From deep dyslexia to agrammatic comprehension on silent reading

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SUMMARY

We report on a case of a French-speaking patient whose performance on reading aloud single words was characteristically deep dyslexic (in spite of preserved ability to identify letters), and whose comprehension on silent sentence reading was agrammatic and strikingly poorer than on oral reading. The first part of the study is mainly informative as regards (i) the relationship between letter identification, semantic paralexias and the ability to read non-words, (ii) the differential character of silent and oral reading tasks, and (iii) the potential modality-dependent character of the deficits in comprehension encountered. In the second part of the study we examine the patient's sensitivity to verb-noun ambiguity and probe her skills in the comprehension of indexical structures by exploring her ability to cope with number agreement and temporal and prepositional relations. The results indicate the patient's sensitivity to certain dimensions of these linguistic categories, reveal a partly correct basis for certain incorrect responses, and, on the whole, favor a definition of the patient's disorders in terms of a deficit in integrating indexical information in language comprehension. More generally, the present study substantiates a microgenetic approach to neuropsychology, where the pathological behavior due to brain damage is described as an arrest of microgenesis at an early stage of development, so that patient's responses take the form of unfinished "products" which would normally undergo further development.

INTRODUCTION

Fine-grained investigation of the comprehension skills of agrammatic aphasics has provided evidence of the patients' sensitivity to a wide range of grammatical structures, and has offered a wealth of detailed descriptions of their patterns of deficit. Such investigations have provided the factual basis

for several theoretical descriptions of agrammatic and normal language comprehension. The aim of the present study, conducted with a patient who was agrammatic on silent sentence reading and deep dyslexic on reading aloud single words, was threefold:

- First, we sought to clarify the critical role of letter identification in deep dyslexia, the relationship between the latter and agrammatic comprehension in reading, and, correlatively, the effect of modality of impairment on deficit type in comprehension. In this respect, it should be taken into consideration that disorders of comprehension may to some extent be modality dependent, e.g. due to structural differences between auditory and visual linguistic stimuli, or to the possibility that both modalities do not allow for the same modes of compensation.

- Secondly, the main part of this study was devoted to an inquiry into the *structure* of agrammatic (and normal) language comprehension in reading. To this end we conducted a series of pilot experiments which addressed the issues of verb-noun ambiguity and number agreement, as well as temporal and prepositional relations. It is our contention that there is a systematic basis for many observable errors made by agrammatic patients in language comprehension, and, often, an implicit correct basis even for what appears to be corrupted understanding. We thus tried to tease apart some of those implicit unimpaired skills by trying to identify dynamically and developmentally relevant dimensions of certain linguistic categories, and by conducting, when possible, *qualitative analyses* of errors.

- Third, in opposition to the widespread cognitivist, subtractive approach to the exploration of neuropsychological disorders due to brain damage, where the patient's behavior is described as a direct manifestation of intact and void (i.e. damaged) processing modules, we sought in this study to substantiate an alternative microgenetic approach to these disorders, according to which the pathological behavior is viewed as an arrest or interruption of microgenesis at a "primitive" (i.e. developmentally early) stage of development and differentiation, so that patient's responses take the form of unfinished or unstable "products," which would normally undergo further elaboration (see Conrad 1954; Brown & Pachalska 2003; Rosenthal 2004; Semenza, Bisiacchi, & Rosenthal 1988; Werner 1956).

The entire study ought to be viewed as exploratory; we believe that the particular configuration of deficit and preservation encountered is quite unique and sheds light on several research issues regarding agrammatism and deep dyslexia. Unfortunately, the patient was available for testing for too short a period to permit a more elaborate investigation.

The concept of *microgenesis* refers to the *development* on a brief *present-time* scale of a percept, a thought, an object of imagination, or an expression. It defines the occurrence of immediate experience as a process of *dynamic unfolding* and *differentiation*, in which the "germ" of the final experience is already embodied in the early stages of its development. Immediate experience typically concerns the focal experience of an object that is thematized as a "figure" in the global field of consciousness; this can involve a percept, thought, object of imagination, or expression (verbal and/or gestural). Yet, whatever its modality or content, focal experience is postulated to develop and stabilize through dynamic differentiation and unfolding. Such a microgenetic description of immediate experience substantiates a *phenomenological* and *genetic* theory of cognition, where any process of perception, thought, expression or imagination is primarily a process of genetic differentiation and development, rather than one of detection (of a stimulus array or information), transformation, and integration (of multiple primitive components), as cognitivist theories have contended (Rosenthal 2004).

