# THE MORE YOU KNOW THE LESS YOU CAN TELL: INHIBITORY EFFECTS OF VISUO-SEMANTIC ACTIVATION ON MODALITY SPECIFIC VISUAL MISNAMING

#### Georg Goldenberg and Franziska Karlbauer

(Neuropsychological Department, Bogenhausen Hospital, Munich, Germany)

#### Abstract

WH, a 77-years old right-handed psychoanalyst, displayed modality specific visual misnaming as a sequel of an embolic stroke in the left posterior cerebral artery. WH's errors in visual object naming consisted mainly of semantic paraphasias and perseverations. His verbalizations during testing sometimes manifested a conflict between correct responses and perseverations. Analysis of the stream of information from visual perception via semantics to phonology suggested incomplete access from vision to semantics as the source of errors. The disconnection did not affect verbo-visual matching, though he was unable to reject names that did not correspond to visual stimuli. Action naming was relatively spared, but naming of pictures of actions with objects was worse than naming of pictures of intransitive actions. Tactile naming worsened with simultaneous vision of objects. In visual object naming the error rate increased with increasing familiarity of objects. We propose that an interaction of excitation and inhibition within a single semantic system can explain the clinical phenomena of modality specific visual misnaming.

Key words: optic aphasia, associative agnosia, semantic memory, perseverations

#### INTRODUCTION

Modality specific visual misnaming has been termed "optic aphasia" (Freund, 1889; Lhermitte and Beauvois, 1973), "associative mindblindness" (Lissauer, 1890), "associative agnosia" (Hécaen, Goldblum, Masure et al., 1974) and "semantic access agnosia" (Riddoch and Humphreys, 1987). We prefer the purely descriptive term "modality specific visual misnaming" because it is not committed to any of the controversial interpretations implicated by the other labels.

Patients with modality specific visual misnaming produce incorrect names to visually presented objects, although they can name the same objects from other modalities, and although their visual perceptual abilities are sufficient for object recognition. Modality specific visual misnaming is associated with left posterior lesions which destroy the visual cortex of the left hemisphere and affect the splenium of the corpus callosum. Destruction of the left visual cortex deprives the left hemisphere of direct visual input and the corpus callosum lesion interrupts the direct transmission of information from the right visual cortex to the left hemisphere. This anatomical pattern suggests that misnaming results from a disconnection of the speech dominant but "blinded" left hemisphere from the "seeing" right hemisphere.

The idea that modality specific misnaming is caused by disconnection of speech from vision needs elaboration to account for the role of semantic memory in object naming. In order to be named, the visual percept of an object must first be assigned a representation in the semantic system. Semantic identification of objects can be indicated non-verbally, for example, by miming their use or classifying them according to properties which cannot be directly inferred from vision. It can be expressed verbally without production of the name, for example, by adequate circumlocutions or responses to questions about their properties.

There is controversy as to where the stream from visual perception via semantics to speech is affected by the interhemispheric disconnection (Lhermitte and Beauvois, 1973; Poeck, 1984; Riddoch and Humphreys, 1987; Coslett and Saffran, 1989; Hillis and Caramazza, 1995). One opinion holds that the disconnection resides between visual perception and a unitary semantic system (Riddoch and Humphreys, 1987; Feinberg, Dyckes-Berke, Miner et al., 1995; Hillis and Caramazza, 1995) located in the left hemisphere. This theory predicts that patients have incomplete semantic knowledge about misnamed object which may suffice to identify the class or category of an object but not its individuality.

An alternative theory proposes that the disconnection resides between two semantic systems located in the right and in the left hemispheres (Coslett and Saffran, 1989, 1992; De Renzi and Saetti, 1997). The left hemisphere system has access to speech production. The right hemisphere can provide non-verbal indications of semantic identification, has receptive lexical competence, but cannot produce speech. Therefore, verbo-visual matching is by far superior to naming (Assal and Regli, 1980; Ferro and Santos, 1984; Morin, Riurain, Eustache et al., 1984; Poeck, 1984; McCarthy and Warrington, 1986; Riddoch and Humphreys, 1987; Iorio, Falanga, Fragassi et al., 1992; Schnider, Benson and Scharre, 1994; Feinberg, Dyckes-Berke, Miner et al., 1995).

However, some observations are not readily accommodated by any of the interpretations of interhemispheric disconnection.

## Spared Action Naming

It has repeatedly been reported that patients with modality specific visual misnaming name actions distinctly better than objects (Ferro and Santos, 1984; McCarthy and Warrington, 1986; Zingeser and Berndt, 1988; Manning and Campbell, 1992; Schnider, Benson and Scharre, 1994; Hillis and Caramazza, 1995; Campbell and Manning, 1996; Teixeira-Ferreira, Giusiano, Ceccaldi et al., 1997). A ready explanation for the dissociation between naming of objects and actions would be that they are treated by distinct left hemisphere semantic systems, and that the splenial lesion interrupts transfer of information to the object system but spares transfer to the action system. Acceptance of this hypothesis poses the question of why the opposite dissociation – visual misnaming of actions with spared object naming – has never been reported.

### Inhibitory Effects of Vision on Naming

The concept of disconnection implies that errors are due to an interruption of information flow. There are however indications that naming errors may be provoked by too much rather than too little visual information. For example, Lhermitte and Beauvois (1973) noted that their patient made more errors in naming realistic coloured photographs than black-and-white drawings of objects. Coslett and Saffran (1989) reported that tactile naming was perfect when the patient was blindfolded but deteriorated markedly with eyes open. Apparently, the additional visual information interfered with correct naming.

#### Perseverations

A phenomenon which speaks to the importance of inhibitory processes in the genesis of visual misnaming are perseverations. Perseverations of either the names or semantic associations from previously presented objects are a prevailing type of errors in some patients (Lhermitte and Beauvois, 1973; Hécaen, Goldblum, Masure et al., 1974; Michel, Schott, Boucher et al., 1979; Ferro and Santos, 1984: Morin, Riurain, Eustache et al., 1984: Poeck, 1984; Schnider, Benson and Scharre, 1994; Hillis and Caramazza, 1995; Endo, Makishita, Yanagisawa et al., 1996) although they are rare or completely absent in other patients (Assal and Regli, 1980; McCarthy and Warrington, 1986; Riddoch and Humphreys, 1987; Coslett and Saffran, 1989, 1992; Iorio, Falanga, Fragassi et al., 1992; Manning and Campbell, 1992; Campbell and Manning, 1996). They are not restricted to immediately preceding objects but can refer to objects that have been presented with an interval of up to some 40 objects (Lhermitte and Beauvois, 1973; Michel, Schott, Boucher et al., 1979). It would appear that the semantic representations of these objects have remained abnormally active throughout the interval. Lhermitte and Beauvois (1973) concluded that "there may exist inhibitory processes that specifically control and modulate visual-speech functions and that these processes were disturbed" (p. 710). This idea was further elaborated by Plaut and Shallice (1993) who postulated damage to "clear-up units" within the semantic system to account for perseverative errors.

