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Selective Preservation of Naming from Description and the "Restricted Preverbal Message"

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We report the case of a patient, LEW, who presents with modality-specific naming deficits. He is seriously impaired in naming pictures of both objects and actions. His naming to auditory verbal definitions and of actions carried out by the experimenter is, however, relatively well preserved. He has no visual perceptual deficits and his access to the semantics of pictures is as good as that to the semantics of spoken words. While LEW is not an optic aphasic patient, his pattern of performance is relevant to the debate that has taken place of the organization of the semantic system. We discuss his case from this perspective and argue that LEW's selective deficits support the multiple semantics position. We also argue that the "preverbal message" level in the speech production model of Levelt (1989) is the equivalent of "verbal semantics." We provide additional constraints and principles to the concept of the preverbal message and we term the system so constrained the "restricted preverbal message." © 2000 Academic Press

INTRODUCTION

The organization of the semantic system and, in particular, the question of whether the semantic system is better conceptualized as a unitary store which is modality independent or as multiple stores which are linked to different modalities has remained controversial. Studies on normal subjects

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could not clearly distinguish between the two proposals (e.g., Snodgrass, 1984; Te Linde, 1982). However, it has been argued that a number of neuropsychological phenomena support the existence of multiple semantic systems (Warrington, 1975; Beauvois, 1982; Shallice, 1987).

One line of evidence is based on patients who are held to have a specific degradation of information—typically due to a dementing condition—of either a verbal semantic memory store (e.g., Lauro-Grotto, Piccini, & Shallice, 1997) *or* a visual semantic memory store (e.g., Breedin, Saffran, & Coslett, 1994). More complex examples of this line of evidence are obtained from study of patients who are held to have degradation of stored information specific to one of these two types of memory systems for certain categories of material only (e.g., McCarthy & Warrington, 1988). To draw theoretical conclusions about the existence of multiple semantic systems from the observation of such modality-specific and category-specific impairments depends upon assuming that the deficits are of storage rather than ones of access to a storage system, an assumption that has been criticized (Rapp & Caramazza, 1993). Recently, however, Lauro-Grotto et al. (1997) presented evidence to the effect that the deficits of their patient were ones of storage. This consequently made explanations in terms of multiple semantics more plausible. The critics of the multiple semantics position, instead, hold that the storage system for semantic information is unitary but either that additional information is available from a structural description system for visually presented material (Riddoch & Humphreys, 1987) or that input to the semantic system from the structural description has privileged access (Caramazza, Hillis, Rapp, & Romani, 1990). This line of interpretation cannot, however, explain selectively preserved access from the verbal modality (Breedin et al., 1994).

A second type of disorder which has been used to support the evidence for multiple semantic systems is one where the operations of the two types of system are held to be disconnected. The standard example of this argument has been provided by the inference from optic aphasia where that is viewed as a functional syndrome in the sense of Shallice and Plaut (1992) and Plaut and Shallice (1993) (see, e.g., Beauvois, 1982; Beauvois & Saillant, 1985). Prototypically, an optic aphasic patient is poor at naming visually presented stimuli, but good when he or she is allowed to palpate the objects or when a verbal description of the object is provided. Also, optic aphasic patients are held to be good at miming the use of the visually presented objects that they cannot name, indicating that they have a better knowledge of the objects than is evident from their naming performance (Lhermitte & Beauvois, 1973; Beauvois, 1982; Gil, Pluchon, Toullat, Michenau, Rogez, & Levevre, 1985).

The explanation given on the multiple semantic systems position is that the visual and verbal semantic systems are disconnected and that the visual semantic system does not have its own autonomous route to naming. However, again, alternative interpretations have been provided. According to Riddoch and Humphreys (1987) the deficit in optic aphasia is in accessing an intact semantic system from an intact structural knowledge system. Their model does not necessitate the assumption of multiple semantic systems, but stored structural descriptions are assumed to be more powerful than in other models. Accordingly, visual/structural information present in structural descriptions does not need to be further interpreted in a conceptual–semantic system in order to control action. Gesturing and other apparently semantic tasks are carried out with information available in stored structural representations. This explains the accurate gesturing that has been reported of certain optic aphasic patients without accepting it as evidence of semantic access. Naming, however, is impaired since naming is held to be dependent on *full* semantic access.

Caramazza and his colleagues also assume that such optic aphasic patients obtain only a partial semantic representation of visually presented stimuli that is insufficient for naming to proceed (Caramazza et al., 1990; Hillis, Rapp, Romani, & Caramazza, 1990). They differ from Riddoch and Humphreys in their respective models of naming. While in Riddoch and Humphreys' model structural and visual features of objects are not interpreted further in the semantic system, in Caramazza et al.'s model, the visual features of objects are represented in structural descriptions *and* as abstract predicates in the semantic system. There are strong links between the visual features of the 3D model represented in structural descriptions and the abstract predicates relating to visual features in the semantic representation of the same item. This is the *principle of privileged access*, and it explains why (at times and for some patients) visual input is easier to process than verbal input. A corollary claim, the *principle of privileged relationships*, maintains that there are systematic relationships between an object's visual appearance and its function (or other semantic features determined in an ad hoc fashion) so that good gesturing is possible without the accessing of the full semantic representation of an object. The arbitrary relationship between an object and its name, however, necessitates the accessing of a fuller semantic representation for naming to be successful.

The empirical critiques of Riddoch and Humphreys (1987) and of Caramazza and colleagues of multiple semantics depends on their argument that such optic aphasic patients are not able to obtain full semantic representations of visually presented objects. They argue that good gesturing and success in tasks such as categorization and associative matching cannot be taken as evidence for the attainment of full semantic representations, as these tasks can be carried out by relying on stored structural descriptions (Riddoch & Humphreys, 1987) or on partial semantic access (Caramazza & Hillis, 1990).

One of the problems in the theoretical controversy about optic aphasia has been the defining of what would constitute the full semantic access that enables naming to take place and how to demonstrate semantic access empirically in the absence of the ability to name. Manning and Campbell (1992) present a successful attempt in this direction (see also Campbell & Manning, 1996). AG, a patient whose naming of visually presented stimuli is poor (46%) while his naming to verbal definition is normal (100%), was presented with a series of tasks that probed access to the semantics of words and pictures. His performance was equally good with both modalities of input (91 and 88%), indicating that his deficit in naming pictures was not related to inadequate semantic access. A similar methodology was employed in testing DHY (Hillis & Caramazza, 1995), whose pattern of naming was similar to AG's. DHY's performance on the semantic probing tasks, however, was different; her performance in the more difficult tasks was significantly poorer when the stimuli were pictures (50, 18, and 43% errors) than when the stimuli were words (3% errors in one task and no errors in another). One of these ''difficult'' tasks—answering questions about objects—was entirely comparable in its level of difficulty to one AG in Manning and Campbell's study successfully performed. Thus DHY, having a problem in accessing semantics from vision, should be viewed as a different type of patient from AG, who appears not to have such a problem, and so the existence of DHY does not weaken any interpretation based on the results of AG.

The first part of our article addresses this type of issue. We present findings on an aphasic patient who has very serious deficits in naming pictures and objects, but has a relatively well-preserved ability to name from definitions. We show that his semantics of visually presented objects is, as far as can be assessed, virtually intact, and that if he has any semantic deficits, they are unrelated to his ability to name. His performance on identical semantic tasks on the basis of pictures and words is equally good. It is argued that the nature of the impairment provides empirical support for the multiple semantics position. The argument therefore has similarities to that developed from cases of optic aphasia, such as that of Manning and Campbell, though the constellation of the patient's symptoms differ from that of optic aphasia.

