. On rare occasions, this kind of behaviour was so striking that it led one to wonder whether visual recognition was normal, e.g. in the responses to pictures of the aquarium and especially of the crown. Visual perception was excellent, as judged from patient's comments which lasted more than two minutes after a two-second presentation of the picture but the analysis did not allow the elicitation of the right word. On the contrary, the patient's comments (picture of the crown) showed that he had not recognized the picture: "I do not know what this could be . . . a hat; it should be a very fancy hat to look like that . . . it would be very fancy . . . I do not know of a fashion that . . . " This picture is one of the three for which the patient could not give the correct name. The comment: "it could be an aquarium if it is made of glass" also showed that the nature of the wall had not been recognized. Such occasional difficulties did not disprove the hypothesis that the fundamental disorder was one which disturbed the naming of correctly perceived and recognized objects and pictures of objects. It showed that from time to time there were difficulties in the recognition of complex pictures.

Discussion

The disorders in the patient reported here are of the same kind as those of Case 1 described by Freund (1889) and termed optic aphasia. The answers of Freund's patient were similar to our patient's, e.g. a brush: "it's a key with all the thingumagigs that are in that," then: "it could be anything else, something like a brush"; a box: "it's a small case, it's a suit-case . . . it's a drawer, it's a pen-box perhaps." Such a disorder cannot be accounted for by aphasia; nor can it be accounted for by visual agnosia in the long accepted sense of this word (Lissauer, 1890; Freud, 1891; Dejerine, 1892; Head, 1926; Alajouanine and Lhermitte, 1963; Frederiks, 1969): the peculiar disorder in our patient was characterized by errors in naming objects that were seen while all other speech activities were normal and while visual perception and recognition of misnamed objects were normal.

Naming visible objects at least implies a synthetic activity which comprises a processing of visual information leading to perception of components of the object, to their recognition according to past experience and the activation of associative systems which, as a whole, constitute the physiological basis of the concept of the object. Moreover it implies the specific arousal of speech structures resulting in the production of the word adequate to the object (as far as such a word is known by the subject). If this general and doubtless too simple view is accepted, we would propose the following hypothesis to account for this disorder of naming: visual stimuli were normally processed to a quite high level thus allowing normal or subnormal drawing and recognition; but, at a higher level, specific patterns of messages which conveyed visual information to speech mechanisms were altered; hence normal speech mechanisms were abnormally activated, resulting in errors in naming objects verbally. Bearing this in mind, we think it inappropriate to term the errors in our patient "paragnosia" or "paraphasia" and we think that the term "visual-speech disconnexion" is an apt description and an adequate explanation of the disorder. The word "disconnexion" is not used here in its narrow sense, i.e. the interruption of subcortical axons conveying messages from one cerebral region to another one; rather, it is used in the broader sense of a disturbance of the visual-speech function, which implies involving neurons which elaborate and convey visual-speech messages. Thus two cerebral regions which subserve different functions are disconnected. Although the physiological processes linking vision and speech are not well known, it may be assumed that visual-speech patterns which result in the arousal of the name of an object are specific. When this visual-speech process is disturbed—even a very slight disturbance is likely to be effective—the pattern of the name cannot be activated. At first sight, this visual-speech function might be considered as a whole, the alteration of which should result in closely allied disorders, whatever the site of the lesion, but it may be asked whether the disorders should not be different according to: (*a*) damage to elaboration and transfer of visual information, speech mechanisms being normal, or (*b*) damage to the region of speech mechanisms. In our patient, qualitative and quantitative analysis of the errors suggested that the disorder was situated either among neuronal populations which process visual informations into messages to speech mechanisms or upon their connexions *en route* to the temporal region.

(1) *Horizontal semantic errors* (*HSE*).—In every experimental situation there was a contrast between the presence of numerous HSE and the rarity or even absence of morphological errors. This fundamental characteristic deserves comments. From a psycho-linguistic point of view, words are not entities, independent from each other but are closely linked, particularly by semantic relationships. Therefore it may be assumed that seeing a given object arouses in various degrees some features pertaining to the semantic field of the word corresponding to the object. Neurophysiologically, it is obvious that patterns specific to each word are not independent entities. It is likely that their arousal implies a selection from the activation of a number of patterns which share common characteristic features. Normally the visual-speech message must be so specific as to determine a process of activation-selection resulting in the arousal of the pattern corresponding to the object apprehended by sight. In the case reported here, an imprecise elaboration of the visual-speech message or a disturbance *en route* to the temporal region could account for a defective selection of the adequate word and for a less differentiated and more extensive activation of the semantic field, hence the high number of HSE. Such HSE are opposed to morphological errors usually present in visual agnosia; in the latter case, the transfer of visual-speech messages should be normal but would deal with false messages, elaborated upon perceptual inaccuracies.