Understanding of modality specific visual misnaming thus poses two questions. Where is the stream of information from visual perception to speech disrupted and what is the nature of this disruption? We had the opportunity to examine a patient with modality specific visual misnaming who displayed spared action naming, a deleterious influence of vision on tactile naming, perseverations, and a paradoxical effect of familiarity on naming, a clinical phenomenon not yet described.

#### CASE HISTORY

WH was a 77-year-old right-handed psychoanalyst who suffered a myocardial infarction followed by a cardiac embolic stroke in May 1995. The medical records reported right-sided hemianopia and some problems with memory and word-finding. MRI at that time was interpreted as showing infarction within the left PCA territory. In July there was a

sudden deterioration of his language problems accompanied by mild right-sided weakness and alexia. At that time it was first noted that WH had problems with the recognition and naming of seen objects above and beyond his general language difficulties. A control MRI showed expansion of the left PCA infarction. WH was referred to our department for further diagnosis and rehabilitation in November 1995.

On admission, neurological examination revealed a very mild weakness of the right upper extremity. Goldmann perimetry brought forward a right sided hemianopia which spared the central 2 degrees. Spontaneous language was fluent and well articulated. Syntax and phonology were inobstrusive. WH had word finding problems which he compensated mainly by circumlocutions. Visual confrontation naming of pictures or objects elicited gross errors. Writing was only mildly disturbed by rare orthographic errors and occasional confusions of visually similar letters. By contrast, there was a marked dyslexia. Reading of single letters was hesitant, and reading of whole words proceeded letter-by-letter.

WH observed that he saw everything as colourful as always but that he could not "say yellow if there is yellow". He read correctly all Ishihara plates and performed the FM 100 hue test in the normal range of his age group (error score 124), but misnamed colours. From a set of 20 colours he named 8 and correctly pointed to 15 when given their name. By contrast, retrieval of colour names to verbal questions specifying symbolic connotations (e.g., what are the colours of grief, communism, ecology) was perfect.

WH was treated as an in-patient until April 1996. During that time there was a complete remission of the right-sided weakness. Word finding difficulties in spontaneous speech became confined to proper names and numbers, and reading improved to correct albeit slow reading of whole words. WH was then followed as an out-patient until January 1997. During that time neuropsychological findings remained stable.

#### Anatomy of Lesion

Figure 1 shows MRI obtained in December 1995. The lesion was restricted to the left hemisphere and spared the midline of the splenium corporis callosi. In the left hemisphere it completely destroyed the cuneus and the gyrus lingualis and hence the primary visual cortex. It extended rostrally and laterally into the lateral part of the splenium corporis callosi and into the forceps major. In addition there were several lacunar infarctions in the subcortical white matter of the left frontal lobe.

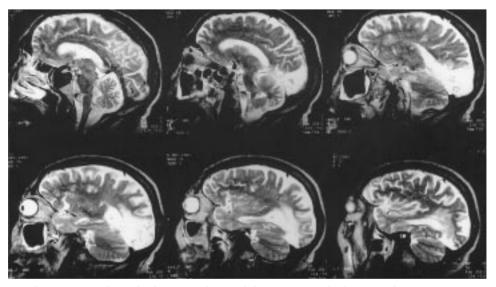


Fig. 1 – MRI: T2 weighted pictures showing left posterior cerebral artery infarction.

#### Clinical Presentation of Modality Specific Visual Misnaming

WH misnamed visually presented objects or pictures of objects. There was no consistency in his errors. The same objects which were named correctly in one test might give rise to a long and fruitless search in another test, and there was no improvement when the same items were repeatedly tested. Visual misidentification of objects was observed also outside the testing situation, for example in shopping. Spontaneously he resorted to tactual exploration of objects in order to identify them.

In visual naming WH was generally dissatisfied with his visual naming errors and struggled for finding the correct name. When he eventually produced the correct name, he sometimes rejected it and continued searching. More frequently, however, he was satisfied and he always recognized the correct name when it was spoken to him by the examiner.

His errors were frequently perseverative. A peculiar feature of his attempts to name objects was the melting of correct information about the seen objects with perseverations. The following protocol shows the apparently simultaneous presence of the correct concept and a perseveration.

WH was shown the picture of a dog which he named correctly. The next item was a spider which he named correctly too. Then he was shown an umbrella:

WH: That looks to be a badger-dog, that is a dog, a very simple concept.

E: What do people do with this thing?

WH: It should protect, it should... sometimes it is also used as a kind of decoration for the lady of the house and then it is specially cared for together with the – similarily cared for – animal... no, that's wrong! It is not a lap-dog. An accompanying dog, a... a... It should protect and at the same time make a good impression. A well-groomed fur as you can see... with hanging ears.

E: Could one open up this thing?

WH: Opening up? This is not a dog made in the factory. It is something elegant and it helps the lady. It is not only for protection.

E: Against what does it protect?

WH: Well, to what degree such a type of dog – did I say dog? Such a type of "Sch...  $o\beta$ hund" (*German*: "Scho $\beta$ hund" = lap-dog; "Schirm" = umbrella!)? Wrong again! I would doubt whether this one could protect.

E: At what weather would this thing protect?

WH: Ah, I see, haha! Well, that long-haired dog would get rather wet, that would not be good. Anyway, dog is dog, no matter whether it rains or snows.

## THE LOCUS OF VISUAL-SPEECH DISCONNECTION

Our analysis is based on a three stage model of visual object naming. In the first stage, perceptual processing culminates in a structural representation which guarantees object constancy. In the second stage, the structural representation sends information to semantic memory where the object is identified and knowledge about its properties can be retrieved. In the third stage, semantic knowledge activates the appropriate name in the phonological lexicon.

We will present the results as they are pertaining to these stages. If not stated otherwise, WH's first response was considered for scoring of naming tests.

## Perceptual Processing

*Object Constancy.* WH performed very well the Facial Recognition Benton Test (Benton, Hamsher, Varney et al., 1983) which requires matching of faces shown under different angles and different lightnings (52/54). He performed

perfectly the subtest Minimal Feature Match and almost perfectly (30/32) the subtest Item Match of the Birmingham Object Recognition Battery (BORB; Riddoch and Humphreys, 1993). These tests require matching of two different views of the same object or of two different instances of the same basic object.