The second part of the article addresses the verb production of the same patient. There have recently been a number of reports of dissociations between the ability to produce nouns and verbs by aphasic patients. The precise reason for this dissociation is not yet known, but arguments based on the complexity of verbs (Gentner, 1982) or nouns are implausible because of the existence of double dissociations in the domain (Miceli, Silveri, Villa, & Caramazza, 1984; Zingeser & Berndt, 1988, 1990; Caramazza & Hillis, 1991; Damasio & Tranel, 1993; Miozzo, Soardi, & Cappa, 1994; Berndt, Mitchum, Haendiges & Sandson, 1997). Interpretations both in functional (Miceli et al., 1984; Caramazza & Hillis, 1991; Zingeser & Berndt, 1990) and in neuroanatomical terms (Damasio & Tranel, 1993; Miozzo et al., 1994) have been suggested. It is unlikely that there will prove to be only a single cause of the verb/noun dissociation across all relevant patients. Thus Miceli et al. (1984) and Caramazza and Hillis (1991), for example, claimed that the dissociation occurs at a late stage in the production process, at the level of the phonological output lexicon. Zingeser and Berndt (1990), on the other hand, put forward two other explanations. One is that since verb retrieval is a syntactic process, patients with a syntactic deficit will have a verb deficit too (and patients whose syntax is intact will not have a verb deficit). The second is that the source of the dissociation is conceptual–semantic: some patients have a selective deficit with objects and others with actions (see also McCarthy & Warrington, 1985).

We report the action verb production of our patient in a series of single-word verb-production tasks. He indeed is better at producing action verbs than nouns (see also the case of AG in Manning & Campbell, 1992 and Campbell & Manning, 1996) but this advantage is evident only under certain conditions and not under others. It appears that action verb production is possible when the task has one format, but fails when it has a second one. Thus, in his case, the explanation cannot be syntactic, and the dissociation between verbs and nouns cannot occur at the level of the phonological output lexicon. Rather, the dissociation seems likely to be linked to the issue of different types of semantic representation, which we discuss in the earlier part of the article.

CASE REPORT

At the time of the tests LEW was a 60-year-old man who had left school at the age of 14 and previously worked as a clerk. He had had a stroke 2 years prior to the investigations. This has left him with a right-sided hemiplegia, aphasia, and inattention to the right side. He fully understood that the experimental tasks were carried out for research purposes and he participated in the study willingly and with interest. On the WAIS IQ test he had a Verbal IQ of 71, Performance IQ of 83. Subtest scores ranged from normal range (Block Design) to well beneath it (Digit Span). In particular, performance with pictorial material was consistent with his performance on other verbal and nonverbal tests. Scale scores for Picture Completion and Picture Arrangement were 7 and 6 respectively. His performance on the VOSP was satisfactory (Shape Detection 20/20, Object Decision 19/20, Position Discrimination 18/20). On Warrington's (1984) forced-choice recognition memory task he performed just above the normal mean for faces (44/50), but somewhat below it for words (39/50).

Language Processes

LEW's profile on the Assessment of Aphasia is closest to the profile of high-level Wernicke's aphasics (Goodglass & Kaplan, 1972). His spontaneous speech is fluent and grammatical but, often, marred by word-finding difficulties. His auditory comprehension in everyday contexts is adequate. LEW's reading and writing abilities were tested using the PALPA test battery (Kay, Lesser, & Coltheart, 1992). His performance in reading aloud is severely impaired. He cannot read aloud individual letters and read aloud only

TABLE 1
LEW's Performance on Single-Word Comprehension Tasks with Spoken and Written Presentation (Case Study)

	Number of items	Spoken presentation	Written presentation[a]
Peabody (4-choice)	150	118	
Shallice and McGill (4-choice); abstract and concrete word/picture matching task	75	62	44**
Synonym judgement (2-choice); PALPA	76	67	54*
Comprehension of adjectives and verbs; judgements on definitions PALPA	41	34	
Word/picture matching task; PALPA; close and distant semantic, visual, and unrelated distractors	40	33	
Word/picture matching task; five semantically related pictures	93	82	

[a] Difference between spoken and written presentation: $*p < 0.02$ and $**p < 0.01$.

4/24 concrete nouns. His performance in matching upper- and lowercase letters was almost perfect (98% correct). In a lexical decision task he made 6/60 errors on words and 9/60 errors on nonwords. However, in a lexical decision task that contained suffixed (derivational and inflectional) words and nonwords (words affixed with illegal endings) he made 37/60 errors showing that he has serious problems in identifying grammatical morphemes from the written modality (see ML of Shallice & Saffran, 1986). LEW cannot write letters or single simple words to dictation, and he performed at chance in a written homophone decision task (16/30). LEW was presented with a variety of word-comprehension tasks (see Table 1). When a direct comparison could be made, comprehension performance was significantly worse with visual than auditory word presentation.

Clinical Investigations of Naming and Nature of the Basic Phenomenon

The Naming of Line Drawings and Naming to Definition

LEW was asked to name 60 pictures (a collection of low-, medium-, and high-frequency items from the Snodgrass and Vanderwart battery selected in the PALPA) and provide the name following their auditorily presented verbal definitions. The definitions were taken from the Concise Oxford Dictionary, with some clarifications (examples: *frog: a small animal, lives in muddy surrounding, with legs developed for jumping; knife: a metal blade used as a cutting tool with one long sharp edge fixed in a handle*). The experiment was carried out twice with an 8-month interval between the two presentations. On the first presentation, LEW produced only 7 (11%) names when shown the pictures, but was able to produce 33 (55%) names when definitions were presented as stimuli; significantly better (McNemar test,

TABLE 2
Combined Results from the First and Second Presentation of 60 Line Drawings: The Number of Names Correctly Produced by LEW (Clinical Investigations)

	High frequency	Medium frequency	Low frequency
2 × correct	3	—	—
1 × correct	5	7	3
2 × wrong	12	13	17

$p < .001$). On the second occasion, he produced 14 (23%) names of pictures (7 high- and 7 medium-frequency words) and 39 (65%) names following definitions; again, significantly better (McNemar test, $p < .001$).

It is evident that LEW has a serious naming deficit when the input is visual. However, his naming improved greatly when the input was a verbal definition instead of a picture. In naming pictures, he makes semantic errors (e.g., *leaf → branch, tree with leaves on*), circumlocutions (*fence → outside the house*), and perseverative errors and makes attempts at gesturing the function or the shape of the object. In naming to verbal definitions, his most frequent error is an omission; he made only a few semantically related incorrect responses and no circumlocutions and did not perseverate. The combined results of the two presentations of the pictures is shown in Table 2, which shows that there was an effect of frequency (Jonckheere Trend Test, $p < .001$).

Production of Verbs

LEW was presented with 73 line drawings from Warrington's unpublished action pictures, definitions of 67 of them (e.g., the definition for *lick* was *pass the tongue over to taste, to moisten or to clean*), and 39 sentence frames with a missing verb. He produced 7/73 (9%) verbs on the basis of pictures, 25/67 (37%) verbs on the basis of definitions, and 26/39 (66%) verbs when sentence frames were the stimuli. Thus, LEW's verb production on the basis of pictures is no better than his noun production. His production of verbs, however, improves when definitions or sentence frames are provided.

Naming of Food Items from Taste

LEW was presented with 34 familiar food items such as *orange, cheese, jam, honey,* and *milk* to taste. His eyes were covered and he was not allowed to touch the food. He was asked to name the food items. Two normal adults had no difficulty in performing this task. LEW produced five correct food names and two more following verbal self-cueing and four close semantic errors (e.g., *almond → cashew nut*) to the target. Thus, LEW's naming from taste is no better than his visual and tactile naming.

