

## Neuropsychological evidence for “word-meaning deafness” in a Spanish-speaking patient

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### Abstract

In this paper we present a case of “word-meaning deafness,” characterised by serious problems in the comprehension of spoken language, whilst repetition and writing words and non-words from dictation are preserved. This performance indicates the impossibility of correctly accessing phonological representation from the semantic representation of words. Neuropsychological evidence on specific alterations in word-meaning disorders is scarce, and this study contributes new findings with a Spanish-speaking patient. The nature of the processes involved in understanding language and the cerebral mechanisms that might be affected in each case were discussed, in accordance with current neuropsychological theories.

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### 1. Introduction

Cognitive neuropsychological models of the comprehension of spoken language define three distinct sub-processes: first, the sound wave is phonemically categorised through perceptual analysis; next, this representation is identified as a word by means of lexical representation; finally, once the words have been recognised, their semantic representation is accessed (see, e.g. Coltheart, 1987; Ellis & Young, 1988; Patterson & Shewell, 1987). Such models have been based chiefly on the study of subjects with specific cerebral injuries involving alterations in the different sub-processes related to the language parameters identified above (see, for example Hart, Berndt, & Caramazza, 1985; Martín, Serrano, & Iglesias, 1999; McCarthy & Warrington, 1984).

Researchers have identified different impairments to the initial sub-processes of spoken language comprehension,

that is, those processes related to auditory analysis, to lexical analysis, or to the connection between the two. Examples of such impairments are “pure word-deafness,” which consists in a loss of the ability to discriminate the sounds making up the linguistic message (Vignolo, 1978), more specifically, an impaired verbal comprehension sparing discrimination and recognition of non-verbal sounds with fairly well-preserved spontaneous speech, reading comprehension and writing (Shivashankar, Shashikala, Nagaraja, Jayakumar, & Ratnavally, 2001). Also, “phonological agnosia,” characterised by an inability to recognise the sounds of known words (Beauvois, Derosne, & Bastard, 1980).

Impairments have also been identified, in a smaller number of cases, in the more central sub-processes of language comprehension. These impairments would result from a presumptive interruption of the path of information from phonological lexical representation (*input*) to semantic representation. At the end of the 19th century, Branwell (1897) presented, under the designation of “word-meaning deafness,” the case of a patient with serious difficulties for

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understanding spoken language, but whose ability to repeat and write dictated words remained intact. Unlike pure-word deafness, in this case the repetition of words is preserved and writing from dictation may also be maintained. Since this pioneering description, documented cases of this specific disorder have been scarce (Goldstein, 1915; Henschen, 1919; Kleist, 1934; Liepmann, 1915; Luria, 1976, 1980; Symonds, 1953; Yamadori & Albert, 1973).

Kohn and Friedman (1986) have proposed that the differential assessment of “word-meaning deafness” requires that the phonological analysis is preserved, as evidenced by correct repetition; and, additionally, that semantic representation remains intact and is accessible by another route (see Fig. 1). There is no general consensus on whether writing words to dictation is essential for characterising the syndrome (Allport & Funnell, 1981; Ellis, 1984). In this regard, Kohn and Friedman (1986) point out that writing is not a determinant characteristic of word-meaning deafness, but it has implications for the exact source of the disorder. Impairments in the ability to write from dictation reflect an interruption between phonological analysis and phonological lexical representation (point ‘a’ in Fig. 1). However, orthographic production is possible if interruption occurs between phonological representation and semantic representation (point ‘b’ in Fig. 1).

In this study we describe the case of a patient who, as a result of a cerebro-vascular accident (CVA), presented the characteristic features of “word-meaning deafness,” that is, a serious impairment of oral and written language comprehension and an intact ability to repeat and write words to dictation.