*Object Decisions.* WH did not commit a single error on the Object Decision subtest of the BORB requiring a distinction between real objects and chimera made up of two objects of the same semantic category. WH was also presented with a more difficult test of reality decision (Goldenberg and Artner, 1991) which demands a choice between two pictures of the same object differing only in one detail (e.g., a bear with rounded or pointed ears). He correctly decided for 22/25 pairs of pictures (normal range 20-25) whereas he correctly named only 13 of the depicted objects.

## Discussion

Deficient perceptual processing does not appear to be responsible for misnaming. WH could attain object constancy between different views or different instances of the same kind of object. There is controversy whether object decisions necessitate access from vision to semantics (Humphreys, Riddoch and Quinlan, 1988; Hodges, Patterson and Tyler, 1994), but certainly they require perceptual processing up to the stage of structural representations. The observation that WH could pass these tests is a further indication that his visual misnaming was not caused by perceptual problems.

### Access to Semantic Memory

Association Match. WH scored 24/30 on the BORB subtest Association Match, and 38/52 on the Pyramid and Palm Trees Test (Howard and Patterson, 1992). These scores are in the defective range albeit above chance. In both tests a target picture is presented together with two other pictures, one of which is associatively or functionally related to the target. For example, the target picture is a train and the two alternatives are rails and a road.

*Category Match.* Items from the Pyramid and Palm Trees Test were used to construct an experimental test requiring matching by superordinate category rather than by functional or associative relationships. The odd-one out item of the original test was used as the target for matching. For example, the target picture was an owl, the correct choice a hen and the foil an egg-cup with an egg. WH correctly matched only 10/18 items which is virtually at chance level. He performed the same test almost perfectly (17/18 correct) when the examiner provided WH with the name of the superordinate category (e.g., birds).

Demonstration of Object Use. When shown a manipulable object and asked to mime its use, WH generally succeeded only if he could name the object. For misnamed objects the pantomime was either amorphous or corresponded to the wrong name. There were, however, rare instances of a correct pantomime in combination with a wrong name.

Verbal Questions about Properties of Visually Presented Objects. WH was presented 64 line drawings of objects, and was asked questions about their properties (see Table I). He was warned not to name the item before having answered all questions. After each series of questions he was asked for the name of the object. One week later, WH was asked the same questions in response to presentation of object names.

	From name	From picture		Chance	
Question		Name correct $(n = 30)$	Name wrong $(n = 34)$		
Is it bigger or smaller than a person?	100	100	97	50	
Is it a plant, an animal, or man-made?	100	100	94	33	
Can it move by itself?	100	100	94	50	
Can one lift it with one arm?	100	97	88	50	
Does one have it at home?	100	97	82	50	
What colour is it?	97	97	68	_	

 TABLE I

 Access to Knowledge about Objects from Pictures and from Names

*Note*. There were 64 items (16 each from the categories manipulable objects, non-manipulable objects, food, and animals). They were shown on line drawings (Foster, Giddan, Stark et al., 1974). The numbers in the table give the percentage of items for which the respective questions were answered correctly. Questions are presented in order of increasing error rates rather than in order of testing. Note that the first two questions can be answered by affirmation of one of the proposals made by the examiner. The third to fifth question require affirmation or negation of a proposed property. The last question is open-ended.

WH gave significantly less correct semantic information about misnamed than about correctly named objects (Wilcoxon test: Z = -2.2, p < 0.05). The number of correct responses to questions about properties of misnamed items appeared to depend on the wording of the question. The proportion of correct responses was 94 and 97% when WH could choose between two or three alternatives proposed by the examiner. It ranged from 82 to 94% when he was asked to decide whether a property named by the examiner applied to the object or not, and dropped to 68% for open questions related to colour.

## Discussion

WH's production of semantic information about misnamed objects was defective but above chance. However, his misnaming too was beyond chance, in that a majority of his responses was semantically related to the target (see next section for a detailed error analysis). There was thus no definite difference between accuracy of semantic knowledge and the naming.

The disconnection between vision and semantics was unidirectional: WH was better able to verify whether a verbally presented semantic information corresponded to the sight of the object than to produce semantic information about the object. His ability to verify verbally presented information was nearly perfect for positive matches but became more prone to errors when only an incorrect match was proposed and he had to reject it (Table I).

# Integrity of Semantic Memory

Association Match. The Pyramid and Palm Trees Test as well as the Association Match of the BORB were presented verbally by giving WH the names of the three objects and asking him which of them went together. He did not commit a single error on either test.

*Category Match.* The category match version of the Pyramid and Palm Trees Test (see above) was presented verbally. WH performed flawlessly.

*Miming of Object Use.* WH scored the maximum (20/20) on a test of miming of use of 10 verbally designated objects (normal range 12-20; Goldenberg and Hagmann, 1997).

*Questions about Properties of Objects.* As can be seen in Table I, WH performed virtually errorless when knowledge questions about object properties were probed with the presentation of the object name.

### Discussion

The results are consistent and straightforward in demonstrating the integrity of semantic memory.

### Access from Semantics to Phonology

We will first report results of non-visual naming tests and then analyze errors produced in visual naming tests for a possible hint to impoverished phonological access.

*Tactile and Acoustic Naming.* WH named correctly 19 out of 20 objects placed in his hands while he was blindfolded. He correctly named the sources of 10 environmental sounds (e.g., telephone, dog, car) whereas in the same session he misnamed 8 of the pictures of the same objects.

*Naming from Definition.* WH was presented verbal definitions of the 64 objects for which naming from vision and access to semantic knowledge had been tested (Table I). Each definition consisted of the superordinate category, a functional or associative attribute, and a visual attribute. He produced the correct name for 55 objects as compared to 30 correct names on visual presentation. The same definitions were presented to 5 controls of comparable age and educational level. None of them produced less than 61 correct responses.

Incomplete Phonological Awareness in Visual Naming and in Naming from Definition. When trying to name seen objects, WH sometimes gave evidence of a tip of the tongue state (TOT), that is, he provided incomplete phonological information about their names. Usually this consisted of either the initial letter or

the number of syllables. Forty TOT were recorded from a total of 241 items to which he had failed to give a correct first response. Thirty-two of them referred to the correct name of the object, 7 to a paraphasia or perseveration and one was ambiguous ("It starts with p" for a penguin which was eventually misnamed pelican).

No TOTs were noted in spontaneous speech, but out of a total of 10 errors in the test of naming from verbal definition (see above), 2 were TOT. The proportion of TOT was thus nearly the same for naming from vision and from definition (17% vs 20%).