TABLE 3
Number of Names for Visual and Tactile Objects, for Photographs, and for Verbal Definitions Correctly Produced by LEW (Clinical Investigations)

Visual object	Tactile object	Photograph	Verbal definition
15/90 (16%)	17/90 (18%)	12/90 (13%)	41/90 (45%)

The Basic Phenomenon: Naming of Photographs, Objects, and Palpated Objects and Naming on Definitions

Ninety household objects were chosen and photographed. The objects, their photographs, and the verbal definitions of their name constituted the stimuli for this naming experiment. All stimuli were presented singly. Testing was carried out over a 3-week period. In any one session the patient was presented with 30 different objects for visual naming, 30 different photographs, and 30 different objects for tactile naming. The order of presentation of visual objects, photographs, and tactile objects varied each week, following a Latin Square design. The verbal definitions of the objects were again taken from the Shorter Oxford Dictionary with occasional alterations for clarification (e.g., *safety pin: a small sharp metal object used for holding together two parts of clothing or the nappy of a baby. The sharp end is bent back to the head and is held locked to protect the body from being pricked; toothbrush: a tool for cleaning the white bony structures in one's mouth*). The verbal definitions were presented auditorily during three different testing sessions in the same period.

LEW's performance differs across tests (Cochran's Q test, $Q = 38.7$; $p < .001$). Naming of real objects, photographs, and palpated real objects was equally impaired. His performance on verbal definitions, however, was much better (see Table 3). His most frequent incorrect response in the present naming task was an omission. His other responses were semantically related to the target. The number and type of errors were similar in naming visually presented objects, in naming photographs, and in naming palpated objects. Thus LEW made the following errors in the naming of photographs: associates of the target (9), e.g., *envelope* → *stamp, letter; scissors* → *nails, nail brush;* coordinates of the target (11), e.g., *fork* → *spoon, no; scissors* → *not a knife but near;* superordinates of the target (3), e.g., *ring* → *jewellery; boat* → *toy;* the function of the target (14), e.g., *cotton reel* → *sew with it; plate* → *eat with it; dice* → *play with it;* perseveration (10 in one session), e.g., 5 *ashtrays* over 11 items; 3 *brushes* over 6 items.

Summary of the Clinical and Basic Investigations

The clinical investigations suggest that LEW has a serious naming deficit when the input is visual. His naming improved greatly when the input was verbal definition. A comparison between the results for visual objects and photographs suggests that LEW is not affected by the quality of the stimuli and this therefore argues against the possibility that his naming deficit derives from visual apperceptive agnosia (see, e.g., Davidoff & De Bleser, 1993), which fits with his performance on the VOSP. His tactile naming is no better than his visual naming, and naming from taste is also very poor. LEW's naming deficit does not fit the pattern of optic aphasia where intact tactile naming is prototypical (Lhemitte & Beauvois, 1973; Beauvois, 1982). Indeed one would not expect the patient to present with an optic aphasia, as he had a hemiplegia, and optic aphasia, typically present following a left posterior cerebral artery lesion, which does not result in hemiplegia.

Considering the contrast between naming to visual confrontation and verbal definition, we are left with two possible simple explanations. The first is that the giving of a verbal definition aided the naming process by nonsemantic means. The second is that LEW has an extra deficit in accessing semantic representations given visual presentation. In the first experimental section we explore these two possibilities.

EXPERIMENTAL

Experiment 1: Naming on the Basis of Pictures and Old and New Definitions

Introduction and Methods

One possibility is that the difference in LEW's performance between naming from visual presentation and naming from verbal definition does not lie in any difference in the semantic representations achieved by the two types of input. Instead it might arise at a postsemantic stage, due to the use of associations operating at the level of the phonological output lexicon. In order to explore this possibility, we repeated the clinical study of naming a year later and added a new condition which removed all strong associates from the definitions.

We re-presented the 60 pictures from the Snodgrass and Vanderwart battery and the 60 definitions and added 60 new definitions. From the new definitions we excluded all words that are lexical associates of the target word. For example, from the previous definition of a *stool, a seat without a back or arms, used for one person and consisting of a wooden slab on three or four short legs,* the word *seat* that might prime *stool* was excluded and *stool* was defined as *something that does not have a back or arms and can be used when we don't want to stand. It is used by only one person. Can be low and high.* In the new set, *a large heavy device fixed to a carriage used in the olden days in times of international conflict to injure people a mile or so away* defined a *cannon,* instead of the previous definition of *a large heavy gun installed on a carriage.* The new test was presented in three sessions with a week between them using a latin-square design. All the definitions were presented auditorily. Three age-matched non-brain-damaged individuals were also tested in naming the pictures and the new definitions.

Results and Conclusions

LEW named 16 (26%) pictures, 36 (60%) old definitions, and 37 (62%) new definitions, giving a significant difference between the conditions

(Cochran's Q test, $Q = 21.5$, $p < .001$). The previously found dissociation between picture naming and naming on the basis of verbal definitions was maintained. The dissociation was not apparent in the control subjects. They named correctly an average of 59 (98%) pictures and 59 (98%) definitions. Thus they performed well in both modalities and, in contrast to LEW, found the naming of verbal definitions somewhat more demanding than the naming of pictures. In naming to definition, but not in picture naming, control subjects made additional errors (mean = 3.6) that were spontaneously corrected.

The quality of LEW's incorrect responses also differs between picture naming and given verbal definitions. While in verbal definitions, most of his errors (21/23) were omissions, in picture naming only 43% of errors were omissions, and the rest were semantic errors (e.g., *bottle* → *liquid, glass; watch* → *clock*) and circumlocutions (e.g., *tree* → *something I like, find in the fields; cigarette* → *I don't have nothing to do with, a smoke*). The quantitative and qualitative differences between his naming to verbal definitions and naming pictures are an indication that the two tasks rely on different processing mechanisms. Furthermore, absolutely no difference was found between LEW's performance on the basis of the old and new definitions, showing that even when lexical associates of the target are excluded from the definitions, and so semantic processing cannot be partially circumvented in the naming process, LEW is still far more successful than when he is presented with a picture. LEW's success in naming to definition suggests that his access to semantics from verbal input is relatively well preserved. It is possible that his failure in naming pictures is due to a deficit in the semantic interpretation of visual inputs. In the following studies, therefore, we explored LEW's access to semantics. In all investigations we contrasted his performance in the verbal and the visual modalities.

Experiment 2: Pyramids and Palm Trees

Introduction and Methods

Pyramids and Palm Trees (Howard & Patterson, 1992) is a test of a patient's ability to access semantic representations. The task is to select one item of two that is associated with a third item when the association depends on an inference. For example, the subject has to select one picture of the pictures of a *daffodil* and a *tulip* that is associated with the windmill, *tulip* being correct because both the tulip and the windmill are characteristic features of Holland. Three versions of the Pyramids and Palm Trees test were presented: three pictures, one picture and two written words, and three written words. The different versions of the test were presented on different testing sessions at least a week apart. Three months later the task was presented again and the conditions of three-spoken-words (they were repeated on request) and one-word-and-two pictures were added and the condition of one-picture-and-two-words was omitted.