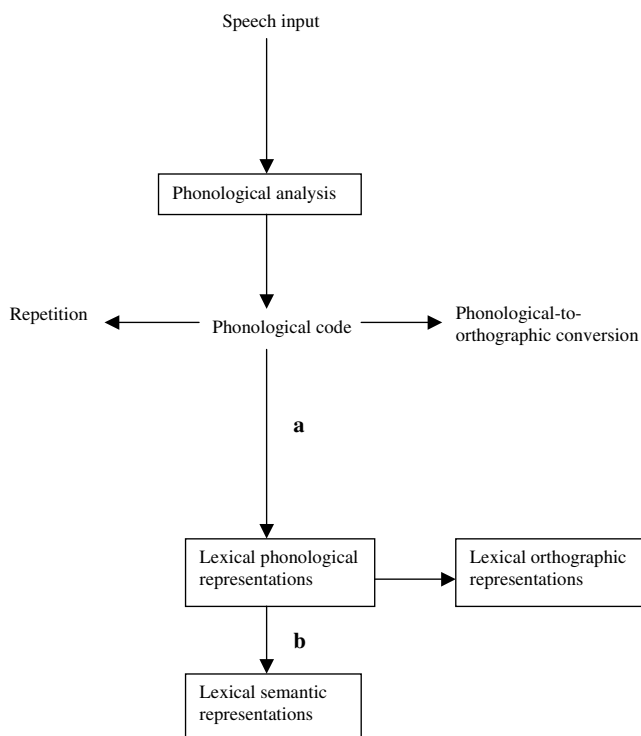


Fig. 1. Model proposed by Kohn and Friedman (1986) to explain word-meaning deafness.

## 2. Case report

GGM is a 73-year-old woman, right-handed, and with elementary education, who suffered a CVA of the left middle cerebral artery. The CT scan showed a hypodense left temporo-parietal infarct with a slight mass effect as the left ventricular atrium had collapsed. There is also discrete cortico-subcortical atrophy (see Fig. 2).

## 3. Basic neuropsychological assessment

The neuropsychological assessment was carried out one year after the CVA, in four sessions, each of approximately one hour's duration. Performance IQ assessed with the WAIS (Wechsler, 1955), was normal to low (IP=85); verbal IQ was unable to be assessed due to the patient's difficulties in understanding language. Visual memory, assessed by means of visual reproduction tests I and II of the revised Wechsler clinical memory scale (Wechsler, 1945) and Benton's visual retention test (Benton, 1963), was found to be normal. It was impossible to assess verbal memory. Verbal memory could not be assessed due to the patient's verbal comprehension difficulties. The recognition of natural sounds was also assessed by means of a test created specially which consisted in a series of 20 sounds (e.g., telephone, waves, a baby crying, plates breaking, etc.). The subject correctly identified 100% of the sounds presented. The praxis tests of the Luria–Christensen Battery (Christensen, 1987) indicated correct execution in ideomotor and ideative praxis and difficulties in constructional praxis in three dimensions.

The language assessment, made using the Spanish translation of the BDAE (Goodglass & Kaplan, 1972), demonstrated fluent spontaneous speech without articulatory difficulties and with normal syntactic construction. Repetition of words and phrases was also relatively correct (percentiles 70 and 60, respectively), as was naming to visual confrontation (percentile 60). In contrast, auditory comprehension was found to be highly impaired, and the patient failed to surpass percentile 10 in any of the tests. Finally, copying and writing to dictation presented acceptable levels (percentile 70), but reading aloud was found to be totally impaired (word reading and sentences reading, percentile 0).

## 4. Cognitive assessment of language

In view of the fact that the patient's language problems were considerable with regard to auditory analysis, we proceeded to an in-depth assessment of the sub-processes and components involved. This assessment was carried out over four weeks, in a total of eight sessions, each of approximately one hour's duration.

### 4.1. Phonological analysis

#### 4.1.1. Repetition

First of all, the patient was asked to repeat 20 words of average frequency of use and of varying length (four of one



Fig. 2. CT scan of the patient CGM showing a hypodense left parieto-occipital infarct.

syllable, four of two syllables, four of three syllables, four of four syllables and four of five syllables). GGM completed this task correctly (100% of correct answers). Secondly, she was asked to repeat 20 non-words, also of varying length. This test was performed with 80% of correct answers (16). The difficulties in this case did not appear to depend on the length of the non-word, since errors were distributed as follows: two with non-words of two syllables, one with a three-syllable non-word, and one with a five-syllable non-word (see Table 1, A).