## Discussion

Both word-finding problems in naming from definition and the occurrence of TOT indicate that WH had problems to produce the names of objects even when their semantic specification was achieved. These problems affected naming from definition as well as visual naming. We therefore consider it unlikely that impaired access from semantics to word forms was the source of the disproportionate difficulties which WH encountered with visual naming.

## Unidirectionality of Disconnection – Access from Names to Vision of Objects

WH always recognized the correct name of a misnamed object when it was spoken to him. The following experiment was aimed at qualifying the unidirectionality of the visual speech disconnection.

*Comprehension of Object Names.* WH was shown 30 quadruplets of semantically related pictures and the examiner named one of them. WH pointed to the correct picture in all cases. In another session, the same 30 stimuli were presented but for 20 of them the examiner named semantically related, but not presented, objects. WH did not reject the wrong names but pointed to one of the pictures. When, in a further session, he had been warned that some of the names might not correspond to any of the pictures, he rejected 6 out of the 20 wrong names but pointed to inappropriate pictures for the remainder.

## Discussion

Perfect or at least relatively preserved access from language to vision is a regular finding in modality specific visual misnaming (see Introduction). Our experiment replicates previous observations demonstrating that access from language to vision permits unequivocal recognition of correct names but not rejection of wrong names (Lhermitte and Beauvois, 1973; Hillis and Caramazza, 1995).

### Discussion of the Locus of Visual-speech Disconnection

The above results strongly suggest deficient access from structural representations to semantics as the locus of the visual speech disconnection<sup>1</sup>.

WH's success on tests of object constancy and object decision provides evidence that perceptual processing was sufficient for visually identifying objects. By contrast, WH performed in the defective range on tests which probed access to semantic memory from vision even when the response was given nonverbally by associating pictures or by gesturing. WH performed perfectly on all of the foregoing tests when they were given in the verbal modality, thus showing that the semantic store of its own was intact. There was evidence of a mild impairment of access from semantics to phonology which affected not only visual naming but also naming from verbal definitions.

As in other cases of modality specific misnaming, the access disorder in WH was unidirectional sparing the backward route from speech to vision. The route from language to vision displayed the curious feature of supporting only positive matches between verbally presented information and visually presented objects.

## INHIBITORY EFFECTS OF OBJECT VISION ON NAMING

The following experiments were carried out to assess whether lack of access from visual perception to semantics was the only source of visual misnaming. They demonstrated that additional input from vision to semantics can inhibit correct naming.

# Evaluation of Errors

A detailed analysis of the quality of errors was applied to most of the experiments reported in this section: WH was given unlimited time for responses. Help, usually by multiple choice questions, was given only when WH despaired of his ability to find a satisfactory name. Examinations were audio-taped and completely transcribed. Both authors independently classified the errors. Cases of disagreement were very rare and were solved by discussion. WH's responses were considered until either he was satisfied with his response or resigned, or the examiner helped because of WH's despair. They were classified as perseverations, semantically related errors, circumlocutions, TOT, or correct responses. As there were only two purely visual errors for a total of 331 recorded naming errors, this category was not considered for statistics, and semantic errors with a visual similarity to the target were classified as semantic. For statistical evaluation, the number of response types rather than the number of responses was counted. If, for example, WH first named the superordinate

<sup>&</sup>lt;sup>1</sup> As the source of naming errors was incomplete access from vision to semantics, WH's misnaming may be classified as "associative" or "semantic-access agnosia" as opposed to "optic aphasia". We avoid such a classification for several reasons: The similarities between these allegedly different disorders are more important than their differences, and it has been cogently argued that they represent a continuum (De Renzi and Saetti, 1997). They are caused by the same type of lesion, and alternations between "agnosic" and "aphasic" errors depending on the mode of testing have been demonstrated in one and the same patient (Schnider, Benson and Scharre, 1994). The diagnosis of "optic aphasia" rests crucially on the demonstration of intact access from vision to semantics. It thus depends on the scrutiny of examination, as testing of fine-grained semantic specification may reveal deficiencies missed by less stringent testing (see Riddoch and Humphreys, 1987; Hillis and Caramazza, 1995; De Renzi and Saetti, 1997). On the other side, the term "associative agnosia" has been applied to patients in whom visual misidentification resulted from perceptual deficits although they produced recognizable copies of drawings (Rubens and Benson, 1971; Farah, 1990).

category and then mentioned a function of the target item, this was counted as one semantic error. More than one response type could be counted for one item. For example, WH might produce first a semantic error, than a perseveration, and then a correct name. In such a case, three different response types would be counted for one item.

# Influence of Vision on Tactile Naming

WH spontaneously palpated objects in order to identify them. Frequently this strategy was successful, but sometimes he perseverated errors which had been elicited by the sight of the object. The following two experiments explored the interaction between visual and tactile naming of objects.

## Visual Naming Preceding Tactile Naming

WH was presented 20 manipulable real objects and was asked to name them from sight. If the name was not correct he was given the object for tactile exploration. Only the first responses were recorded and evaluated. WH correctly named four objects by sight. Ten of the remaining objects were named correctly after tactile exploration, yielding a total of 14/20 correct names. In a second session, one week later, WH was blindfolded and given the same objects for tactile naming only. He gave the correct name for 19/20. The difference between 14/20 and 19/20 is statistically significant (chi<sup>2</sup> = 4.3, p <0.05).

# Simultaneous Visual and Tactile Input

In the above experiment WH tried visual naming before touching the object. Tactile naming might have been inhibited by the already produced paraphasias rather than by visual input *per se*. To control for this possibility, simultaneous presentation of visual and tactile input was compared to tactile naming without vision.

For tactile naming without vision, WH was blindfolded and objects were placed in his right hand (in previous testing no difference had been found between right and left hand tactile naming). For simultaneous tactile and visual input, WH was asked to close his eyes and stretch out the right hand. The experimenter put an object into WH's hand and told him to open his eyes immediately before the object touched the hand<sup>2</sup>. Between trials all objects were hidden from view.

Naming was tested with 50 manipulable objects. All of them were presented twice in two sessions, three weeks apart, in the same order and in four blocks of 12 or 13 objects. The conditions of naming were ABBA in the first session and BAAB in the second, where letters refer to blocks, A to tactile naming without

 $<sup>^2</sup>$  In preliminary experiments WH had been told to open the eyes only when the object touched his hand, but we observed that he would delay eye opening until he had identified the object, apparently to avoid the interference from vision on tactile naming. Therefore we decided to give the command to open the eyes immediately before the object touched the hand.

vision and B to tactile naming with simultaneous vision. Thus, naming of each object was tested without vision in one session and with vision in the other.