Results and Conclusions

A summary of LEW's performance in the two testing sessions is presented in Table 4. In all conditions LEW performed the task reasonably well though

TABLE 4
Summary of LEW's Performance (in Percentages) in the Pyramids and Palm Trees Test during the Two Testing Periods (Experiment 2)

	3 pictures	3 spoken words	3 written words	1 picture, 2 written words	1 written word, 2 pictures
First testing period	84	—	84	88	—
Second testing period	88	84	73	—	86

below the norm (normals perform 95% correct, but 90% correct performance does not indicate clinically significant impairment). His level of performance was similar in the different modes of presentation and in the two testing periods. It indicates that LEW does not have a selective deficit for accessing the semantic system from the visual modality. Most critically, given his present level of intelligence, the level of performance obtained is acceptable considering the inferences involved in performing the task.

Good performance on a related associative semantic task to Pyramids and Palm Trees has not been accepted by all as evidence for intact semantic representations (e.g., Hillis et al., 1990). Therefore, to find out more about LEW's knowledge about pictures and words, detailed questions were prepared to probe his knowledge about different types of objects.

Experiment 3: Semantics of Animate Objects: (i) Fruit and Vegetables and (ii) Animals

Introduction and Methods

Twenty-four line drawings of fruits and vegetables and their spoken names and 22 drawings of animals and their written names were presented during four sessions. The Latin Square design was used and the same item never appeared twice in a single testing session. LEW was asked to name the pictures, and if he could not produce the name, he was asked 10 questions about fruits and vegetables and 14 questions about animals. The same questions were presented to him in the spoken-and-written-words condition in order to compare his performance with visual and verbal inputs, and the questions about fruits and vegetables were presented to his wife, who acted as a control (all the questions are listed in Appendix 1).

Results and Conclusions

On the fruit and vegetable items, LEW named four (e.g., *lemon, onion*) before the questions and one more item following the questions. He made five semantic and perseverative errors (e.g., *pineapple* → *melon grapefruit; carrot* → *a melon, not a melon; pepper* → *a melon, I don't recognize it; peach* → *apple; grapes* → *apple, no*). LEW answered the questions without difficulty and made only a few errors (4% on pictures and 5% on spoken words). Almost always when he made an error on the picture condition he made the identical error on the spoken-word condition (e.g., *orange, corn, and carrot have seeds; watermelon grows on a small plant*) and his wife made virtually the same errors. This indicates that his errors reflect gaps in his knowledge about particular items just as normal controls have and that his deficit in naming is not the result of selectively impaired access to semantics from visual input. This has been confirmed by the almost identical performance of his wife. On the animal items, LEW named spontaneously six animal pictures (e.g., *mouse*, *owl*) and, following the questions, six more (e.g., *rhinoceros, tortoise*). He made five semantic and six perseverative errors.[1] In his replies to the questions, LEW displayed very good and detailed knowledge of all the animals including those that he could not name. For all he was able to answer all 14 questions correctly and often provided distinguishing features that uniquely identified the animal in question (e.g., for a *snail* → *in France, they eat it;* for an *elephant* → *never forgets*). Thus it would appear that LEW has access to a full semantic representation with visual presentation.

The questions in the exploration of LEW's knowledge of the semantics of fruits, vegetables, and animals were so phrased that they would not provide information. It could, however, be argued that the questions, being mostly yes–no and multiple-choice questions, facilitated semantic access insofar that they helped in collecting and organizing knowledge about the items in the pictures. In order to rule out the possibility that LEW's display of knowledge about fruits, vegetables, and animals was, in part, indirectly assisted by the questioning, we conducted an additional experiment. LEW is at times able to produce the name of an object following conversation about it (see Experiment 3). In the house experiment, therefore, we did not ask him any questions. Instead we explored the effect of nonverbal stimulation.

Experiment 4: The House Experiment

Introduction and Methods

Pictures of typical rooms of a house, a living room, a bedroom, a kitchen, a bathroom, a hall, a children's room, and a garden were placed in front of LEW. He was then presented with 63 individual pictures of objects and pieces of furniture that are habitually found in a house and was asked to place each in its correct location in the house (e.g., *ashtray, television* → *living room; blouse, chest of drawers* → *bedroom; bread, kettle* → *kitchen; cot, balloon* → *children's room; umbrella, telephone* → *hall; leaf, butterfly* → *garden*). None of the individual pictures of the household objects (apart from *bed*) were depicted in the pictures of the rooms. He was also asked to estimate the size of the real object and to show the estimated size on a tape measure and, finally, to name the object.[2] Three age-matched non-brain-damaged individuals were also asked to give size estimations of the spoken object names. All instructions were given prior to the commencement of the experiment and LEW was discouraged from talking during the procedure. The aim was to provide LEW with nonverbal stimulation about the semantics of household items (by his indicating their location and size) and observe

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[1] He read the names of 12 animals and, following the questions, a further 6 (the written names of *kangaroo* and *snail* were not recognized by him and, therefore, he could not answer any questions about them).

[2] He was also asked to gesture the use of the objects, but his gesturing was of poor quality. No modality difference was evident.

TABLE 5
Performance of LEW on Estimation of Object Sizes from Pictures and Spoken Words Compared with the Performance of Normal Controls (Experiment 4)[a]

		Pictures				Expected	
z value	Spoken words (total)	Total	Named	Not named	Cumulative (%)	Cumulative	Modified cumulative[b]
<1	30	35	7	28	71	60	68
1.01–1.5	11	5	1	4	82	82	84
1.51–2	6	5	1	4	92	94	95
2.01–2.5	3	4	1	3	100	100	99
>2.5	10	10	1	9	—	—	—

[a] The number of items at different degrees of deviation from the normal mean is shown in different rows. For both pictures and words his estimates for 10 items deviate by more than 2.5 *SD*s. The cumulative estimate in the final column gives the expected deviation if the 10 most deviant items are not considered. The Picture results are broken down according to whether LEW was able to name the picture. LEW's estimates on 3 items were omitted as he differed from the three control subjects, who all produced identical responses. The item ''saltcellar'' is also omitted from the Picture results, as LEW refused to provide an estimate for this item.

[b] Ignoring items where $z > 2.5$.

the effect of such stimulation on his ability to name these items. The experiment was also an opportunity to investigate LEW's knowledge of a further category, this time of household objects. In order to compare LEW's ability to derive knowledge about objects from pictures with his ability to derive knowledge about the same objects from spoken words, we conducted the same experiment again approximately 2 months later when instead of pictures he was presented with spoken words.

Results and Conclusions

In the final naming stage, LEW correctly named only 11 objects (17%; e.g., *balloon, rolling pin, tree, ashtray, dummy*). This was similar to his level of performance on naming simple household objects (clinical investigations). He made 16 errors: circumlocutions (*bird* → *a parrot, or anything like that*), function of the object (*rocking chair* → *laze around in the room*), and coordinate errors (*knife* → *knife and fork*). LEW had no problems in placing the pictures of furniture, clothes, and other household objects in their appropriate rooms. He made only two errors in this task (*cot* in *bedroom; feeding bottle* in *living room*). LEW's performance on the estimation of object sizes from pictures and spoken words compared with that of normal controls is shown in Table 5. There were an equal number of items (10) for auditory and visual presentation on which his estimate differed by more than 2.5 *SD*s from the mean of the normal subjects (these were large items such as *sofa*, *tree*, *bed*, *pram* or items on which normals had perfect or near-perfect agreement such as *hotwater bottle, cake, toothpaste*). Perfect items were omitted (see Table 5). For all the other items the cumulative distribution of deviations from an accurate report fits the distribution expected from three normal controls (see

Table 5). The most critical result is that there is absolutely no difference between LEW's size estimation performance with visual and auditory input.