The term *microgenesis* was first coined by Heinz Werner (1956) as a means of providing a genetic characterization of the structure and temporal dynamics of immediate experience, and, more generally, of any psychological process (Werner 1957; Werner & Kaplan 1956; Werner & Kaplan 1963). For Werner, *microgenesis* had not only a substantive meaning (as a psychological theory), but also a methodological meaning. As a method, it often referred to *genetic realization* (*Aktualgenese*), which sought to provide the means of externalizing the course of brief perceptual or other cognitive processes by artificially eliciting "primitive" (*i.e.* developmentally prior) responses that are normally occulted by the final experience (see in this respect Sander 1930; Werner 1956). It also referred, however, to a method of neuropsychological investigation which sought to explore patterns of pathological behavior structurally and dynamically akin to those studied in genetic realization. Although since the early studies of Conrad (1954) this methodology of neuropsychological investigation has been extensively applied by Brown (e.g. 1983; 1985) and others (e.g. Rosenthal 1988; 2004) and proved to be a valuable heuristic tool, the microgenetic approach has so far had little impact on mainstream neuropsychological thinking.

CASE DESCRIPTION

Mrs L, a saleslady in a Parisian department store who demonstrated the use of household electrical appliances, was hospitalized in October 1982 at the age of 57, a few hours after she incurred a cerebrovascular accident. On admission to Bicetre Hospital, the patient was suffering from right hemiparesis involving the face and upper limb, as well as right hypoesthesia; she was unable to utter a word. A CT scan done 5 days after onset showed an area of hypodensity corresponding to partial left sylvian infarction. The patient was right-handed.

L remained totally speechless during the first few days of hospitalization but manifested good comprehension on preliminary neuropsychological examination. Within a week she began to recover her speech rapidly, but her locution during the following three weeks remained slow, with a slightly deficient articulation reminiscent of non-fluent Broca's aphasia. Initially she presented a mild word-finding difficulty, and occasionally produced substitutions of function words and semantic paraphasias. Repetition of words, non-words, and sentences was quite similar to her spontaneous speech; specifically, she correctly repeated all words and non-words but made a few substitutions of function words in repeating sentences, which she occasionally paraphrased. She scored 18/20 on an object naming task involving pictures of everyday objects, domestic animals, fruits, vegetables and vehicles. Her oral comprehension, as assessed in a series of neurolinguistic tasks, appeared nearly perfect; in particular, she scored 20/20 on an oral version of a sentence-picture matching task composed of simple reversible, non-reversible and more complex declarative sentences involving several function words. By contrast, her performance was much worse (12/20) on the written version of the latter task (which she was asked to carry out on silent reading).

L's script (using the left hand) was distorted. Her copying was correct, but writing to dictation and spontaneous writing of sentences was dyssyntactic (the words were written out of order).

Of particular interest, however, was L's behavior in reading, which is the object of the present report.

PART I: EXAMINATION OF L'S BEHAVIOR IN READING

The following examination of the patient's behavior in reading was conducted during the third and fourth weeks after onset. At that time L no longer presented any signs of deficit in oral comprehension.

Reading aloud single words, non-words, letters and syllables

In reading aloud single words, L's behavior appeared to be characteristically deep dyslexic (see Coltheart 1980). Specifically:

 – The patient was unable to read pronounceable non-words (0/40).
 – Function words were seldom read (7/28) and she made two substitution errors within the class of function words; total correct: 5/28.
 – The reading of content words was well-preserved (54/60), but the patient produced seven semantic errors (e.g. *docteur —› médecin*), one derivational error (*coiffeur —› coiffure*) and one visual or phonological error (*poisson —› boisson*) error; total correct: 45/60.
 – She made 2 visual-semantic paralexias in trying to read 10 pseudohomophones visually similar to real words (e.g. *ancle*, a non-

word visually similar to *oncle* 'uncle' was read *l'enfant* 'the child')
and failed to utter the remaining 8 pseudohomophones.

– A lexical decision task (with no time limit) for 45 words (15 function words and 30 content words) and 40 orthographically legal non-words was performed without a single error.

It should be noted, however, that unlike most deep dyslexic patients reported in the literature, L was able to point to named (printed) letters (both uppercase and lowercase), and she either named or sounded out 17 of 26 letters presented individually. She was also able to sound correctly most of the single syllables she was presented (14/20).

