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KNOWLEDGE CONSTRAINTS AND LANGUAGE COMPREHENSION IN APHASIA

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Introduction

You are walking in the street and hear a sentence "Paul didn't want...". As you neither know who is Paul nor the person talking, you can hardly grasp the problem in its complexity. Yet, you have sufficient metapsychological knowledge on wanting, human relations, etc... to have some idea about the meaning of the sentence. That is, instead of explicit relevant knowledge, you have normally sufficient tacit knowledge to fulfill the *minimal requirements of understanding*.

The controversy regarding the ubiquity of the penetrations of knowledge into mental functions continues to flourish in cognitive psychology (see for instance Pylyshyn, 1981). The question might be crucial to some extent, for we are all intuitively tempted to believe that words have mentally encoded independent meanings that are reactivated on each occurrence of a word - and we sometimes have an impression of being able to undergo a linguistic, knowledge-independent comprehension. The trouble is that, in normal conditions, the use of tacit knowledge in the meaning-making acts is so indissociable from knowledge-independent contributions that it is impenetrable to our insights, and, until present, unisolatable in experimental designs. The findings from psycholinguistic laboratories that were believed to provide evidence for the consulting participation of knowledge in the act of understanding (e.g. the findings on inferential intrusions) could always be interpreted either as compatible with an alternative hypothesis of post-understanding facultative contributions or as limited to the particular experimental settings from which these findings have arisen.

In the present discussion we shall consider a two-stage model of understanding language in which we assume that related pre-existing knowledge is necessarily consulted. Our arguments will be mostly based on findings stemming from studies on language comprehension in aphasia. The most salient characteristic of aphasic disorders is a deficit (resulting from a brain damage) in the expression and comprehension of language. Such a deficit is not equivalent to a uniform decrease of linguistic performance: often aphasic patients suffer from a discrete impairment of a functionally distinct part of the language mechanism. As Saffran (1982) stated: "It is not unusual to find that some aspects of language function have been severely disrupted, while others remain relatively intact. (...) When subsystems that normally operate in concert break down independently, it becomes possible to investigate the residual systems in isolation. In some cases, the investigator can exploit specific functional deficits to control processes that may be difficult to manipulate under normal conditions"- The analysis of these selective disturbances could lead us to identify the aspects of language that are subserved by functionally distinct mechanisms. Aphasic disorders might stand, therefore, for some sort of natural "pseudo-experimentation" as they allow us to observe functional dissociations in the language mechanism which are unconceivable in the psychological laboratories. With reference to our topic, cognitive neuropsychology offers the possibility of dissociating tacit knowledge contributions from knowledge-independent contributions to the understanding of language. We shall refer henceforth to any contributions of knowledge by using the broader term - *knowledge constraints*.

Two stages of comprehension: from pre-understanding to mental scenario

In terms of naive rationalism there is a simple correspondence between words and sentence meanings. The meaning of a sentence is a function of particular meanings of words and their structural arrangements. However, it is easy to demonstrate that there is no direct lexical basis for interpreting a sentence of the kind "can you give me the salt" (see Deloche and Andreewsky, 1981), and we all know simple examples showing that the meaning of a word can considerably differ as a function of the context in which the word is used (see Bransford and McCarrell, 1974). Winograd (1980) calls this paradox - the *hermeneutic circle*: you have to understand words in order to understand a sentence but in order to understand words you must understand the sentence. The hermeneutic circle is intrinsically linked to lexical-semantic approach to comprehension. *As long as you believe that words have mentally encoded independent and stationary meanings, and the meaning of a sentence is a combination of particular lexical meanings, the hermeneutic circle may prevent you from accessing any further understanding of comprehension.*

It seems worthwhile to distinguish two stages in the process of understanding (but we make no claim as to exclusiveness of these two stages). The first stage involves an introductory pre-processing of a sentence (see also Flores and Winograd, 1981). This pre-processing appears to be twofold:

- structural analysis of a sentence is done. This analysis leads the system to detect and syntactically disambiguate the key-words of a sentence, and globally to extract structural-relational information concerning the actual "state of affairs".
- as a consequence of detecting key-words, related knowledge constraints can be selected. The selection of knowledge constraints entails pre-understanding. (But note that, according to the present approach, words are considered only as abstract clues guiding the selection process).

The second stage of processing leads to a mental representation of the sentence content. This representation may be conceptualized as a scenario that you put on your mental stage. Here the information is no longer linguistic (nor semantic), rather a mental scenario represents *events* or *situations* described in sentences and constrained by your knowledge. Two complementary procedures appear to be involved in creating and staging a mental scenario.

The selection of related knowledge constraints allows the system to release appropriate knowledge-based routines which can promptly structure a scenario of the event. Their main advantage lies in the fact that they allow systematic processing of every item of information to be avoided. This reduces the processing load on the cognitive system, and, as a consequence, increases its capacity. Routines based on knowledge constraints cannot, however, supplant systematic processing of actual and specific aspects of situations. Casting actors for the parts they really play in an event (e.g. agent, recipient), situating an event in time and space (e.g. past, present, future, precedence, simultaneity), setting up each relevant relation (on time, space, causality, instrumentality), all this requires systematic processing (based in part on structural-relational information stemming from the pre-processing stage) that follows strictly determined rules (see Rosenthal and Bisiacchi, 1982). In short, systematic processing is responsible for the precise and actual "state of affairs" and assumes the role of cognitive controls preventing from an over-application of knowledge. These controls can sometimes be ineffective, as in the case of some common misunderstandings or as in certain artificial experimental tasks yielding knowledge-based intrusions. For instance, if you present a subject with a list of sentences such as: "The woman slipped in the staircase" and then test him for the immediate recall, it is very likely that you will notice several reproductions of the sort :

"The woman fell in the staircase" (Rosenthal, 1981).