This view is supported by the fact that the various series of objects belonging to one semantic category increased the number of HSEs, and made morphological errors disappear. In such a condition (i.e. various objects belonging to one semantic category) imprecise or distorted messages sent to speech mechanisms bear a higher probability than in a random series of objects to be closely linked to each other and to determine contaminations and perseverations. All these factors lead to the arousal of words belonging to the semantic field common to all the stimuli of the series, hence the increase in number of HSEs. The fact that a close morphological relationship increased the number of morphological errors may be accounted for in the same way when it is borne in mind that a morphological category is also a semantic category (such as round objects or long objects). The fact that the decreasing structural complexity of pictures (black and white drawings as opposed to realistic coloured pictures), decreased the number of errors, especially the number of HSEs, appears to support our hypothetical explanation and opposes our patient's performances to those of aphasics. In the latter, Bisiach (1966) reported that a reduction in the redundance of stimuli, outlined figures against realistic pictures, favours the appearance of anomia. This clearly shows that the disorder is situated at the other end of the visual-speech function. In the aphasics processing of visual information and its transfer to speech mechanisms are likely to be normal and it can be admitted (Bisiach, 1966) that "a message of low redundancy would be less likely to reach the threshold of excitation necessary for activating the verbal centres, especially if these were damaged." The state of affairs in our patient is opposite although it does not contradict Bisiach's views: with outlined pictures there is less information to be processed and significant features are more meaningful since they have been selected by the observer. In such conditions coding of the message is easier. Thus, in a patient such as ours, whose main disorder lay in the elaboration of visual-speech messages, HSEs were less numerous with outlined than with realistic pictures.

(2) *Semantic perseverations.*—Perseveration implies that an activated pattern is not inhibited, thus interfering with subsequent processes. In our patient the many perseverations were not of a visual nature since no visual perseveration was present in the series of drawings. Perseverations were of a linguistic nature, more precisely they were semantic perseverations. Speech being normal it could have been expected that speech activities would have been normally inhibited. Therefore semantic perseverations appeared as a peculiar phenomenon inasmuch as linguistic resurgences—words, stimuli or only some of their semantic features—could occur long after their primary arousal (Table IV). This would suggest that there may exist inhibitory processes that specifically control and modulate visual-speech functions and that these processes were disturbed in our patient. This is strongly supported by the surprising fact that a sixty seconds delay between a response and a new stimulus did not alter the number and percentage of perseverations, although during these sixty seconds the observer talked without interruption with the patient. It could be expected that speech mechanisms might be able, after a sixty seconds delay, to react normally to a new visual stimulus. This was not the case. Therefore it may be assumed that the activity of visual associative neuronal networks from which visual-speech messages originate was not altered by this delay, i.e. that inhibitory processes did not intervene. In such a state of affairs, a new visual stimulus, although correctly recognized, resulted, with the same frequency as in successive presentations, in the arousal of a previously arisen and non-inhibited visual-speech pattern.

(3) *Approach towards correct words.*—"Conducts of approach" towards correct words are of prime importance. First, they were constituted by a peculiar mingling of semantic errors, perseverations and descriptions of morphological features which were characteristic neither of aphasia nor of agnosia, although, during the examination, the observer often wondered if the patient was not aphasic or, at other times, agnosic. Secondly, these "conducts of approach" showed that visual retention was normal since the object had been shown for two seconds only. Finally and most important, they resulted in correct responses for the great majority of objects. The process of naming appeared as if memory of the object and analysis of its salient features determined a redundance of information thus a succession of stimulations from vision to speech mechanisms, ending in arousal of the specific pattern for the name of the object.

(4) *Pointing.*—In our patient pointing to objects upon spoken order was normal except in the peculiar experimental situation described, as when the patient was asked to point to objects not present in the pictures shown to him. To account for this it must be borne in mind that pointing is easier than naming since the number of possible responses among which the correct one must be chosen is smaller. The few errors which were present in pointing were of the same nature as those present in naming (semantic errors). They suggest that there was also a disorder of messages in the speech-vision direction.

Disturbances of visual perception should not be underestimated. There were a few perceptual difficulties in copying some drawings, occasionally an object was not recognized, agnosic alexia and colour agnosia were present. This important syndromic association implies a discussion of some points pertaining to visual agnosia. The descriptions of visual disorders entail the distinction of successive steps for the sake of clarity. It is likely that a physiological counterpart corresponds to each of these steps, but it is difficult to imagine that these physiological counterparts are located in as many discrete cerebral parts and are independent of each other. Thus it can be understood that in most patients a cerebral lesion does not alter selectively one of these steps and that cases with subtle functional dissociation are very rare indeed. To divide visual agnosia into apperceptive and associative agnosias (Lissauer, 1890) stems from theoretical considerations and does not tally with usual clinical data. Obviously many levels may be implied in visual agnosia from elementary perceptual activity to complex perception and visual recognition. Each clinical syndrome implies several disorganizations at different levels. In most patients with visual agnosia, disorders of both apperceptive and associative type are present.

In the patient reported by Rubens and Benson (1971) an associative agnosia for pictures and an apperceptive agnosia for written language were present. In the case reported here there were: (1) for objects and pictures essentially an optic aphasia, a few slight elements of associative agnosia and few perceptual disorders (since difficulties were present in copying a drawing, although these difficulties did not prevent the recognition of the object depicted by the copied drawing); (2) an agnosic alexia with an apperceptive (copied writing was disturbed) and an associative component (since, contrasting with Rubens and Benson's case our patient could not correctly read letters or syllables traced in the palm of his hand); (3) for colours, a perceptive disorder (axis of tritanopia) and an associative disorder (since he could not select colours corresponding to objects).