Reading aloud sentences

L's performance in reading aloud sentences was markedly different from her performance on single words. In particular, she was able to read aloud long sentences containing words she was unable to read in isolation. For instance, when presented with a set of 20 sentences containing a variety of different classes of function words, she read out loud 38 of 49 function words (77.5%, as compared to 25% of function words presented singly). This included 26 correct readings and 12 substitution errors, such as modification of number, or substitution of another preposition for the target. Quite interestingly, many of the function word substitution errors occurred when she paraphrased the target sentence. Indeed, paraphrasing turned out to be the principal characteristic of her errors in reading aloud sentences. Some of these errors were acceptable paraphrases of the target; in several cases a target sentence phrased in the plural was read in the singular, but there were also a few "corrupted paraphrases" involving semantic paralexias (which, proportionately, were much more frequent for sentences than for single words). For instance, the target sentence

Ce pilote est un as (This pilot is an ace)

was read as

Le pilote est un pique (The pilot is a spade).

The finding that the reading of single words is a poor predictor of performance in sentence reading, either with respect to the overall capacity to read various syntactic classes of words or with respect to the types of errors, suggests that the relationship between deep dyslexia and agrammatic reading may not be purely quantitative. It would be difficult to compare L's results with those of other reported cases of deep dyslexia (where there may also have been agrammatic reading), as the reading behavior of these patients was mostly studied using single words.

L's performance on silent reading

On silent reading, L did not present the slightest sign of difficulty in tasks involving single content words. Thus, for instance, she performed without a single error a word-to-picture matching task (using a multiple-choice array) as well as on a task where she was required to sort 20 words into four semantic categories (animals, furniture, fruits and vehicles). This was not the case, however, when L was presented with sentence-length material. For example, when requested to carry out written orders, half of which were in the style of the Token Test, she scored only 12/20 (recall that her score on silent reading in the sentence-picture matching task, reported above in *Case description*, was also 12/20).

We thus decided to compare L's behavior on silent and oral reading presenting her, whenever possible, with the same material twice.

Silent versus oral reading comprehension

The most startling characteristic of L's behavior in reading was, as it turned out, the contrast between her relatively poor comprehension on silent reading and her good comprehension of the same written material on oral reading. In spite of several paralexias, L made no single comprehension error when presented again with the sentence-picture matching task from the initial battery (see above) and was requested to first read each sentence aloud and then to point to the corresponding picture. She also made only two errors (18/20 correct as contrasted to 12/20 correct on silent reading) when carrying out the same written orders on oral reading, both errors being consistent with sentences she actually uttered. We then devised for her another sentence-picture matching task, which consisted of 10 reversible sentences and of 10 sentences containing spatial prepositions (*devant, derrière, sur, sous, entre, a côté, dans*, etc.). She scored 19/20 when reading aloud the target sentences, but when presented with the same task a few days later and asked to carry it out silently, she scored only 11/20. L's performance on the sentence completion task described in Experiment 4 (see below) presented the same contrast. On silent reading, she scored only 30/42, but on oral reading she scored 40/42 correct.

We presented the patient with a grammaticality judgment task, in which the sentence material consisted of 27 sentences comprising 9 grammatical sentences, 9 ungrammatical sentences created by removing a necessary function word, and 9 scrambled sentences. The sentences were printed on cards and shown one by one to the patient who was asked whether they looked correct, no matter what they mean. On silent reading, she accepted as correct all grammatical sentences (9/9 correct), all ungrammatical sentences lacking a function word (0/9 correct) and 4 scrambled sentences. Out of the 5 scrambled sentences she rejected as incorrect, 2 were actually grammatical but semantically anomalous (e.g. *La marche ne montre pas*)[1] and 3 sentences were

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[1] This is a scrambled version of a sensible sentence, *La montre ne marche pas* ('The watch doesn't run').

indeed ungrammatical. When asked afterwards to read all these sentences aloud, L spontaneously and unwittingly corrected 14 out of 18 incorrect sentences either by completing the missing function words or by means of de-scrambling (rearranging the order of words) the sentence. For instance, the target

Un compose il numéro de téléphone

was read aloud as

Il compose un numéro de téléphone.

This *completing* and *de-scrambling* behavior appeared to be involuntary; although L was aware that some of the target sentences were meaningless and/or ungrammatical, she was nevertheless unable to read their constituent words as they occurred. She was herself puzzled when we pointed out to her afterwards that she had not read what she had actually seen. At first, she was unwilling to admit this, but once we showed her word by word that she was actually correcting the target sentences, she laughed and said that she done so without noticing it.

Discussion

The investigation of deep dyslexia in the 1970s and early 1980s led to the publication of countless studies, and arguably played a substantial role in the emergence of modern cognitive neuropsychology. Recently, however, studies of deep dyslexic patients rarely appear in the neuropsychological literature. This state of affairs is a bit puzzling. Why did the syndrome of deep dyslexia, which gave rise to so many passionate theoretical and methodological debates, suddenly become an outdated issue in the late 1980s? Could it be that all possible research issues regarding deep dyslexia have been completely exhausted and brought to satisfactory resolution, so that we now know exactly what deep dyslexia is? Are we really in a position now to explain the part of speech effect, to provide a convincing account of the mechanism underlying semantic paralexias, or to explain the critical role in this respect played by the capacity to identify letters (and also in regards to the ability to read non-words)? And all this is to mention only a few of the issues.

