

SYNTACTIC AND SEMANTIC ORGANIZATION IN WORD FORM RETRIEVAL?

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Many studies have reported that naming disorders may affect selectively certain semantic categories (animals vs. vegetables or artifacts, see Caramazza and Shelton, 1998, for a review) or syntactic categories (open vs. closed class items, Friederici and Schoenle, 1980, nouns vs. verbs, Baxter and Warrington, 1985; Caramazza and Hillis, 1991; Daniele et al., 1994; McCarthy and Warrington, 1985; Miceli et al., 1988) suggesting that the conceptual system and the output lexicon are organized along both syntactic and semantic dimensions. Most current models of speech production distinguish two components in the output lexicon: *lexical selection* and *word form retrieval*. Lexical selection consists in comparing the conceptual representation of the object to be named to the lexical entries, and selecting the best match. Conceivably, this level should be both sensitive to syntactic and semantic parameters. Word form retrieval involves recovering the phonological information associated to the selected entry which is then used to construct a *phonological plan* to be executed by the articulatory system. Prima facie, word form retrieval should not be influenced by syntactic, and even more, semantic variables.

However, Cohen et al. (1997) reported the case of a patient impaired in word form retrieval, as evidenced by a predominance of phonological paraphasias in naming and reading tasks, which totally spared names for numbers. The authors speculated that the topographical segregation of numbers in the conceptual system propagates along the speech production pathway, even down to word form retrieval. In this paper, we report the case of another aphasic patient who shows a word form retrieval impairment in production which surprisingly spares certain syntactic and semantic categories.

CASE REPORT

DPI was a 68-year-old right-handed retired medical doctor, tested one year after a temporo-occipital left ischemia which led to a Wernicke's aphasia. At time of testing, fluency, syntax, prosody and articulation were normal. Comprehension of words and simple sentences was normal, but complex or long sentences were sometimes misunderstood. Word repetition was relatively preserved but sentence and non word repetition were impaired. Reading and written comprehension were correct. Picture auditory word and picture written word matching tests demonstrated intact conceptual knowledge. Naming was the

main deficit. Tested on a battery of 238 pictures of concrete nouns, DPI produced only 50% incorrect responses at the first attempt and his errors were mostly phonological paraphasias or verbal errors (86%). The probability of producing a correct response was higher for high frequency words, and for short words (with an additive effect of the two variables). When he could not find the right answer, DPI could nevertheless provide the semantic properties of the target item. He could give its gender (95%) and number of syllables (70%). Phonological cues were helpful (raising performance to 81% correct). Given this pattern, we concluded that DPI's deficit was localized mainly in form retrieval, that is, he seemed unable to retrieve the phonological shape of a correctly selected lexical entry.

We then investigated DPI's performance across wider semantic and syntactic domains. Numerals, days and months were totally spared (0% errors). This was significantly better than control words matched for frequency, length and structure. This sparing was not due to the finite nature of these lexical categories: body parts, also a finite category, were as impaired as control pictures. Within the domain of concrete nouns, artifacts, animals and vegetables, matched for length and frequency, were equally affected. Surprisingly, abstract nouns were less impaired than concrete nouns. In a definition naming task with matched materials and control subjects, DPI produced twice as many errors for concrete than abstract nouns.

Turning to syntactic variables, nouns were more affected than verbs, when frequency and phonological structure were matched. Although the effect was not numerically large (a difference score on average of 15%), it was replicated in several tasks (definition naming, sentence completion, oral picture naming). This was found even when morpho-phonological differences between nouns and verbs were neutralized using noun-verb homophone pairs, e.g. 'boucher' (*butcher* or *obturate*), and when concreteness was matched.

DISCUSSION

We reported a patient differently impaired across semantic and syntactic domains whose deficit was located mainly at the word form retrieval step. The sparing of numbers, days and months, and relative sparing of verbs and abstract nouns confirm and extend the observations of Cohen et al. (1997) and also Friederici and Schoenle (1980). It provided evidence that the organization of the word form store is influenced by semantic (concreteness) and syntactic variables (nouns versus verbs).