To account for optic aphasia Freund (1889) put forward several hypotheses among which was the interruption in the corpus callosum of an association tract between right occipital visual structures and the left temporal region (fig. 1). According to this view, speech and visual perception were normal but disconnected. It was a quite remarkable view in relation to knowledge at the end of the nineteenth century, even though it belonged to a rather simple associationism and even though there is no right occipital-left temporal association tract. Later attention was focused upon visual agnosia and it became rapidly clear that, in the right handed, a left occipital lesion was all important. A trend therefore developed to assign to the major occipital lobe the fundamentals of the mechanisms of visual perception. Contemporary studies showing the role of the right occipital lobe in cognitive processes for space and faces did not alter the commonly accepted explanation of visual agnosia, namely: (1) due to right homonymous hemianopia visual stimuli reach the right occipital lobe only; (2) an occipito-occipital tract should transfer messages into the left occipital lobe where they should be normally treated; (3) this treatment is not carried out since either the association tract or the left associative visual cortex (areas 18 and 19) are damaged. Setting apart the Goldstein view this appears to have been generally accepted. The only new and important advance came from studies of lesions of the corpus callosum causing interhemispheric disconnexions such that left tactile and visual inputs are no longer connected to speech mechanisms. The characteristics of the case reported by Geschwind and Kaplan (1962) and those of the cases of split corpus callosum (Gazzaniga and Sperry, 1967) showed some apparent similarities with those of our patient, but in fact they are quite different. In Gazzaniga and Sperry's and in Geschwind and Kaplan's patients spoken responses to visual or tactile stimuli were absent or were aberrant confabulations. Pointing to objects to spoken order was impossible. In contrast, while unable to utter letters or words presented in the left half of the visual field, Gazzaniga and Sperry's patients were able to recognize them since they could pick out the corresponding letter or object with their left hand. Even if one agrees with Geschwind (1965) that the less complete the disconnexion the more significant is the stimulus spoken response relationship, even if it may be admitted that "out of sphere" responses correspond to perseverations which went unrecognized due to a lack of study of the temporal succession of stimuli and responses, other features of the "splitbrain" syndrome are quite distinctive of our case. In our patient pointing to an object upon spoken command was normal, except in the very peculiar experimental situation which has been described, and the characteristics of the alexia were entirely different. The interest of such a discussion lies in the development given by Geschwind (1965) to the concept of callosal disconnexion extended to agnosic alexia, colour agnosia and even visual agnosia.

It is certainly to Geschwind's credit that he showed the significance of hemispheric disconnexions. This, however, doubtless minimized the role of visual cortical mechanisms in the processing of information. A callosal lesion cannot explain how Rubens and Benson's (1971) patient was unable to group objects according to catégories while he could group them according to similar shape. It cannot explain why the same patient could read large letters and could not read small letters (a common finding in agnosic alexia). It cannot explain why patients, among whom is the patient reported here, make mistakes in selecting and using colours as specific attributes of objects, a disorder that appears to be the core of colour agnosia (Lhermitte *et al.*, 1969).

Lesions of the splenium, the role of which in alexia without agraphia was successively disregarded (Dejerine, 1892), tentatively proposed (Foix and Hillemand, 1925) and finally asserted (Geschwind, 1965) are frequent. They may also be frequent in visual agnosia for objects and colours but it is not a constant finding, or perhaps the lesion is too small to be held responsible for the whole clinical picture. We have observed this in the post-mortem examination of a case of global visual agnosia (unpublished), in a case of colour agnosia due to a missile wound of the left occipital lobe behind the corpus callosum (Lhermitte *et al.*, 1969) and in the post-mortem examination of a case of prosognosia (Lhermitte *et al.*, 1972). This point is not essential to the case reported in the present paper. When available pathological data are examined, it may be assumed that in this case: (1) right-left occipital connexions may have been damaged in the splenium or white matter of the left occipital lobe; (2) left associative areas 18 and 19 may also have been damaged (alexia, colour agnosia, non-linguistic perceptual difficulties). Occipito-occipital connexions and left associative visual areas are more likely to be spared or almost spared since the patient could perceive and recognize objects. The disorders of our patient suggest that, from the left occipital association areas and perhaps from the occipito-temporal part of the inferior aspect of the left hemisphere (Mishkin, 1972) impulses bound to the ipsilateral temporal lobe are disturbed. The disturbance would occur either where the impulses are elaborated or on their way to the temporal region, namely on the ipsilateral transcortical association tracts (inferior longitudinal tract, perhaps the occipital part of the fasciculus arcuatus (Crosby *et al.*, 1962)). It might also be that the cortical control normally exerted by the pulvinar is in abeyance. Their specific features being lost, the impulses would not normally activate speech mechanisms thus determining the errors in naming which have been reported in the present paper.

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