We submit that none of these issues has been given a satisfactory answer, and hope that the present study will incite fellow neuropsychologists to reopen the deep dyslexia file. Although far from conclusive, we believe that our study sheds light on the following issues:

The relationship between letter identification, semantic paralexias, and the ability to read non-words. Recall that L was unable to read non-words and made several semantic paralexias on single content words (not to mention her paraphrasing behavior on reading aloud sentences) in spite of her ability to identify printed letters (both in lowercase and uppercase). This observation

is important, as it suggests that the inability to identify letters *per se* may not be the explanation for the performance pattern in reading single words characteristic of deep dyslexia (especially the semantic paralexias, the inability to read non-words, and the infrequent reading of function words), but rather the inability to make use of local (letter-level) information as a clue for orthographic discrimination. Why this is so and what it tells us about the normal mechanisms of reading are issues which call for an investigation of the way global and local processes interact in visual word recognition (for a discussion of this issue from a microgenetic point of view, see Rosenthal 2004). In any case, contrary to the claim put forward by Coltheart, Patterson, and Marshall, "a minimal ability to translate from orthography to phonology at a subword level" *may not be* "sufficient to stop anyone from reading *gift* as 'present'."

The relationship between silent and oral reading. Oral performance on written material does not appear to be transparent with respect to the patient's skills in visual word recognition. The so called "pathway from print to phonology" may actually be likely to make a detour. In the present context, the disparity in L's performance on silent and oral reading, and, in particular, her *completing* and *de-scrambling* behavior in the grammaticality judgment task clearly appears to be an effect of mobilizing her preserved (if not intact) oral comprehension (and production) skills to compensate for impaired reading ability. Such a compensatory effect may, by the way, better explain her paraphrasing behavior in reading *sentences* than a mere extrapolation of the semantic paralexic behavior characteristic of deep dyslexic reading of *single words*. It may also account for the patient's ability to produce many more function words in a sentence context as compared to lists of words presented singly. It would appear that L, in her effort to make sense of the reading material, was unwittingly re-creating a plausible meaningful context on the basis of what she was actually able to process. The question then arises as to why a similar procedure was not applied (e.g. by means of subvocalization) to compensate for her impairment on silent reading – the more so, since we never attempted to prevent her from subvocalizing. There is of course no way to ascertain that L had never attempted a compensatory procedure, but even if she had, there still remains a disparity between her silent and oral reading, which needs to be accounted for. On the other hand, it might also be that, much as in Vygotsky's account of inner speech, subvocalization does not need to comply with the oral standards of well-formedness.

Does the finding of differential performance on silent vs. oral reading render it necessary to reconsider the conclusions reached from studies of other reported cases of deep dyslexia? To some extent it does, insofar as reading aloud may not amount to a pure conversion from print to speech. On the whole, however, the question may not be easily answered, given the lack of comparative data on silent vs. oral reading, especially in sentence reading. It should be remembered that (unlike the present patient) many deep dyslexic patients reported in the literature were also agrammatic aphasics, and their

performance on sentence reading was thought to primarily reflect their agrammatism in speech. In his review of the syndrome, Coltheart ruled out a necessary relationship between deep dyslexia and agrammatism in speech, in view of the fact that some patients were not agrammatic speakers. He went on to conclude, in view of this, that "patients can be agrammatic in their reading without being agrammatic in their speech." It remains unclear whether by "patients" Coltheart was referring specifically to deep dyslexics; but in any case, the nature of the relationship between deep dyslexia and agrammatism in reading (oral *and* silent) appears to be rather underspecified.