Such an organization is surprising from a linguistic perspective: indeed, there is no reason that concreteness or word class should affect the word form retrieval system. From a functional perspective, our findings relate to the current debate regarding the degree of integration of lexical selection and word form retrieval. Levelt et al. (1999) defend a model where these two steps are clearly separated in time and in terms of functional organization. In contrast, Caramazza (1997) argues that lexical selection and word form retrieval arise within a single processing system. In this latter view, it is perhaps not so surprising to observe

that semantic as well as phonological variables can affect word form retrieval. Let us point out, however, that even in Levelt's model, a rather peripheral functional segregation respecting semantic variables could theoretically arise for developmental/neuroanatomical reasons. Indeed, there is evidence that the lexico/semantic system is distributed in a perisylvian network within which, words of different grammatical and semantic categories seem to be sustained by partially overlapping and partially distinct subsystems (Miceli et al., 1988, Damasio and Tranel, 1993; Daniele et al., 1994; Hillis and Caramazza, 1995). Assuming that the production system is established in childhood starting from the higher levels downwards to the more peripheral levels, one might speculate that part of the initial topography is relatively preserved and reproduced in the downwards projections. This might account for the presence of a semantic segregation at the word form level, even though it has no clear linguistic or processing advantage.

Acknowledgments. This study was supported by a grant from the Assistance Publique/Hopitaux de Paris (Poste de Recherche Associé), as well as from a grant from the "Cognitive" program of the French Ministry of research and higher education.

REFERENCES

- BAXTER DE and WARRINGTON EK. Category-specific phonological dysgraphia. *Neuropsychologia*, 23: 653-666, 1985.
- CARAMAZZA A. How many levels of processing are there in lexical access? *Cognitive Neuropsychology*, 14: 177-208, 1997.
- CARAMAZZA A and HILLIS AE. Lexical organization of nouns and verbs in brain. *Nature*, 349: 788-790, 1991.
- CARAMAZZA A and SHELTON JR. Domain-specific knowledge systems in the brain: the animate-inanimate distinction. *Journal of Cognitive Neuroscience*, 10: 1-34, 1998.
- COHEN L, VERSTICHEL PS and DEHAENE S. Neologistic jargon sparing numbers: A category-specific phonological impairment. *Cognitive Neuropsychology*, 14: 1029-1061, 1997.
- DAMASIO AR and TRANEL D. Nouns and verbs are retrieved with differentially distributed neural systems. *Proceedings National Academy of Sciences*, 90: 4957-4960, 1993.
- DANIELE A, GUISTOLISI L, SILVERI C, COLOSIMO C and GAINOTTI G. Evidence for a possible neuroanatomical basis for lexical processing of nouns and verbs. *Neuropsychologia*, 32: 1325-1341, 1994.
- FRIEDERICI AD and SCHOENLE PW. Computational dissociation of two vocabulary types: Evidence from aphasia. *Neuropsychologia*, 18: 11-20, 1980.
- HILLIS AE and CARAMAZZA A. Representation of grammatical categories of words in the brain. *Journal of Cognitive Neuroscience*, 7: 396-407, 1995.
- MCCARTHY RA and WARRINGTON EK. Category specificity in an agrammatic patient: the relative impairment in verb retrieval and comprehension. *Neuropsychologia*, 23: 709-727, 1985.
- LEVELT WJM, ROELOFS A and MEYER AS. A theory of lexical access in speech production. *Behavioral and Brain Sciences*, 22: 1-75, 1999.
- MICELI G, SILVERI MC, NOCENTINI U and CARAMAZZA A. Patterns of dissociation in comprehension and production of nouns and verbs. *Aphasiology*, 2: 351-358, 1988.