## Results

With simultaneous visual and tactile presentation the number of correct first responses and of final correct responses was lower, and the number of perseverations and of semantic errors higher than without vision (first response correct: 29/50 vs 39/50, chi<sup>2</sup> = 4.6, p <0.05; any correct response: 42/50 vs 48/50, chi<sup>2</sup> = 4.0, p <0.05; perseverations: 15/50 vs 6/50, chi<sup>2</sup> = 4.9, p <0.05; semantic errors: 11/50 vs 2/50, chi<sup>2</sup> = 7.2, p <0.01). The number of circumlocutions did not significantly differ between conditions (1/50 vs 3/50), and there were no TOT in this experiment.

# Discussion

The experiments replicate and extend a previous observation that vision of objects interferes with tactile naming (Coslett and Saffran, 1989). Apparently, distorted visual information led the left hemisphere to produce wrong names which interfered with the expression of the tactually recognized correct names. Even with simultaneous presentation of visual and tactile information the left hemisphere responses were guided by visual rather than tactile information. This suggests that visual information could reach the left hemisphere and that paraphasias were provoked by the presence rather than the absence of visual information.

### Interactions between Vision of Objects and Vision of Actions

The failure to name visually presented stimuli was contingent upon the nature of the information they depicted. Action naming was much better than object naming.

## Naming of Actions Demonstrated by the Examiner

The examiner demonstrated actions and WH was asked to name them. The first response was recorded and scored. If WH responded to a mime of object use by saying the name of the action (e.g., "sweeping"), he was asked to supply the name of the corresponding object ("broom"). He did so correctly in all cases.

WH named correctly the pretended objects of 23/30 mimes of object use. Naming of mimes improved to 27/30 when WH imitated them before naming, and to 29/30 when the examiner demonstrated the use of a real object. When WH was shown pictures of the same objects he correctly named only 11/30. When he was asked to mime their use before naming, he provided the correct mime for 18/30 and subsequently gave the correct name for 17 of these objects.

In a further experiment the examiner demonstrated 19 mimes of object use and 11 intransitive actions like jumping, running or yawning. WH's correctly named 16/19 mimes of object use and 11/11 intransitive actions.

### Influence of Object Vision on Action Naming

WH was shown static photographs of persons performing actions and was asked to name the actions. There were 16 photographs depicting intransitive actions and 24 photographs depicting actions with objects (transitive actions). The pictures were shown in blocks of four starting with 4 transitive actions followed by 4 intransitive actions and so on.

## Results

WH spontaneously preferred verbs for characterizing transitive actions but, as in the previous experiment, he never had difficulties to give the names of the objects corresponding to these verbs. When misnaming transitive actions he was more likely to produce verbs designating other actions than nouns designating other objects. For example, seeing a man brushing teeth with a toothbrush he said: "He is wiping dry, no, he is washing himself, he washes dishes, lathering".

Correct responses were more frequent with intransitive actions (first response correct: intransitive 13/16, transitive 10/24;  $chi^2 = 6.2$ , p <0.5; any response correct: intransitive 15/16, transitive 15/24,  $chi^2 = 5.0$ , p <0.05) while the number of perseverations was higher with transitive actions (intransitive 2/16, transitive 12/24,  $chi^2 = 5.9$ , p <0.05). The number of semantic errors was higher with transitive actions but the difference did not reach statistical significance (intransitive 1/16; transitive 7/24,  $chi^2 = 3.2$ , p = 0.08). There were no TOTs and only one adequate circumlocution concerning an intransitive action.

### Discussion

WH's better naming of actions than of objects cannot plausibly be referred to a difference between verbs and nouns. WH was always able to convert the verb designating a transitive action into the noun designating the corresponding object, and when the sight of objects induced misnaming, his errors were frequently expressed by verbs. The source of better action naming is to be sought at a semantic rather than at a grammatical level.

WH named actions demonstrated by the examiner better than actions shown in static photographs. With both modes of presentation he named intransitive actions better than transitive actions. However, vision of the associated object appeared to have differential effects on transitive action naming in both modes of presentation. When the examiner demonstrated the action with the real object, naming became nearly perfect. By contrast, naming of photographs showing a person using the object yielded only about 40% correct first responses and thus turned out to be the most difficult of all conditions of action naming.

Transitive actions are associated with objects but this association is only one of the many semantic attributes of the object. When the appropriate actions are demonstrated with real objects, attention is focused on the function of the object while at the same time the object disambiguates the functional significance of the demonstrated movements. Thus, the sight of the object and the sight of the movement cooperate to indicate the action the object is made for. Actions consist of movements in three-dimensional space. A static, twodimensional, photograph may leave the action itself ambiguous and divert attention to other attributes of the object, thus inducing a more thorough and widespread semantic processing of the object. This additional semantic processing seemed to exert a deleterious influence on naming.

Naming of visually presented manipulable objects improved when WH mimed their use before producing any verbal response. A similar observation has been made by Schnider, Benson and Scharre (1994). It may be that miming of the action cut short further semantic processing of the object and thus reduced the inhibitory effects of semantic activation on identification.

# Influence of Familiarity on Naming

WH sometimes named rare and unfamiliar items like "unicorn" or "sphinx" without hesitation while getting caught in a stream of perseverations and paraphasia when trying to name highly familiar items like "bed" or "house". On one occasion, he commented: "I have at my disposal things which I do not encounter frequently, while I am blocked for things which I see every day". The following examinations, performed between December 1995 and August 1996, explored the influence of familiarity on naming.

## Rating of Familiarity

WH was given the names of the objects used for visual naming and was asked to rate how often he got in contact with the object, either directly or indirectly via media. A five-point scale was defined as follows: 1 - less than once a year; 2 - less than once a month, but at least once a year; 3 - less than once a week, but at least once a month; 4 - less than daily, but at least once per week; 5 - daily. For the Snodgrass-Vanderwart pictures (see below) familiarity norms obtained from a German population sample were available (Genzel, Kerkhoff and Scheffter, 1995).

## Materials and Method

Three collections of black-on-white drawings of objects were used:

*Snodgrass-Vanderwart Pictures.* Using the published norms, 24 familiar and 22 unfamiliar items<sup>3</sup> were selected from the Snodgrass-Vanderwart pictures (Snodgrass and Vanderwart, 1980; Genzel, Kerkhoff and Scheffter, 1995). Familiar items had ratings between 4.4 and 4.9 (mean 4.67, SD 0.13). WH himself rated all of them with 5. Unfamiliar items had ratings between 1.6 and 2.2 (mean 1.88, SD 0.17). WH rated them between 1 and 3 (mean 1.85, SD 0.59). These pictures were presented twice with an interval of one week.