Deep dyslexia, agrammatic comprehension in reading, and the effect of impairment modality on comprehension skills. Several reasons exist to favor a working hypothesis that deep dyslexia and agrammatism in reading are two behavioral manifestations of the same phenomenon, depending on the type of material (single words vs. sentences) and the nature of the task being carried out (reading aloud vs. a comprehension task on silent reading). First, such a hypothesis makes possible a *linguistic* account of the part of speech effect in deep dyslexia. Secondly, it makes a clear case for the study of modality specific disorders in language comprehension. For example, a contrasted study of deep dyslexic and deep dysphasic patients might be highly instructive in this respect. Presumably, other comparative studies (e.g. writing vs. speech) might also be relevant. Thirdly, this hypothesis is to some extent amenable to empirical evaluation. For instance, it would be clearly disconfirmed by finding a patient presenting no deficit in reading single words who would be able to read aloud non-words and nevertheless show agrammatic comprehension on silent sentence reading. Fourthly, this hypothesis provides an interesting framework both for the study of compensatory behavior in language comprehension and for neuropsychological rehabilitation. The foregoing description of L's compensatory behavior appears to be specific to the selective impairment of the visual modality with preserved oral skills. Since one can read out loud a text to compensate for impaired reading skills, perhaps it may also be possible to find a patient who writes down aurally presented sentences to compensate for disorder in auditory comprehension. It is actually a commonplace observation in neuropsychology that some patients who are severely impaired in auditory comprehension show almost perfect comprehension of written material. Note that compensatory behavior may not merely amount to a guessing strategy applied to inaccessible information, but rather consist in the use of partial knowledge (or results from incomplete development due to prematurate arrest of microgenesis), which under different circumstances would remain unexploited. We shall turn to the issue of the partially correct basis of erroneous or blank responses in the second part of this study.

PART II: AGRAMMATIC COMPREHENSION IN READING

Four weeks after onset, L had almost totally recovered her speech, which remained only a bit slower than normal, and she no longer presented the slightest sign of deficit in oral comprehension. Her ability to read sentences aloud improved, and her paraphrasing behavior tended to decrease. In reading aloud isolated words there was also improvement, but she was still totally unable to produce non-words, uttered less than half the function words, and continued to make semantic errors, though to a lesser extent. However, her behavior in comprehension on silent reading remained severely agrammatic. The disparity between her performance on silent and oral reading had even increased.

At this point, we conducted a series of pilot experiments devised to further explore her skills in reading comprehension and to tease apart her preserved, partly preserved and impaired capabilities. Apart from the first experiment, whose purpose was to make sure that L was able to carry out lexical categorization, i.e. to determine the lexical identity and syntactic class of words in sentences (in this case to deal with verb-noun ambiguity), the remaining four experiments addressed the issue of the patient's indexical skills in comprehension. By indexical skills we mean the ability to identify and use in a co-operative, synthetic fashion various "directions" (which are at the same time grammatical, semantic and pragmatic) for interpretation that are embedded in the structure of utterances. It is these directions that are assumed to permit a situationally sensible use of the individual's general knowledge, and thus, in a way, "to grasp what has actually been said" rather than to merely elaborate, on a key-word basis, on what one already knows. The indexical operations explored are number agreement, temporal location of events, and prepositional relations. Each of these operations is multidimensional, so that correct index processing requires an integrative ability, and, as such, is susceptible to partial disruptions.

These experiments, completed during the following two weeks, were initially designed only to pilot the development of a more elaborate experimental battery. Unfortunately, the patient left the hospital before we were ready for more elaborate experiments and was no longer available for testing.

EXPERIMENT 1: VERB-NOUN AMBIGUITY

The purpose of this experiment was to examine L's ability to achieve lexical identification of homographs on the basis of the morpho-syntactic properties of the sentences in which they occurred. The resolution of verb-noun ambiguity embedded in a homograph requires the ability to conduct certain grammatical and/or semantic analyses, and as such constitutes a valuable probe for the exploration of the comprehension skills of agrammatics. Given L's specific impairment in the visual modality, we were particularly interested

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in her ability to cope with homographs which are not homophones, and whose readings are not only semantically distinct but pertain to different syntactic classes. For instance, when the written French word *portions* is a verb (from *porter* 'to carry', 1st person, plural, past tense), it is pronounced /portjo/, but when it is a noun ('portions') it is pronounced /porsjo/. The question arises, what would happen were an individual unable to carry out the morpho-syntactic analyses necessary for the lexical and syntactic identification of such words? It appears obvious that, in the case of verb-noun ambiguity, such a situation would be disastrous for comprehension, even very superficial comprehension, if only because as long as the nouns and verbs of a sentence are not identified, it is impossible to determine its argument and thematic structure. With respect to L, given her relatively well preserved auditory comprehension, it was felt that she ought to be able to resolve such verb-noun ambiguities.

Materials and procedure

We constructed 12 sentences around non-homophone homographs, where the ambiguity was both semantic and bore on verb-noun class distinction. The sentences were as semantically neutral as possible, in the sense that both readings of the homograph were semantically plausible on telegrammatic analysis, but only one reading was grammatically acceptable. In the following example sentence used in the study

1) Nos rations sont dans le train (Our rations are on the train)

the critical word rations is a noun (pronounced rasjo), but the same written word would be a verb (pronounced ratjo) in

Encore un peu et nous rations le train (A little later and we would have missed the train).

Another example is

2) Je vis à Paris (I live in Paris),

where the target *vis* is a verb (pronounced /vi/), whereas in

Il prend une vis (He takes a screw)

vis is a noun (pronounced /vis/).