Summary of the Semantic Exploration Experiments

LEW carried out a wide range of tasks that aimed at exploring the knowledge he has about objects, fruits, vegetables, and animals that he cannot name. We contrasted his ability to carry out the Pyramids and Palm Trees with visual and verbal presentation and his ability to answer questions on the basis of pictures and of spoken words. LEW revealed detailed and accurate knowledge about all the items in the tasks, with only few errors. The modality of the input made no difference whatsoever to his ability to answer questions. These results indicate that the reason for LEW's naming deficit is not inadequate semantic access. Thus his performance is far better than that manifested by Hillis and Caramazza's patient, DHY, in the difficult questions of their items. His comparable performance in the visual and the verbal modalities argues against the position of Riddoch and Humphreys (1987) and Caramazza et al. (1990), according to which modality-specific naming deficits are the consequence of an impairment in the pathway between the visual input system and an amodal semantic system. These accounts would predict poorer performance when the input is visual. LEW, however, has virtually intact performance in both modalities except when making size judgements, but even here his performance is equivalent in the two input modalities.

Production of Verbs

In the clinical investigations we found that LEW was no better in producing action verbs than nouns when verbs were elicited by pictures (10%). His performance was better when verbal definitions were given (37%), but this improvement was no different from that which occurred when nouns were elicited by verbal definitions. We noticed, however, that when LEW was asked what the experimenter was doing, he responded with the correct verb. We decided, therefore, to investigate LEW's action verb performance on the basis of actions. The following tests were conducted.

Experiment 5: Action and Object Naming

Introduction and Methods

To exclude the possibility that LEW's better performance when the input is an action than when it is a picture is due to the fact that actions are more salient inputs than pictures, his naming of actions and of real-life objects was compared. We also wanted to establish that his superior naming of actions was not due to the verbs being more frequent items in the language. Therefore, 30 verbs and 30 objects which were frequency matched were chosen. Among the items there were very low-frequency items such as *yawn, tickle, kettle, peg;* medium-frequency items such as *sweep, smell, shoe, chair;* and high-frequency items, such as *read, sit, book,* *money*. LEW completed the test in two sessions, employing the Latin Square design. Three age-matched control subjects were also tested in naming the actions and the objects.

Results and Conclusions

LEW produced 11 (36%) object names and 26 (86%) action names. Thus, his verb production on the basis of actions is much better than his production of frequency-matched names of objects ($\chi^2 = 15.9$, $p < .001$). The control subjects named on average 29.6 (99%) actions and 29.6 (99%) objects correctly.

Experiment 6: Verb Production on the Basis of Line Drawings and Actions

Introduction and Methods

From the clinical investigations it was known that LEW's verb production on the basis of action pictures was as impaired as his noun production. The following experiment aimed to test directly the hypothesis that LEW's ability to produce verbs is a function of the type of input; that he is good at producing verbs when the input is an action of the experimenter and poor when the input is a picture.

Sixty verbs that were both picturable and feasible for the experimenter to act out were chosen. Forty were transitive actions such as *shoot, sew, stir,* and *hammer* that are carried out with an instrument, and 20 were intransitive actions such as *kneel, stand, smile,* and *wave* that are carried out by the body alone including those carried out with the limbs and the face (Rothi, Raymer, & Heilman, 1997). The 60 verbs were divided into three groups and the pictures of actions and the actions themselves were presented to the patient for naming in three testing sessions employing a latin-square design. No verb occurred twice in any one session. The experimenter interacted with objects (e.g., *flower, spoon, teddy bear, broom, gun,* and *razor*) when it was necessary to demonstrate an action (e.g., a *flower* was used to demonstrate *smelling*).

Results and Conclusions

LEW produced 12 (20%) verbs (the names of 5 transitive and 7 intransitive actions) when the stimuli were pictures and 49 (81%) verbs (30 transitive and 19 intransitive) when the stimuli were actions of the experimenter; significantly more (McNemar test, $p < .001$). His ability to produce verbs on the basis of pictures is no better than his ability to produce names of objects. When, however, the stimuli are the actions of the experimenter, his performance improves strikingly. Improving the quality of the input (from pictures to real objects and from pictures to actions) made no difference for noun production (see study with photographs and real objects in clinical investigations and Experiment 5), but made a significant difference for verb production. It indicates that better performance on action naming is not merely due to the fact that actions are more salient stimuli than pictures. Actions would appear to be not just ''better,'' but qualitatively different kind of input to pictures.

TABLE 6
Percentages of Correct Actions Given Different Stimuli LEW Performed (Experiment 7)

Pictures	Spoken words	Actions	Written words
80	90	93	30

Experiment 7: The Recognition of Action Pictures and the Comprehension of Spoken and Written Verbs

Introduction and Methods

In order to demonstrate that LEW's inability to name pictures of verbs does not arise just because he cannot identify the pictures, we presented him with a task that did not require a naming response but imitation. The same 60 pictures used in the previous experiment were divided into four parts. The experiment was carried out over four testing sessions employing a latin-square design. LEW was asked to imitate the actions in the pictures, the actions of the experimenter, and to carry out the actions designated by the written and spoken words. He had about 10–15 objects (e.g., *broom, book, soap, spoon,* and *flower*) in front of him in order to carry out the actions.

Results and Conclusions

The number of correct actions performed by LEW on the basis of pictures, spoken and written words, and actions is shown in Table 6. LEW could indeed imitate the actions with the help of the objects provided (he had difficulties in miming actions carried out by facial expressions such as crying, blowing, and smiling), demonstrating relatively good understanding of the action pictures. Although his performance was somewhat better following spoken words and in imitating the experimenter's actions, the critical comparison between producing actions on the basis of pictures and of spoken words was not significant ($\chi^2 = 1.2$, n.s.).[3]

From these results we may conclude that LEW's poor naming of pictures of actions is not due to a difficulty in recognizing these pictures or understanding their significance. This finding is important for evaluating the findings of the previous experiment, that LEW is far better naming actions than naming pictures of actions.

Experiment 8: A Verb Production Experiment in Which the Patient Gestures an Action Depicted and Names His Own Action

Introduction and Methods

This experiment was devised to explore further the finding that the actions of the experimenter are especially good at eliciting a verbal response from LEW. It is still possible, despite

[3] His performance is, however, very much poorer when the stimulus is written-word. He has clearly a problem in comprehending written verbs. In this modality he also made semantic errors. This is in contrast to his ability to comprehend written nouns (see Experiment 3).

TABLE 7
Number of Names and Gestures LEW Produced in the Three Stages of the Experiment (Experiment 8)

Stage I (naming pictures)	Stage II (gesturing)	Stage III (naming after gesturing)	
$n = 50$	$n = 39$	Correct gestures, $n = 22$	Ambiguous gestures, $n = 8$
Correct named, $n = 11$	Acted out well, $n = 22$	Named, $n = 20$	Semantically related name, $n = 7$
Semantically related name, $n = 3$	Semantically related or ambiguous gesture, $n = 8$	Not named, $n = 2$	Not named, $n = 1$

the argument to the contrary presented on the basis of previous experiments, that actions, being vivid and continuous in time, are generally more salient as visual input than the other stimulus categories used and are not *qualitatively* different from them. LEW therefore was presented singly with 50 pictures of actions and first was asked to name them. Second, if he could not name a picture he was asked to act it out with the help of a variety of objects (e.g., *flower, spoon, pen,* and *knitting needles*) in front of him and then, third, to name his own action. By acting himself, we eliminated the visual aspect involved in perceiving the actions of the experimenter in order to observe the effects of actions alone on LEW's ability to name.