Two stages of comprehension in the light of neuropsychological investigations
-evidence for pre-processing

Let us suppose the feasibility of limiting our comprehension to the outcome of the pre-processing stage. If presented with a sentence, we would have the impression of knowing something about the meaning of the sentence, but would be unable to spell it out accurately. This situation is reminiscent of two experimental findings.

In now classical experiments on subliminal perception (or pattern masking) of individual words, subjects are often found to be unable to report what they saw, but if they are presented subsequently with a list of possible lexical alternatives, they are either capable of recognizing the stimulus or able to point to a semantically related word. In some conditions, they produce errors which bear a striking relationship to the stimulus but little other similarity (e.g. "king" for *queen*, "red" for *yellow*; see Dixon, 1971). That is, the subliminal presentation of a word appears to last long enough for selecting a related knowledge constraint but to be too brief for retaining the morphological pattern of the word.

In language pathology, similar findings have been reported with respect to the cases of deep dyslexia. A deep dyslexic patient cannot read nonsense words and reads function words (prepositions, conjunctions, etc...) very poorly. The reading of content words appears to be better preserved with a clear superiority of concrete nouns over the abstract ones, but a patient often produces semantic errors like: "crocodile" instead of *aligator*, "church" instead of *cathedral* (see Marshall and Newcombe, 1966; Coltheart et al., 1980). In the last few years, several cases of the auditory analogue of deep dyslexia have been discovered (Goldblum, 1979). In repeating words, a deep dysphasic patient performs in a way directly comparable to the way a deep dyslexic performs in reading. It has been noted that, in such a patient, the probability of producing semantic errors is inversely related to the typicality of a word (Goldblum, personal communication). Clearly, these patients are impaired in the ability to retain the perceptual (visual or auditory) pattern of a word but are able to perform the pre-processing leading to the selection of a related knowledge constraint. Accessing knowledge affords pre-understanding, but, since the lexical form is no longer available, a patient asked to reproduce the word would have no choice but to re-create it. Hence the factors such as abstractness, typicality, or number of synonyms should be relatively accurate predictors of the subject's performance.

Evidence for structural pre-processing arises from a study by Andreewsky and Seron (1975). They examined the ability of an agrammatic patient to read sentences aloud. The word *car* in French can be either a noun or a conjunction. The patient presented with the sentence: "Le car ralentit car le moteur chauffe" (The bus slows down because the motor overheats) read "car ralentit moteur chauffe". That is, he was clearly able to utter *car* since he produced the first *car*. In addition, when the second *car* (conjunction) was replaced by an unambiguous noun which he was able to read few minutes before, the patient read the sentence as in the example above. Implicitly, his selective ability to read words was determined by a structural analysis of the sentence. In general, studies on agrammatic patients force us to distinguish the ability to perform syntactic analyses of a sentence and the ability to use some of this structural information as clues for understanding (see Saffran, 1982). In terms of the above-described model, this distinction covers the structural pre-processing and the application of systematic processes during the staging of a mental scenario.

- evidence for knowledge-based routines and systematic processes.

We have seen in the preceding section that agrammatic aphasics are able to perform structural pre-processing and to access related knowledge constraints. It is our impression that their impairment has to be attributed to the representational stage, that is - agrammatic

patients preserve the capacity of using knowledge-based routines but often cannot perform systematic processing (Rosenthal and Bisiacchi, 1982). Hence their comprehension is more related to their knowledge of the world than to the actual state of affairs. In matching sentences to pictures, agrammatic patients perform on the basis of the "standardness of situations" irrespective of the precise characteristics of the situation described (Caramazza and Zurif, 1976; Deloche and Seron, 1981). Provided with reversible sentences they assign roles to actors according to greater plausibility. When the roles are interchanged violating pragmatic habits (i.e. The patient takes care of the doctor) agrammatic aphasics apply a normative strategy inverting the S-O relation. On the other hand, presented with sentences unconstrained by the pragmatic knowledge (e.g. The circle is above the square) they perform on the chance level.

Posterior Wernicke's aphasics show an opposite tendency in comprehension. They are insensitive to the "standardness of situations" (often mismatching both sentences that describe odd events and those that describe highly plausible events; see Deloche and Seron, 1981) and inclined to over-rely on structural information (von Stockert, 1972). This suggests that posterior aphasics could be limited in their ability to use knowledge-based routines but retain the ability to apply systematic processes. It should be recalled that routines afford the possibility of avoiding systematic processing of every bit of information and thus increase the processing capacity of the system. If actually, posterior aphasics suffer from low availability of routines we may predict that their processing capacity should be overall reduced. We examined this prediction in an experiment using riddles composed of two descriptors. The information contained in *both* descriptors was necessary to identify the intended item. Posterior aphasics, provided with a multiple choice array, performed poorly on this task. Most of their errors were responses based on only one descriptor (Rosenthal and Bisiacchi, 1982).

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In short, the reported findings with aphasic subjects provide at least partial support for the two-stage model of language comprehension, and illustrate some possible contributions of cognitive neuropsychology to adjacent arts.

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