The difference in performance between the repetition tasks with words and non-words was statistically significant, according to the difference of proportions test ( $Z=2.22$ ,  $p<.05$ ). GGM performed the lexical phonological analysis correctly, but presented slight difficulties on carrying out auditory-phonological conversion in the case of non-words. In all probability, the auditory comprehension problems have a residual effect on repetition. The mistakes made were changes in one of the phonemes, preserving the general structure of the non-word (see Table 1). This could be due to a slight difficulty in the autistic discrimination of some phonemes.

#### 4.2. Auditory-graphemic analysis

##### 4.2.1. Writing to dictation

GGM was asked to write 20 words and 20 non-words (those that had been used in the repetition task) to dictation. The patient completed the task with 100% of correct answers in the case of the words, and with 85% of correct answers (17), in the case of the non-words (see Table 1, B). This difference is not statistically significant, according to the difference of proportions test.

Table 1

List of words and non-words used in repetition and dictation tasks, and erroneous answers observed

| Words                   | Non-words | Erroneous answers in repetition (A) | Erroneous answer in dictation (B) |
|-------------------------|-----------|-------------------------------------|-----------------------------------|
| Mano (hand)             | Deji      | Diji                                |                                   |
| Azul (blue)             | Mopu      | Macu                                |                                   |
| Gato (cat)              | Sute      |                                     |                                   |
| Bata (coat)             | Cali      |                                     |                                   |
| Libro (book)            | Tour      |                                     |                                   |
| Puma (puma)             | Proen     |                                     |                                   |
| Domino (domino)         | Pituvo    |                                     |                                   |
| Próximo (next)          | Calire    | Calemi                              | Calide                            |
| Sereno (calm)           | Consuto   |                                     |                                   |
| Camino (road)           | Aboli     |                                     |                                   |
| Garage (garage)         | Tricose   |                                     |                                   |
| Natillas (custard)      | Ambite    |                                     |                                   |
| Bolígrafo (pen)         | Pelete    |                                     |                                   |
| Cuaderno (notebook)     | Ostuvi    | Otube                               | Ortube                            |
| Anillo (ring)           | Osley     |                                     |                                   |
| Cajón (drawer)          | Cutipo    |                                     |                                   |
| Papelería (stationer's) | Pulade    |                                     |                                   |
| Tulipán (tulip)         | Coluro    |                                     | Conudo                            |
| Lapicero (pencil)       | Melusa    |                                     |                                   |
| Canario (canary)        | Tulisa    |                                     |                                   |

#### 5. Analysis of access to the semantic system (semantic representation)

##### 5.1. Comprehension of oral language

Auditory comprehension was tested by means of probe questions referring to personal matters or common objects

and with picture–word pairing tests. All of them were designed specifically for this case.

- (1) *Response to personal matters questions.* First, 10 questions referring to personal matters were prepared for oral presentation: “Where do you live?,” “How old are you?,” etc. The patient responded correctly to all of them.
- (2) *Response to common object question.* Next, 80 questions referring to objects were presented. Yes or no answers were required (e.g., Is a harmonica a musical instrument?, Is a lion a domestic animal?). The patient responded incorrectly to all of the questions, either repeating the question or indicating that she did not understand it.
- (3) *Picture–word pairing.* This task consisted of indicating, from three semantically-related pictures (e.g., a reel of cotton, a needle, and a thimble), which one corresponded to the word spoken by the examiner. Total number of items in this test was 52. The patient completed the test with 70% correct answers (36), a result that falls below that attained by a control group made up of 20 subjects of similar age ( $M = 64.5$ ;  $SD = 9.5$ ; range 50–77) and educational characteristics as the patient (100% correct answers). Nevertheless, the patient’s performance was better than expected, given the auditory language comprehension deficiency she presented. This result appears to indicate, then, that the presence of the picture aided recognition of the word and permitted an acceptable level of performance. This would imply that the cognitive system of semantic analysis was intact, or at least not severely impaired.

### 5.2. Semantic tasks with non-linguistic material

Given that the patient presented serious difficulties in understanding oral language, the semantic tasks were given using pictorial material.