Results and Conclusions

The number of actions (gestures) and verbs produced are summarized in Table 7. Initially LEW named only 11 pictures but he correctly acted out 22 of the rest and he then named most of these correctly. While seeing a picture only occasionally (11/50 times; 22%) led to his producing the appropriate verb, acting it out almost always led to his producing a correct verb (20/22 times; 90%). There were only two items (*feed*, *knit*) that were acted out well, but not named. A further finding of this experiment is that only unambiguous acts were useful triggers for LEW to produce the verb; he could not name any of the actions that he did not carry out well. For the eight items for which he could only provide ambiguous gestures, he produced no names. This finding emphasizes the key role of the semantic representation of actions as inputs for verb production.

Experiment 9: A Verb Production Experiment on the Basis of Actions Performed on the Patient's Own Body

Introduction and Methods

The purpose of the experiment, similar to the previous one, was to establish that LEW's better naming performance given perceived actions than given pictures is not due to actions being more visually salient inputs than pictures. In the previous experiment LEW produced the actions and, following his own actions (providing a primarily kinaesthetic input rather than a visual one), he named far more verbs than he did when given pictures, indicating that actions provided a *different* channel of input to the naming system that is relatively unimpaired for LEW. In the present experiment we wanted to test another input channel: actions such as *comb, scratch, pinch, pull,* and *brush* were performed by his wife on LEW (with his consent) while his eyes were closed and he was asked to name the action.

Results and Conclusion

LEW produced 20/20 correct verbs. A comparison with his poor naming of objects from touch (in the clinical investigations) shows that the kinaesthetic input was not the critical factor for the excellent results here. Rather, these results support the findings of the previous experiments of relatively intact naming from semantic representation of actions. LEW's performance is (almost) equally good when he is naming seen actions, actions carried out by him, or actions felt on his body.

Experiment 10: An Object Naming Task on the Basis of Actions Carried Out with Objects

Introduction and Methods

It is possible that seeing actions could improve LEW's naming performance for nouns as well as for verbs. The aim of this experiment was to investigate this possibility. LEW watched the actions of the experimenter (using real and toy objects), then heard the corresponding verb and the preposition if required (e.g., *hug, pour, cut, sit on, write with,* and *drink from*) and was asked to produce the name of the object used—an instrument, a container, or the object acted upon (e.g., *a toy gun, a chair, a doll, a pencil*). In a somewhat similar experiment with a patient who is analogous to LEW in some respects, Zingeser and Berndt (1988) found that a sentence frame (i.e., the verb) facilitated the production of a noun only if it was highly probable in that environment. The syntactic frame as such was not sufficient for activating a noun that was not semantically probable. We knew from a preliminary investigation using the materials of Bloom and Fischler (1980) that LEW, too, was good at sentence completion when the missing word was predictable (82/100 correct completions). It was important, therefore, to distinguish between objects that were predictable and unpredictable in the environment of the verb. For example, *hugging* was presented with both a *teddy bear* and a *jacket; cutting* with *hair* and a *leaf; shooting* with a *gun* and a *hammer,* and *writing with* with a *pencil* and *paintbrush.* LEW was expected to be good at producing predictable complements to verbs, but we were interested in his performance on the unusual complements.

In the experiment there were 19 transitive verbs that required a direct object and 18 prepositional verbs that required an indirect object as a complement. The experiment was presented over three sessions. In the first session LEW was presented with the transitive verbs with predictable objects and the prepositional verbs with unusual objects and in the second session with the prepositional verbs with predictable objects and the transitive verbs with unusual objects. In a third session, he was presented for naming with the objects employed in the earlier sessions. Forty-eight objects were employed, some of which were used more than once.

Results and Conclusions

The numbers of correct noun complements and nouns in isolation produced by LEW are shown in Table 8. While no difference was found between the production of complements to transitive and prepositional verbs ($\chi^2 = 0.2$; n.s), there were reliable differences between probable and improbable

TABLE 8
Number of Object Names LEW Produced in Conjunction with Actions of the Experimenter and Heard Verbs and in an Object-Naming Task (Experiment 10)

Transitive verbs (probable complement)	Transitive verbs (improbable complement)	Prepositional verbs (probable complement)	Prepositional verbs (improbable complement)	Object naming
12/19 (63%)	6/19 (32%)	12/18 (67%)	7/18 (39%)	15/48 (31%)[a]

[a] Some objects were used more than once in other parts of the experiment.

complements ($\chi^2 = 6.54$; $p < .01$). Improbable complements were produced at approximately the same rate as the names of objects in the object-naming task (31%).[4] Only the production of highly probable complements were facilitated by the action of the experimenter and/or the sentence frame provided. Unusual complements were not often produced. In fact, LEW often substituted a probable complement for an improbable one. For example, LEW produced *spoon* when the experimenter stirred the coffee with a pencil. At times LEW expressed his surprise at the anomaly; nevertheless, he could not often correct himself. For example, when the experimenter knocked a nail with a shoe, LEW said *knocking a nail with . . . hammer . . . you are knocking with something else.*

These results demonstrate that actions as such do not facilitate the production of object names. The facilitation of the probable object names was due either to the sentence frame provided or to the strong association between certain verbs and their complement.

A Summary of the Verb Experiments

In Experiments 5–10 LEW's action-verb production was explored. We found that while LEW was no better at producing verbs than nouns when

[4] LEW's production of object names in this experiment (31%) is somewhat higher than in previous ones (11 and 23%; 16 and 13% in clinical investigations; 26% in Experiment 1; 17% in Experiment 4). The first study in clinical investigations shows that LEW's naming is affected by frequency. In Experiment 5, for example, where the object names were matched for frequency with the verbal labels of actions, his performance was also higher than usual (36%). This list contains many high-frequency nouns (nine items higher than 100 per million and only five items had a frequency of less than 20 per million) as simple action verbs tend to be of relatively high frequency.

In the present experiment, the list contained a higher proportion of medium- and high-frequency items than in other lists: 13 (27%) low-frequency (less than 20 per million), 22 (46%) medium-frequency (between 20 to 99 per million) and 13 (27%) high-frequency (more then 100 per million) items. For comparison, the list used in the clinical investigations and in Experiment 1 contained an equal number (20) of high-, medium-, and low-frequency items. LEW named one (7.7%) low-frequency item, five (22.7%) medium-frequency items, and eight (61.5%) high-frequency items. We think that a combination of the frequency effect and some fluctuation in his performance level may account for the relatively high object naming performance in this experiment.

the stimuli were pictures, he was strikingly better when the stimuli were the experimenter's or his own actions. We established that LEW had little difficulty in recognizing the action pictures. It appears that actions are not just better but different kind of input to pictures.

GENERAL DISCUSSION

To summarize, the following empirical generalizations can be made about LEW's abilities to name objects and actions.

(1) LEW has a naming deficit that is much more severe when the modality of the input is visual or tactile. His performance improves greatly when the stimuli are auditory verbal definitions (see ''Clinical Investigation'' and ''Experiment 1'').

(2) In naming objects from visual presentation, his performance does not depend on the quality of the stimulus: he is equally poor at naming line drawings, photographs, and objects (see ''Clinical Investigation'').

(3) In naming pictures, he makes both semantic and perseverative errors, but his most frequent error type is the omission. He can, frequently, produce the name of an object that initially was unavailable to him following his own verbal semantic cueing.

(4) LEW's performance in naming actions is similar to naming objects when the inputs are pictures (or objects); when, however, the inputs are the actions of the experimenter, or his own, or his body is acted upon he is much better at producing the appropriate verbs (see Experiments 6, 8, and 9).