Since these target homographs are not homophones, it is the patient's pronunciation in reading aloud which constitutes the critical test of disambiguation.

Results and discussion

Presented with these sentences, L read out loud correctly 10 out of 12 target homographs. In one of the remaining two sentences she correctly disambiguated the target verb but uttered its infinitive instead of inflected form (this makes for 11/12 correct disambiguation), and uttered only two words of the other sentence but not the target word. This ability to determine the lexical identity and syntactic class of ambiguous words on the basis of morpho-syntactic structure cannot be explained by a compensatory strategy of mobilizing her intact oral skills. In the present setting such a strategy would be of little help – recall that the context of these target sentences was semantically neutral to both readings of the homophone – for it was first necessary to identify (at least implicitly) all visually presented words, and if she was able to achieve that correctly, she needed no extra compensation. Although one would have to be careful in interpreting the results of an experiment conducted with a single agrammatic patient, this finding corroborates the earlier suggestions by Andreewsky and Seron (1975), and by Rosenthal and Goldblum (1989), that *lexical categorization* (the ability to determine both the lexical identity and the syntactic class) of words in sentences is the minimal requirement for any understanding whatsoever (and *ipso facto* for agrammatic comprehension), and that agrammatics are able to carry out this process. This preserved capacity for lexical categorization, which involves a morpho-syntactic disambiguation, does not imply an ability to identify and use all grammatical indexical directions for interpretation, and leaves room for a variety of subtle deficits in agrammatic comprehension.

EXPERIMENT 2: NUMBER AGREEMENT

In French, most nouns are morphologically non-transparent with respect to number and gender (i.e. the form of the word does not tell one whether it is singular or plural, masculine or feminine). Despite a longstanding tradition of treating them under the same heading, functionally gender and number do not play the same linguistic role. Grammatical gender primarily pertains to a noun's identity as a lexeme and may thus be critical for lexical categorization (for instance, in the case of homonyms, the article's gender provides the critical disambiguation clue), whereas number is primarily an indexical device signaling connections between agents, objects, goals, actions. Sensitivity to gender information (as a cue for the lexical identification of nouns) may thus be part of the minimal requirements for understanding anything (and appears indeed to be preserved in French agrammatics), whereas the ability to make use of number information, less critical for basic comprehension but nevertheless important for indexical interpretation, may be more liable to damage or disruption[2]. The purpose of this experiment was to explore L's ability to

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[2] Note that beyond its involvement in lexical identification, gender may also play an indexical role very similar to that assumed by number. As such, gender may be as liable to damage as number.

make indexical use of number indications[3] provided by both the article and the morphology of nouns and verbs.

Materials and procedure

The experimental material consisted of 27 sentences divided into three conditions:

In the first condition (*Morphologically ambiguous condition*) we used nouns which, regardless of whether they are singular or plural, always take the orthographic form (final -s) characteristic of the plural (e.g. *puits* 'well', *tapis* 'carpet'). It is thus the determiner (i.e. article or pronoun) which specifies whether the noun is in the singular or in the plural and governs the agreement in number of the following verb and adjective modifiers. On this basis we constructed 9 incorrect sentences, such as:

*Le puits sont très profonds (*The well are very deep)

where the critical information is provided solely by the singular article *le* 'the' (masculine and singular).

In the second condition (*Conceptually ambiguous condition*) we used nouns in the singular which refer to an entity that is conceptually plural (e.g. sand, forest) and nouns in the plural referring to a conceptually singular entity (e.g. eye-glasses, scissors). On this basis we constructed 9 incorrect sentences where the verb and adjective agreed with the conceptual status of the noun in violation of its morphology and of the article's number, e.g.

*Le sable sont très fins (*The sand are very fine).
*Les lunettes corrige la myopie (*The glasses corrects myopia).

In the last (*Control*) condition, all 9 sentences were correct and based on morphologically transparent nouns.

The experimental technique was that of grammaticality judgment. We presented L with these 27 sentences and asked her to evaluate on silent reading whether they looked correct. The sentences were printed separately on cards and were presented to the patient one by one in random order.