- (1) *Categorisation of pictures.* GGM was asked to categorise 125 cards, each with a picture, without clues as to the categorisation criteria. Given the comprehension impairments, instructions were given by means of examples devised by the examiner using pictures from several categories. The pictures were taken from the Snodgrass and Vanderwart (1980) naming test. GGM formed correctly the following groups: food, clothing, vases, furniture, kitchen utensils, means of transport, animals, personal use objects, and household appliances.
- (2) *Sub-categorisation of pictures.* The patient was asked to make the following distinctions: (a) wild animals vs tame animals, (b) kitchen utensils for use on the cooker vs kitchen utensils that cannot be used on the cooker, and (c) items of clothing that can be washed vs items of clothing that cannot be washed. GGM performed this task without any difficulty.

- (3) *Pyramid and Palm Test* (Howard & Orchard-Lisle, 1984). This test uses 52 sheets, plus 4 more as examples. Each sheet contains a *target* picture and two more pictures, only one of which is semantically related to the *target*, and which the subject must identify. GGM carried out the task with 83% of correct answers (43), a result similar to that obtained by the control group (80–85% of correct answers).

## 6. Discussion

GGM’s neuropsychological assessment shows severe alterations in auditory comprehension of language which does not occur in comprehension activities in which the material is presented visually. The maintenance of the capacity to recognise non-verbal sounds and to repeat words might suggest that the origin of the observed deficiencies were not due to agnosia. On the other hand, although the patient shows a severe reading deficiency, the execution does not fit entirely with a diagnosis of alexia without agraphia. The total inability to read was accompanied by clear difficulties in writing which was limited to isolated words.

The cognitive assessment revealed that GGM was capable of processing phonological information and recognising words, as demonstrated by the correct execution of the repetition and writing to dictation tasks. With regard to understanding oral language, an alteration was found in response to common object questions. The relative improvement observed in the personal matter question task may be due to the subject being involved in a rehabilitation program which precisely dealt with these type of questions.

The subject’s semantic system appears to function correctly, as shown by the results of the different categorisation tasks carried out. The major problems appeared in the tasks involving the use of the linguistic auditory channel, as demonstrated by the subject’s performance in oral comprehension and picture–spoken word pairing. This suggests that GGM may present impairment of lexico-semantic connections, and also that the semantic system is isolated from phonological linguistic representation.

Regarding the ability to write from dictation, in accordance with the model proposed by Kohn and Friedman (1986), we propose that, in this case, auditory information can contact phonological representations (see ‘a’ in Fig. 1), but not semantic representations (see ‘b’ in Fig. 1). Writing to dictation in Spanish might be phonological transcription (phoneme-grapheme correspondence) without comprehension, as opposed to other languages in which homophones are determined by different spellings. As a consequence, it seems that Spanish language might not be ideal for discriminating whether writing is possible through grapheme-phoneme conversion. Nevertheless, Kohn and Friedman (1986) point out that writing ability in word-meaning deafness implies a preserved access to correct representations in the phonological lexicon, and that this enables writing both



of regular and irregular words. Thus, we assumed that GGM carried out the task by means of the preserved connections between the subsystems of phonological analysis and of phonological representation, and between this and orthographic lexical representation. In such a case, the auditory information can be correctly represented phonologically, and can access orthographic representations.

Related to the nature of the deficits observed and the cerebral location of the lesion, it could be noted that word-meaning deafness bears more specific characteristics than pure-word deafness. These specific characteristics could explain why the latter is usually associated with bilateral injuries which affect secondary and tertiary areas of association, whereas the case we are presenting corresponds to a left parieto-occipital injury. Moreover, the location of GGM's cerebral injury is compatible with the proposals of recent models on the cerebral organisation of language. Specifically, Damasio (1992) refers that left temporo-parieto-occipital areas form an interconnecting system between linguistic analysis (lexical and phonological) and the system that modulates the individual's interaction with the environment (conceptual system). Along these same lines, Mesulam (1998) points out that left parieto-occipital areas would affect the functional networks that communicate Wernicke's and hetero-modal associative areas that provide meaning.

In sum, all of the symptoms observed fit the characteristics of "word-meaning deafness" as initially described by Branwell (1897). Deficiencies observed are compatible with a disconnection between semantic and phonological representation. Through the preserved connection between phonological analysis and phonological representation it would seem possible to address the orthographic representations of the word shown by CGG.