(5) Finally, LEW can access full semantic representations from visual input. His understanding of pictures that he cannot name is very good (see Experiments 3 and 4 that elicited functional and associative knowledge about fruits, vegetables, animals, and household objects).

LEW's pattern of performance is discussed from the perspective of the debate of unitary vs multiple semantics by analogy with discussions referred to in the Introduction that have taken place over optic aphasia, despite the fact that LEW is not a prototypical optic aphasic in whom, while visual naming is impaired, tactile naming and naming to definition are both intact. His tactile naming is no better than his visual naming and his naming to definition is not perfect, even though it is strikingly better than his visual naming. Levelt's speech production model is also considered as another theoretical framework that could accommodate LEW's modality-specific naming deficit.

There are two possible reasons on a single semantic system approach why naming from definition might be better than naming from visual confrontation. The first is that the definition stimulus might provide additional nonsemantic cues to the name so that the accessing of representations in the phonological output lexicon is facilitated. The second is that there may be an additional visual agnosic difficulty which leads to an extra handicap in the accessing of a full semantic representation from visual input.

Consider the first of the two possibilities. The only plausible way that input to the phonological output lexicon other than that from semantic representation may help produce LEW’s better performance in the naming-from-description task is through nonsemantic associations between words in the definition and the target word. Experiment 1 showed, however, that the presence or absence of such words in the definition did not alter the rate of production of target words. Thus the use of nonsemantic associations did not appear to be a factor in the naming-from-definition advantage.

Consider the second potential reason, namely the possibility of an additional visual agnosic deficit which indeed parallels a critique of optic aphasia proper (Riddoch & Humphreys, 1987; Hillis & Caramazza, 1995). JB (Riddoch & Humphreys, 1987), who had a selective naming deficit from the visual modality, was also impaired in accessing semantic knowledge from vision. While he was able to answer general questions about pictures and spoken names of animals, birds, insects, fruits, and vegetables (visual: 92.25% and verbal: 97.89%), his performance was significantly poorer when asked specific questions about the same categories in the visual modality (visual: 62.32% and verbal: 76.06%). Similarly, DHY’s (Hillis & Caramazza, 1995) naming performance was good when the input was verbal or tactile but she made semantic errors in naming visually presented stimuli. Hillis and Caramazza also showed that while in the easier semantic tasks in the visual modality DHY performed well, in the more demanding ones she did not. JB and DHY are patients who, on the surface, present with modality-specific naming deficits without associated semantic access problems. Only more careful testing was able to demonstrate that they had semantic access problems, and so the apparent modality-specific naming deficit could be traced back to a modality-specific semantic access deficit. In order to explore whether a similar possibility might be the source of LEW’s naming deficit too, his ability to access semantics was examined in three experiments.

In Experiment 2 we used the Pyramids and Palm Trees test and presented it in a number of modalities. LEW’s performance was below the norm, but an average of 85% correct responses is entirely in accordance with his IQ. What is striking, however, is that the results were almost exactly the same irrespective of the modality of input, with visual presentation being at the same level as for verbal presentation. Experiment 3 involved testing his comprehension of material presented in visual and verbal (spoken) modalities. LEW was asked multiple-choice questions that related to the perceptual, associative, and functional features of fruits, vegetables, and animals. Overall he demonstrated very good and detailed knowledge of these categories from pictures. Any gaps in his knowledge (about fruits and vegetables) were similar to those that exist in his wife’s knowledge, with the same errors occurring in the visual and in the verbal (spoken) modality at different testing sessions, which is to be expected given a genuine lack of information. Finally, there was no relationship between the accuracy of LEW’s replies to questions and his ability to name the object.

Possibly a very subtle semantic access deficit from vision could be overcome by facilitating the retrieval of a sequence of information about different aspects of the stimulus by asking a series of knowledge questions about the pictures. Such an explanation, however, would not account for the results in the Pyramids and Palm Trees test, which (in the three pictures form of presentation) is a nonverbal test. In the house experiment (Experiment 4), set up to further investigate this possibility, the experimenter did not speak, all instructions being given prior to the presentation of the test items. LEW had to give the natural location of an object, its use and its size. He almost always managed to point to the exact location of the object within the house and gave an approximation of its size at the same level of accuracy with visual as with auditory verbal input. Yet despite his being able to demonstrate *nonverbally* his knowledge of the household objects in the experiment, he could only name 17%. This is exactly in the range of his baseline naming with household objects (Clinical Investigations), indicating that no facilitation took place from the extensive tapping of his knowledge. Thus there is no support for the possibility that the different pattern of naming from the two modalities arises because of a subtle deficit in semantic access from vision. LEW appears to differ critically from JB and DHY in manifesting detailed and accurate knowledge of various categories irrespective of the modality of the input. While JB's and DHY's visual naming deficits could be accounted for by modality-specific semantic access problems and, therefore, their symptom patterns do not necessitate assuming the existence of multiple semantics, LEW's impairment cannot be so interpreted. His visual naming deficit cannot be effectively located on a model consisting a single unitary semantic system.

Instead of considering the nature of his impairment in terms of whether the addition of hypothetical deficits could produce the pattern of result, it is useful, therefore, to consider LEW's pattern of performance within the context of theories of word retrieval which involve a stage of accessing entries in a semantic lexicon (e.g., Butterworth, 1989; Levelt, 1989). Using the terminology of Kempen and Huijbers (1983), this is the stage of ''lemma selection''; a stage in which the semantics and the grammar of words is being accessed prior to their form—lexemes, or the entries in the phonological output lexicon of neuropsychological models (e.g., Patterson & Shewell, 1987).

In Levelt's (1989) approach, lemma selection is a key subprocess undertaken by the *Formulator* which takes the *preverbal message* produced by the *Conceptualizer*, a highly open-ended system involving ''quite heterogeneous aspects of the speaker as an acting person'' (p. 9). Most theorists presume that conceptual representations are not simply mappable one-to-one onto lemmas (but see Roelofs, 1997); thus the process of accessing lemmas is necessarily a complex one. Bierwisch and Schreuder (1992) call it the ''verbalization function.'' To deal with this complexity, Levelt's approach distinguishes between a general message level (the Conceptualizer) and a language-specific message level (the preverbal message). In speech production, representations of the Conceptualizer are transformed into a form (of the preverbal message) that is acceptable to the Formulator and to the process of lemma selection. According to Levelt, the preverbal message is guided by a number of principles to ensure successful lemma selection, namely the *uniqueness principle* (no two lexical items have the same core meanings); the *core principle* (a lexical item is retrieved only if its core condition is satisfied by the concept to be expressed); and, most critically, the *principle of specificity* (it is the most specific item satisfying the core principle that generally should be retrieved; one tends to say *dog,* not *animal,* when referring to dogs). Levelt's principles need to be extended further to cover how multiple lemmas are selected in an utterance. These additional constraints and principles are to be found in Appendix 2. We term the system so constrained the ''restricted preverbal message.''

We adopt the view that the restricted preverbal message is related to the neuropsychological concept of verbal semantics (Warrington, 1975; Beauvois, 1982; Shallice, 1987, 1988). It may be possible to view it, in some sense, as a ''privileged'' aspect of a unitary space, analogous to Caramazza et al.'s (1990) approach to vision-to-action relations. However, such an approach would require a theoretical articulation to make it plausible. It follows from our view that some semantic representations are more simply transformed onto the appropriate restricted preverbal message than others. In particular, we argue that LEW's naming problems arise when the semantic representations accessed are different from those required by the restricted preverbal message.