<sup>&</sup>lt;sup>3</sup> Originally, there were 24 unfamiliar items, but accidentally two of them were not tested.

*Sixty-four Pictures from 4 Categories.* There were 64 line drawings of items from the categories of animals, food, manipulable objects and large objects (Foster, Giddan, Stark et al., 1974). Items rated by WH 1 or 2 were classified as unfamiliar, items rated 4 or 5 as familiar. Items rated 3 were not considered for the analysis. This resulted in 17 unfamiliar and 32 familiar items. Naming of these pictures was assessed twice with an interval of 8 months.

*Boston Naming Test.* From the Boston Naming Test (Kaplan, Goodglass, Weintraub et al., 1983) familiar and unfamiliar items were selected with the same criteria used for the 64 pictures. There were 27 unfamiliar and 21 familiar items. This test was administered once.

The order of presentation of pictures was random with the restriction that no more than 10 familiar or unfamiliar items were given in succession. The mode of testing and the evaluation of errors was done in the same way as in the previous two experiments. Rating of familiarity was done in different sessions than naming.

### Results

The results are displayed in Table II. The number of correct names was significantly higher for unfamiliar items, regardless of whether only the first response or any response was considered. This advantage of unfamiliar items

Influence of Familiarity on Naming											
	First response correct	Any correct response	Perseveration	Semantic	Circumlocution TOT						
Category Naming, Dec. 1995											
Unfamiliar (16)	31	38	13	63	6	0					
Familiar (31)	13	26	61	39	0	3					
Snodgrass-Vanderwa	rt, 11 April 1996	5									
Unfamiliar (22)	18	41	14	82	14	5					
Familiar (24)	17	54	38	63	0	5 8					
Snodgrass-Vanderwa	rt. 18 April 1996	5									
Unfamiliar (22)	18	50	27	59	18	41					
Familiar (24)	17	38	46	54	4	17					
Boston Naming Test,	July 1996										
Unfamiliar (27)	26	59	37	48	15	22					
Familiar (21)	19	33	57	33	5	14					
Category Naming, A	ugust 1996										
Unfamiliar (17)	41	47	18	41	6	29					
Familiar (32)	6	22	50	50	3	28					
Sum across Experime	ents										
Unfamiliar (104)	26	48	23	59	13	20					
Familiar (132)	14	33	51	48	2	14					
p (chi <sup>2</sup> )	< 0.01	< 0.05	< 0.0001	n.s.	< 0.05	n.s.					

TABLE II Influence of Familiarity on Naming

*Note.* The figures represent the percentage of items for which the respective response was given.  $Chi^2$  tests were computed upon the actual numbers of responses. There was no item consistency for responses to tests given twice (for first responses correct: Category naming:  $chi^2 = 0.55$ , p > 0.2; Snodgrass-Vanderwart:  $chi^2 = 0.1$ , p > 0.3).

was contingent upon the lower frequency of perseverations. The frequency of semantic errors and TOT did not differ significantly between familiar and unfamiliar items. Circumlocutions unequivocally referring to the target were more frequent with unfamiliar items.

### Discussion

In the absence of studies on the influence of familiarity on modality specific visual misnaming, we do not know whether better naming of unfamiliar objects was also present in other patients. However, object familiarity is positively correlated with their name frequency, and other reported patients named objects with high-frequency names better than objects with low-frequency names (Riddoch and Humphreys, 1987; Zingeser and Berndt, 1988). This renders it unlikely that the paradoxical familiarity effect pertains to all patients with modality specific visual misnaming.

Familiarity, that is, frequency of contact with objects, increases the number and strength of associations linking their semantic representation to other information in semantic memory. Thus the semantic representations of highly familiar objects grow richer and more widespread than those of unfamiliar objects. Activation of this rich semantic network by visual input seemed to provoke perseverations and to impede naming.

# GENERAL DISCUSSION

The main results can be summed up as follows: WH's errors in visual object naming consisted mainly of semantic paraphasias and perseverations. His responses to visually presented objects sometimes melted correct information about the objects with perseverations. We hypothesize a disconnection between perceptual processing and semantics. It was unidirectional with the peculiarity that the preserved route from speech to vision only supported positive matches. Action naming was spared. Vision of objects interfered with tactile naming, and there was evidence that visual naming deteriorated with increasing activation of associations within the semantic system.

We will discuss how the theories outlined in the introduction can cope with these findings.

### Two Semantic Systems Theory

The two semantic systems theory can explain the unidirectionality of visuoverbal disconnection by assuming that the right hemisphere has verbal comprehension but not production competence. This does not, however, provide an explanation for the inability to reliably reject wrong names. There is no a priori reason for believing that the right hemisphere's lexical-semantic competence is restricted to positive matches between names and objects.

The idea that the right hemisphere semantic system can express non-verbally the identification of misnamed objects explains dissociations between non-verbal and verbal responses to visual stimuli. It cannot, however, account for dissociations between verbal responses to different kinds of visual stimuli. As verbal responses are produced exclusively by the left hemisphere, differences between verbal error rates for visual and tactile naming, action and object naming, and naming of familiar and unfamiliar objects must have their source in the left hemisphere.

#### Single Semantic System Theory

Lhermitte and Beauvois (1973) hypothesized two mechanisms underpinning errors: "incomplete elaboration of the message sent from vision to speech" and "a disturbance of inhibitory mechanisms controlling speech". We will try to elaborate how an interplay of excitation and inhibition within an unitary semantic system can bring forward the critical phenomema of modality specific visual misnaming. Figure 2 illustrates the ideas. It is assumed that the sight of an object activates not only its representation but also related informations and concepts. Within the semantic system there are mutual inhibitory connections between representations of objects. In visual naming the semantic system gets into a stable state when the inhibitory influences from one object representation have extinguished excitation of coactivated object representations. In order to suppress activity in concurring concepts, excitation of the correct representation has to exceed a treshold. This treshold may be either an absolute level of activity or a difference of activity between the representation and its concurrents.