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### References

- Allport, A., & Funnell, E. (1981). Components of the mental lexicon. *Philosophical Transactions of the Royal Society of London*, B295, 397–410.
- Beauvois, M. F., Derosne, J., & Bastard, V. (1980). Auditory parallel to phonological alexia. In *Paper presented at the third european conference of the International Neuropsychological Society*. Chianciano, Italy.
- Benton, A. L. (1963). *The revised visual retention test*. New York: The Psychological Corporation.
- Branwell, B. (1897). Illustrative cases of aphasia. *The Lancet*, 1, 1256–1259.
- Christensen, A. (1987). *El diagnóstico neuropsicológico de Luria* (2nd ed.). Madrid: Aprendizaje Visor.
- Coltheart, M. (1987). Functional architecture of the language processing system. In M. Coltheart, G. Sartori, & R. Jobs (Eds.), *The cognitive neuropsychology of language* (pp. 1–23). London: LEA.
- Damasio, A. (1992). Aphasia. *New England Journal of Medicine*, 326, 531–539.
- Ellis, A. W. (1984). *Reading, writing and dyslexia. A cognitive analysis*. London: LEA.
- Ellis, A. W., & Young, A. W. (1988). *Human cognitive neuropsychology*. London: LEA.
- Goldstein, K. C. (1915). *Die transkortikale aphasien*. Jena: Gustav Fischer.
- Goodglass, H., & Kaplan, E. (1972). *The assessment of aphasia and related disorders*. Philadelphia: Lea and Febiger.
- Hart, D. C., Berndt, R. S., & Caramazza, A. (1985). Category specific naming deficit following cerebral infarction. *Nature*, 316, 439–440.
- Henschen, S. E. (1919). On the hearing sphere. *Acta Oto-Laryngologica*, 1, 433–484.
- Howard, D., & Orchard-Lisle, V. (1984). On the origin of semantic errors in naming: Evidence from a case of the global aphasic. *Cognitive Neuropsychology*, 1, 163–190.
- Kleist, K. (1934). *Gehirnpathologie*. Leipzig: Barth.
- Kohn, S. E., & Friedman, R. B. (1986). Word meaning deafness: a phonological-semantic dissociation. *Cognitive Neuropsychology*, 3, 291–308.
- Liepmann, M. (1915). Diseases of the brain. In C. W. Bart (Ed.), *Churchmann's textbook on nervous diseases* (Vol. 1). Philadelphia: Blakiston.
- Luria, A. R. (1976). *Basic problems in neurolinguistics*. The Hague: Morton.
- Luria, A. R. (1980). *Fundamentos de neurolingüística*. Barcelona: Masson.
- Martin, P., Serrano, J. M., & Iglesias, J. (1999). Phonological/semantic errors in two Spanish-speaking patients with anomia. *Aphasiology*, 13, 225–236.
- McCarthy, R., & Warrington, E. (1984). A two routes model of speaking production: Evidence from aphasia. *Brain*, 107, 463–485.
- Mesulam, M. M. (1998). From sensation to cognition. *Brain*, 121, 1013–1052.
- Patterson, K., & Shewell, C. (1987). Speak and spell: dissociations and word-class effects. In M. Coltheart, G. Sartori, & R. Job (Eds.), *The cognitive neuropsychology of language* (pp. 273–294). London: LEA.
- Shivashankar, N., Shashikala, H. R., Nagaraja, D., Jayakumar, P. N., & Ratnavally, E. (2001). Pure word deafness in two patients with subcortical lesions. *Clinical Neurology and Neurosurgery*, 103, 201–205.
- Snodgrass, J. G., & Vanderwart, M. (1980). A standardized set of 260 pictures: norms for name agreement, image agreement, familiarity and visual complexity. *Journal of Experimental Psychology: Human Learning and Memory*, 6, 174–211.
- Symonds, C. (1953). Aphasia. *Journal of Neurology, Neurosurgery and Psychiatry*, 16, 1–16.
- Vignolo, A. L. (1978). Afasia. In F. Denes & C. Umiltà (Eds.), *I due cervilli: Neuropsichologia dei processi cognitivi*. Bologna: Il Mulino.
- Wechsler, D. A. (1945). *Wechsler memory scale manual*. New York: Psychological Corporation.
- Wechsler, D. A. (1955). *Wechsler adult intelligent manual*. New York: Psychological Corporation.
- Yamadori, A., & Albert, M. L. (1973). Word category aphasia. *Cortex*, 9, 112–125.