Consider the aspects of his difficulties dealt with in the first and second part of the experimental investigations. First, consider naming from definitions as contrasted with naming from visual confrontation. The unitary semantics position cannot explain the discrepancies in LEW's performance without assuming additional visual or semantic access deficits. No such deficits were found despite careful probing. On the multiple semantic systems approach, the initial semantic representation obtained from objects—discussed in much more detail in Lauro-Grotto et al. (1997) and appropriate for a variety of operations related to actions and judgement of proximity among other semantic operations—would, however, require further transformations for it to be in the appropriate restricted preverbal message form, and it is this transformation that is presumed to be damaged in LEW. By contrast, one can argue that the representations required in the restricted preverbal message are *identical* with those produced by the verbal definitions for the speech comprehension system; indeed, Levelt's (1989) speech production model, the ''blueprint for the speaker,'' presupposes that lemmas are accessible from both the Formulator and the speech comprehension system. By way of illustration, consider the definition *A large heavy device fixed to a carriage used in olden times in international conflict.* This definition contains information on a variety of Schematic roles which would frequently be relevant when *cannon* has to be produced. ACTIONS and CAUSES (*injury, international conflict*), SPATIAL DEIXIS (*at a distance*), and TEMPORAL DEIXIS (*in the olden times*) are given in the definition as well as the critical aspects of the THING itself (*large heavy device fixed to a carriage*), which are also represented in the picture. The picture, however, in addition contains many aspects that are irrelevant to its naming such as its toy-like appearance in the Snodgrass and Vanderwart version. Thus the verbal description gives information more directly relevant for the restricted preverbal message and contains less irrelevant information.

Second, consider the case of actions. In a series of experiments (Experiments 6, 8, and 9) we have shown that while LEW could not name pictures of actions or read written verbs, naming actions in different input modalities (visual, motor, and kinesthetic) was well preserved. In Experiment 7 we demonstrated that the failure was not due to an inability to recognize the pictures and in Experiment 8 that the good performance was not due to actions being visually more vivid and salient than pictures. As far as we know, a dissociation between naming pictures of actions and actions themselves has not been reported previously, although there is some evidence that optic aphasic patients might be better at verb then noun production. AR (Campbell & Manning, 1996), for example, was considerably better at naming depicted actions than objects. It is possible that some optic aphasic patients, unlike LEW, are able to transform visual (semantic) representations onto action (semantic) representations to facilitate naming.

If we accept the evidence that the dissociation occurs at a postsemantic level and assume a unitary semantics position, the observations observed in LEW cannot be accounted for. Within the multiple semantic systems approach, however, one can assume that the recognition and production of actions uses a separable part of the semantic system—possibly corresponding to the systems involved in semantic memory for actions postulated to account of ideational apraxia (De Renzi & Lucchelli, 1988; Rothi, Ochipa, & Heilman, 1991).

The pattern of performance exhibited by LEW therefore fits with the theoretical position of multiple semantics in neuropsychology and with a theoretical argument developed from Levelt's (1989) approach to speech production. We postulate that certain types of semantic representations—those obtained from definitions—satisfy the conditions for the restricted preverbal message necessary to drive lemma selection, but others—those obtained from semantic representations accessed from structural descriptions of objects and from actions require some form of transformation. While LEW's lesion would not affect the link between the semantic representation of actions and the preverbal message in that the system is still able to carry out the necessary transformations, this is not so for the semantic representation of visual inputs. LEW, we propose, has deficits in making this type of transformation of representations within the semantic system and hence has the observed problem in naming pictures.

APPENDIX 1

Knowledge Questions about Fruits and Vegetables

1. Is it a fruit or a vegetable?
2. Does it grow in England or only abroad?
3. Is it common or rare?
4. Does it grow on a tree, under ground, on the ground, or on a small plant?
5. Do you eat it raw or do you have to cook it?
6. Do you have to peel it or can you eat it unpeeled?
7. Does it have a stone, pips, or seeds?
8. Does it have a lot of juice?
9. Is it bigger or smaller than an egg?
10. Is it sweet or tangy?
11. What is it?

Knowledge Questions about Animals

1. What kind of thing is it?
2. Where is it native? Europe, Asia, Africa, Australia?
3. Does it live on land, air, or in water?
4. Does it climb trees?
5. Does it swim, jump, crawl, or fly?
6. Does it lay eggs?
7. Is its body smooth, hairy, furry, or covered with scales or feathers?
8. Is it wild or domesticated?
9. What does it eat? Fruit, grass, fish, meat, cheese, insects?
10. Is it fast or slow?
11. Can we eat it or use it in any way?
12. Is it solitary or found in groups?
13. What is its size? (He was given a meter to show approximate size or was offered the following alternatives: height smaller or bigger than a cup, wastepaper basket, radiator, door); width smaller or bigger than a cup, ruler, desk, room.

APPENDIX 2

Levelt’s principles do need to be extended further to cover how a number of lemmas are selected in an utterance. First, there are many things one might want to say at a given time. One needs to select the most critical part of what it would be useful to convey and can be produced in a single utterance. One needs to optimize the sentence topic (Reinhart, 1982). We call this the *principle of utterance optimization.* It might be thought that this is merely a matter of reading out the contents of working memory. However, this can hardly be the case. Thus from the capacity of ''Corsi'' nonverbal span (De Renzi, Faglioni, & Previdi, 1977) it is clear that one can hold roughly six spatial positions in the visuospatial sketchpad. Information on six *precise* spatial positions and their spatial relation to each other are not producable in a single utterance.

Second, one maps the preverbal message onto the utterances using what we will call the *principle of single-coverage constraint.* The process of conceptual dissection (Bierwisch & Schreuder, 1992) by which one maps an appropriate part of a total meaning complex onto an individual lemma needs to be extended to multiple lemmas in an internally consistent fashion. Meyer (1996) has shown that with sentences of the form *the arrow is next to the hay* the lemmas for the two nouns are both selected before the subject begins to speak. Thus the process of multiple lemma selection needs to be done quickly. Yet it has to be done without repeating or omitting elements of the overall meaning. Thus one says after *because of the road conditions* something like *we were forced to drive slowly* or *the car could do nothing but crawl along* rather than *our car was forced to do nothing but crawl along slowly.*

Mapping the preverbal message onto the utterance is not unique in following such a principle. Perception, for instance obeys a stronger version. Thus in Marr's (1982) terminology, the mapping from the primal sketch to the 3D structural description has somewhat similar characteristics: one part of the display is put into correspondence with the representation of a single specific object only; that this is not automatic can be seen in its failure in rare errors (''migration errors'') in normal subjects which can, however, be frequent in patterned masked displays (Mozer, 1983) or in patients (Shallice & Warrington, 1977). It requires a mechanism, as does the language analog. However, other areas of cognition do not respect it. For instance, if an object is flying toward one, one will duck, turn one's head away, and move one's hand up to protect the head all at the same time. What is critical is that one does not have to chose just one of them.

Third, the *principle of utterance optimization* has to be applied under an even more complex constraint than the *single-coverage constraint*, namely the *complete argument constraint.* Any lexical item selected which has arguments must have these obligatory arguments fully specified in the rest of the utterance.

The theoretical hypothesis that is advocated in this article is that those six principles produce severe computational constraints on the form taken by the preverbal message which is unpacked by the Formulator. It seems most natural to have a recursive process where each lemma selected leads to compartmentalization of the message space with complex internal checking occurring after each selection to see whether the second and third multiple-lemma principles apply. For the necessary complex operations to work effectively one would appear to need the preverbal message formulated in a fairly small representational space by comparison with that available at the semantic level in the whole cognitive system. We call it the ''restricted preverbal message.'' This representation relates to that of verbal semantics.

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