Results and discussion

L correctly evaluated all sentences in the *Control Condition* (accepting them) and all sentences in the M*orphologically Ambiguous Condition* (reject-

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[3] We did not attempt to formally contrast L's sensitivity to gender and number, as there is by now sufficient evidence that French agrammatics are able to use gender information as a clue to the lexical categorization of nouns. This does not mean that they would be able to exploit indexical information from long-distance gender agreement, but this issue may require another study.

ing them). But she also accepted as correct 7 out of 9 ungrammatical sentences in the *Conceptually Ambiguous Condition*. Thus, although L was clearly sensitive to the number information provided by the article (and able to notice the ungrammaticality of sentences in the Morphologically ambiguous condition), she failed to make use of this indexical information (even in the presence of additional morphological information) when it conflicted with the conceptual status of the noun. If we infer from her perfect performance in two conditions that L was sensitive to number agreement, how are we to explain why she erred so systematically when confronted with conceptual foils? Notice that in the *Conceptually Ambiguous Condition* no extra grammatical skill was necessary, in comparison to the *Morphologically Ambiguous Condition*, and thus the patient's errors cannot be accounted for by grammatical complexity. Clearly, her failure to detect grammatical *dis*agreement when morphological clues and the conceptual status of the noun diverge suggests a difficulty in integrating competing sources of information. If our interpretation is correct, the patient's agrammatism would be better accounted for by a deficit in indexical structuring of discourse than by a concept of impaired grammatical processes.

EXPERIMENT 3: LOCATING AN EVENT IN TIME

Agrammatic patients are generally believed to be impaired in their comprehension of temporal relations, and indeed several studies conducted during the 1970s and 1980s with French patients provided evidence for a difficulty in processing tense. However, in another study of tense comprehension by French-speaking agrammatics, Jarema and Kehayia found over a 90% success rate. Moreover, it should be borne in mind that temporal relations are encoded by a variety of means (verb endings, auxiliaries, time adverbs, deixis) which may not become uniformly opaque – unless there is a specific deficit in locating events in time. On informal testing, L did indeed present a difficulty in interpreting temporal relations, but was able to arrange time adverbs in the correct temporal order (e.g. yesterday, today, tomorrow). We thus sought to investigate her ability to understand temporal relations in a more systematic fashion.

Materials and procedure

The experimental material consisted of 16 sentences, each printed in four optional forms (past tense, present tense, future tense and infinitive). In 8 sentences the temporal location of the event was provided by a time adverb (e.g. *Yesterday we ate a pizza, *Yesterday we shall eat a pizza*, etc.) and in 8 other sentences the temporal location of the event was knowledge-based (e.g. *Napoleon won the battle of Austerlitz, Napoleon wins the battle of Austerlitz,* etc.). The patient was instructed to choose the correct form on silent reading.

Results and discussion

L scored 7/8 in the condition where the temporal location was knowledge-based and 3/8 in the condition of time adverbs. This contrasted performance cannot be explained by her inability to process verb endings, auxiliaries and time adverbs, or by selective reliance on apparently intact knowledge of historical events. It should be borne in mind that even in the condition where the temporal location of the event was based on her general knowledge, it was nevertheless necessary to select the right tense. Her almost perfect performance in that condition shows that she was still sensitive to verb endings and to auxiliaries, in agreement with the results reported in Jarema and Kehayia. But since she was sensitive to tense marks, why did she perform so poorly in the condition of time adverbs, all the more so since she was able to arrange these adverbs in correct temporal order? Perhaps, the two tasks , i.e. arranging time adverbs on a temporal axis and interpreting a single time adverb as a clue for the temporal location of an event, do not mobilize the same underlying skills. In the first case, the overall context provides an implicit axis of reference so that each adverb is treated *relative* to the others, whereas in the second case one not only has to create that axis but also to structure and locate an event in relationship to that axis. Thus, even a partial ability to interpret time adverbs may suffice for their correct arrangement relative to each other. But the use of a time adverb as a clue for the interpretation of an event in the temporal dimension may require additional referential skills. In any case, since L was both sensitive to tense marks and able to arrange time adverbs in their correct temporal order, her deficit in language comprehension appears once more to be more related to the capacity to integrate various indexical and semantic threads, rather than to be merely and purely grammatical.

EXPERIMENT 4: CONCRETE VS. FIGURATIVE RELATIONS

This experiment addressed L's ability to interpret concrete relational and figurative idiomatic prepositions. Prepositions are perhaps the most versatile class of function words, and understandably also the most difficult lexical category to master in a second language. In Indo-European languages, they are used in at least two distinct ways, and in certain languages, such as English and German, even in three functionally distinct ways. First, they may be used in a concrete relational fashion, e.g. pointing to direction or juxtaposition of agents or objects, locating an event in predefined space and/or time (*She goes* to *the factory*, *I wrote this paper* with *Michel, We finished* before t*hey showed up, Rescue workers found nothing* under *the basement*, etc.). Secondly, the same prepositions may be used in a figurative idiomatic fashion (e.g. *One has to comply* with *the rule* – even though *with* denotes merely an associative relation, much as one works hard *on* a problem without either sitting *on* this problem or physically putting any pressure *on* it). Thirdly, in languages such as English and German, the same prepositions may act

as particles in verb-plus-particle constructions; this use is also idiomatic, but the particle actually modifies the verb and becomes a part of it (Thus planes can *take off*, electricity can be *laid on*, cars can *pull up* and one may *give up* doing neuropsychology).