Modality specific visual misnaming would result from disturbed or attenuated transmission of visual information to the semantic system. The transmitted

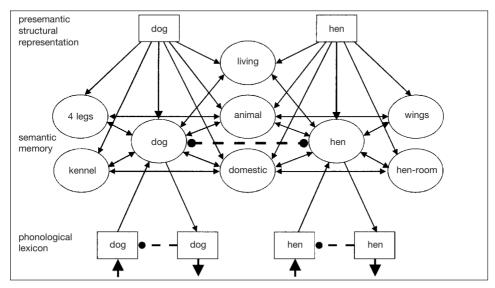


Fig. 2 – A model of how modality specific visual misnaming can derive from an interaction of excitation and inhibition within a single semantic system. Full lines with arrows denote excitatory and dotted lines with circles inhibitory connections. To avoid overfill of the picture, inhibitory connections between mutually exclusive semantic associates (4 legs-wings; kennel-hen-room) are not shown. See text for more details.

information may activate the correct object representation more intensely than that of any other object but the difference does not suffice for extinguishing activity in related representations. Oscillations between simultaneously active object representations may lead to apparent conflicts between correct and wrong naming responses.

Unidirectionality of visuo-verbal disconnection can be explained by the assumption that visual activation of the correct object representation is stronger than that of any other object's representation but not strong enough to settle the system. Listening to the name of an object increases the activation of its representation. Listening to the name of the visually presented object activates its representation beyond the treshold for successful inhibition of concurrents. Listening to the name of a semantically related, but not presented, object diminishes the difference between this and the correct object. This increases the probability of eventually accepting the wrong name. Therefore WH, like other patients (Lhermitte and Beauvois, 1973; Hillis and Caramazza, 1995), could recognize correct names but not reject the names of semantically related objects. A similar mechanism can apply to recognition of object properties. The attributes of the visually presented object are activated stronger than those of other objects but the difference may be too small for settling the system. Hearing the correct attribute enhances the difference and settles the system. Consequently, WH recognized attributes when they were proposed by the examiner. However, he made errors when he had to reject wrong proposals, and he could not produce the attributes in response to open questions.

In Figure 2 we have drawn an inhibitory connection from the phonological output lexicon to the input lexicon with the consequence that listening to a name spoken by oneself does not activate the semantic representation as much as hearing it from someone else. This should explain why WH and other patients (Zingeser and Berndt, 1988; Coslett and Saffran, 1992) recognized the correct name when it was spoken by the examiner but sometimes rejected it when they had produced it themselves.

A similar account can account for interactions between *tactile and visual naming*. When WH was allowed to palpate a visually presented object, the tactile input reinforced the representation of the correct object, and naming improved. However, as the route from tactile exploration to object representation is less definite and less automatized than that from names, the effect of palpation was weaker than the effect of hearing the name. The instability caused by the spreading of visual activation could prevail over tactile identification, and naming from simultaneous visual and tactile input was less accurate than purely tactile naming.

*Preserved action naming* and the *paradoxical influence of familiarity on naming* can be accounted for by insufficient inhibition between semantic representations. The more semantic representations are activated by the visual input, the greater is the chance that activation spreads to other objects and the more instable will the system get. Highly familiar objects activate more widespread associations than unfamiliar objects, and the semantic representations of actions are generally "narrower" and less interconnected than those of objects (Jones, 1984; Miller and Fellbaum, 1991; Robinson, Grossman, White-Devine et al., 1996).

*Perseverations.* To account for distant perseverations we need to assume damage to inhibitory connection within the semantic system in addition to the damage of visuo-semantic connections. This proposal is similar to Plaut and Shallice's (1993) suggestion of additional damage to "clear up units". Otherwise each correct response would settle the system and abolish activation in other object representations. With additional damage to inhibitory connections or, respectively, "clear up units", previously activated object representations may remain abnormally active after the system has temporarily settled on a correct response. If activation from a subsequent object happens to spread to the preactivated representation this may reappear as a distant perseveration. The probability that activation spreads as far as to reach the previously activated concept increases with the richness of associations to the actual object. Because perseverations are caused by additional damage which need not be present in all patients, they are prominent in some patients but rare or absent in others (see Introduction).

### CONCLUSION

Allowing for an interplay of excitation and inhibition enhances the explanatory flexibility of the single semantic system theory. By putting different emphasis on either excitation or inhibition and by constructing interactions between them, the model can be accommodated to a wide variability of clinical manifestations of modality specific visual misnaming. This may be considered as a shortcoming because explanatory flexibility defies firm predictions of future observations. At the same time, flexibility of the explanatory model appears to be a realistic reflection of the variability of modality specific visual misnaming. Conflicting results of tests thought to be crucial for the interpretation of modality specific visual misnaming have been observed not only between but even within individual cases (Schnider, Benson and Scharre, 1994; Endo, Makishita, Yanagisawa et al., 1996; De Renzi and Saetti, 1997). We think that any viable theory of modality specific visual misnaming has to be capable to accommodate this variability.

*Acknowledgement.* We want to thank Prof. B. Conrad for referring WH to us. Udo Münβinger performed perimetry and tests of colour vision. Rosapia Lauro-Grotto drew our attention to the theoretical significance of the deleterious effect of vision on tactile naming. We are grateful to two anonymous reviewers for insightful comments on previous versions of the paper. Finally, we want to thank WH for his collaboration and interest.

#### REFERENCES

ASSAL, G., and REGLI, F. Syndrome de disconnexion visuo-verbale et visuo-gestuelle – Aphasie optique et apraxie optique. *Revue Neurologique*, 136: 365-376, 1980.

BENTON, A.L., HAMSHER, K.S., VARNEY, F.R., and SPREEN, O. Contributions to Neuropsychological Assessment. New York: Oxford University Press, 1983.

CAMPBELL, R., and MANNING, L. Optic aphasia: A case with spared action naming and associated disorders. *Brain and Language*, 53: 183-221, 1996.

COSLETT, H.B., and SAFFRAN, E.M. Preserved object recognition and reading comprehension in optic aphasia. *Brain, 112*: 1091-1110, 1989.

- COSLETT, H.B., and SAFFRAN, E.M. Optic aphasia and the right hemisphere: A replication and extension. Brain and Language, 43: 148-161, 1992.
- DE RENZI, E., and SAETTI, M.C. Associative agnosia and optic aphasia: qualitative or quantitative difference? Cortex. 33: 115-130, 1997.
- ENDO, K., MAKISHITA, H., YANAGISAWA, N., and SUGISHITA, M. Modality specific naming and gesture disturbance: a case with optic aphasia, bilateral tactile aphasia, optic apraxia and tactile apraxia. Cortex. 32: 3-28, 1996.
- FARAH, M.J. Visual Agnosia Disorders of Object Recognition and What They Tell Us about Normal Vision. Cambridge-London: MIT Press, 1990.
- FEINBERG, T.E., DYCKES-BERKE, D., MINER, C.R., and ROANE, D.M. Knowledge, implicit knowledge and metaknowledge in visual agnosia and pure alexia. Brain, 118: 789-800, 1995.
- FERRO, J.M., and SANTOS, M.E. Associative visual agnosia: A case study. Cortex, 20: 121-134, 1984.
- FOSTER, R., GIDDAN, J.J., STARK, J., and SPARKS, P. Visually Cued Language Cards. Palo Alto: Consulting Psychologists Press, 1974.
- FREUND, C.S. Ueber optische Aphasie und Seelenblindheit. Archiv für Psychiatrie und Nervenkrankheiten, 20: 276-297, 371-416, 1889.
- GENZEL, G., KERKHOFF, G., and SCHEFFTER, S. PC-gestützte Standardisierung des Bildmaterials von Snodgrass & Vanderwart (1980). Neurolinguistik, 41-53, 1995.
- GOLDENBERG, G., and ARTNER, C. Visual imagery and knowledge about the visual appearance of objects in patients with posterior cerebral artery lesions. Brain and Cognition, 15: 160-186, 1991.
- GOLDENBERG, G., and HAGMANN, S. Tool use and mechanical problem solving in apraxia. Neuropsychologia, 1998 (in press).
- HÉCAEN, H., GOLDBLUM, M.C., MASURE, M.C., and RAMIER, A.M. Une nouvelle observation d'agnosie d'object. Deficit de l'association ou de la categorisation, specifique de la modalité visuelle? Neuropsychologia, 12: 447-464, 1974.
- HILLIS, A.E., and CARAMAZZA, A. Cognitive and neural mechanisms underlying visual and semantic processing: Implications from "optic aphasia". Journal of Cognitive Neuroscience, 7: 457-478, 1995
- HODGES, J.R., PATTERSON, K., and TYLER, L.K. Loss of semantic memory: Implications for the modularity of mind. Cognitive Neuropsychology, 11: 505-542, 1994.
- HOWARD, D., and PATTERSON, K. The Pyramids and Palm Trees Test. Bury St Edmunds: Thames Valley Test Company, 1992.
- HUMPHREYS, G.W., RIDDOCH, G.W., and QUINLAN, P.T. Cascade processing in picture identification. Cognitive Neuropsychology, 5: 67-104, 1988.
- IORIO, I., FALANGA, A., FRAGASSI, N.A., and GROSSI, D. Visual associative agnosia and optic aphasia. A single case study and a review of the syndrome. Cortex, 28: 23-38, 1992
- JONES, G.V. Deep dyslexia, imageability, and ease of predication. Brain and Language, 24: 1-19, 1984. KAPLAN, E., GOODGLASS, H., WEINTRAUB, S., and SEGAL, O. Boston Naming Test. Philadelphia: Lea and
- Febiger, 1983. LHERMITTE, F., and BEAUVOIS, M.F. A visual-speech disconnection syndrome. Report of a case with optic aphasia, agnosic alexia and colour agnosia. Brain, 96: 695-714, 1973.
- LISSAUER, H. Ein Fall von Seelenblindheit nebst einem Beitrag zur Theorie derselben. Archiv für Psychiatrie und Nervenkrankheiten, 21: 222-270, 1890.
- MANNING, L., and CAMPBELL, R. Optic aphasia with spared action naming: A description and possible loci of impairment. Neuropsychologia, 30: 587-592, 1992.
- MCCARTHY, R., and WARRINGTON, E.K. Visual associative agnosia: a clinico-anatomical study of a single case. Journal of Neurology, Neurosurgery, and Psychiatry, 49: 1233-1240, 1986.
- MICHEL, F., SCHOTT, B., BOUCHER, M., and KOPP, N. Alexie sans agraphie chez un malade avant un hémisphère gauche déafferenté. Revue Neurologique, 135: 347-364, 1979.
- MILLER, G.A., and FELLBAUM, C. Semantic networks of English. Cognition, 41: 197-229, 1991.
- MORIN, P., RIURAIN, Y., EUSTACHE, F., LAMPERT, J., and COURTHEOUX, P. Agnosie visuelle et agnosie tactile. Revue Neurologique, 140: 271-277, 1984.
- PLAUT, D.C., and SHALLICE, T. Perseverative and semantic influences on visual object naming errors in optic aphasia: A connectionist account. Journal of Cognitive Neuroscience, 5: 89-117, 1993.
- POECK, K. Neuropsychological demonstration of splenial interhemispheric disconnection in a case of "optic anomia". *Neuropsychologia, 22:* 707-714, 1984. RIDDOCH, M.J., and HUMPHREYS, G.W. Visual object processing in optic aphasia: A case of semantic
- access agnosia. Cognitive Neuropsychology, 4: 131-185, 1987.
- RIDDOCH, M.J., and HUMPHREYS, G.W. Picture naming. In GW Humphreys and M.J. Riddoch (Eds.), Visual Object Processing: A Cognitive Neuropsychological Approach. Hove-London-Hillsdale: Lawrence Erlbaum, 1987, pp. 107-144.
- RIDDOCH, M.J., and HUMPHREYS, G.W. Birmingham Object Recognition Battery. Hove, Hillsdale: Lawrence Erlbaum Associates, 1993.
- ROBINSON, K.M., GROSSMAN, M., WHITE-DEVINE, T., and D'ESPOSITO, M. Category-specific difficulty

naming with verbs in Alzheimer's disease. Neurology, 47: 178-182, 1996.

- RUBENS, A.B., and BENSONS, D.F. Associative visual agnosia. Archives of Neurology, 24: 305-316, 1971. SCHNIDER, A., BENSON, D.F., and SCHARRE, D.W. Visual agnosia and optic aphasia: are they anatomically distinct? *Cortex*, 30: 445-458, 1994.
- SNODGRASS, J.G., and VANDERWART, M. A standardized set of 260 pictures: Norms for name agreement, image agreement, familiarity, and visual complexity. Journal of Experimental Psychology: Learning, Memory and Cognition, 6: 174-215, 1980. TEIXEIRA-FERREIRA, C., GIUSIANO, B., CECCALDI, M., and PONCET, M. Optic aphasia: Evidence of the
- contribution of different neural systems to object and action naming. Cortex, 33: 499-514, 1997.
- ZINGESER, L.B., and BERNDT, R.S. Grammatical class and context effects in a case of pure anomia: Implications for models of language processing. Cognitive Neuropsychology, 5: 473-516, 1988.

Prof. Dr. Georg Goldenberg, Krankenhaus München Bogenhausen, Englschalkingerstrasse 77, D81925 München, Germany. E-mail: Georg.Goldenberg@trz.tum.de.

(Received 10 January 1998; accepted 2 April 1998)