In most studies of agrammatism which explored the patients' sensitivity to prepositions, no clear distinction was drawn between these three different uses, with the sole exception of Friederici, who contrasted the use of what she called lexical prepositions (concrete relational in our terminology) and obligatory prepositions – actually a combination of both figurative idiomatic and verb-plus-particle constructions – in German. In spite of their superficial similarity, the combination used by Friederici may not be a very fortunate one, since there is no one rule for both figurative idiomatic and verb-plus-particle uses: they simply have to be learned. The use of figurative idiomatic prepositions is purely grammatical and one may, mistakenly, use another preposition (**We have to comply* to *these requirements*) without modifying the meaning of the verb or otherwise being misunderstood. This is not the case for verb-plus-particle constructions, as removing or changing the particle simply changes the meaning of the verb (*to give up* has little to do with *to give*). In other words, incomplete knowledge of figurative idiomatic prepositions may lead one to misinterpret certain local relations, whereas incomplete knowledge of verb-plus-particle structures would undermine one's ability to properly identify the argument and thematic structure of utterances.

Materials and procedure

The experimental technique was that of sentence completion, where the prompt incomplete sentence contained a preposition (or preposition-plus-article or preposition-plus-possessive) in the last position. The sentence material consisted of 42 incomplete sentences divided among the following three conditions:

- in 14 sentences the prepositions were used in a concrete relational fashion (e.g. *Voici une rose sans* ... 'Here is a rose without...', *Il garde les mains dans ses*... 'He keeps hands *in* his...') – *Concrete Condition*;
- in 14 sentences prepositions were used in a figurative idiomatic fashion (e.g. *Nous livrons* sur... 'We deliver on...', *Vous témoignez sous*... 'You testify under...') – *Figurative Condition*;
- in 14 sentences there were no prepositions used (e.g. *Le berger garde ses*... 'The shepherd watches his...', *Le chat poursuit une*... 'The cat chases a...') – *Control Condition*.

The incomplete sentences were printed separately on cards along with a choice of four randomly ordered words. There was only one correct choice for each sentence. In the *Concrete* and *Figurative Conditions* this array consisted of the correct word, one word which would fit the sentence were the preposition to be removed, one word which would fit the sentence were there another preposition, and one unrelated word. In the *Control Condition* the array contained one correct word, two words semantically related to one part

of the sentence, and one unrelated word. The patient was instructed to point on silent reading to the word correctly completing each sentence and was given two examples for training.

Results and discussion

L scored 12/14 (85.7% correct) in the *Concrete Condition;* her two errors consisting in picking the word which would fit the sentence, were there another preposition. In the *Control Condition* her score was 13/14 (92.8% correct), but in the *Figurative Condition* she scored only 5/14 (35.7% correct)[4]. Her errors in this latter condition consisted in picking the word which would fit the sentence if there were another preposition (7 cases) or in choosing the word which would fit the sentence if there were no preposition (2 cases). Given this distribution of errors, we are tempted to conclude that a systematic basis exists for L's performance in this condition, even though her score is only slightly above chance level.

The dissociation between the ability to interpret concrete and figurative prepositional relations is of course consistent with the idea of the functionally different status of concrete relational and figurative idiomatic prepositions. It is not their morphological identity but their function as indexical clues which seems to determine the mechanisms responsible for the interpretation of morphologically identical prepositions. Accordingly, morphologically identical prepositions used in different referential contexts may tap different interpretive skills, which may not be equally prone to disruption.

Beyond this general point, it is the pattern of errors made by the patient which deserves attention. Recall that L's errors on figurative idiomatic prepositions consisted most often in treating them as though they were concrete relational prepositions, rather than as though there were no preposition. Could this be so because concrete relational prepositions allow for partial interpretation?

On the other hand that, it could be that, as far as the indexical process is concerned, concrete relational prepositions are themselves a heterogeneous category. For instance, certain relations may be knowledge-constrained (e.g. non reversible), while others may be knowledge independent (e. g. reversible); there may also be polar (e. g. above-below, before-after, up-down) and non-polar relations (e.g. by, for, between). The following experiment was undertaken with the aim of exploring the possibility of a cognitive basis for the distinction between polar and non-polar relations.

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[4] It may be of interest to note that we presented the same material to L a second time, asking her to read aloud the target incomplete sentences and to produce orally the missing word. Her global score on this auxiliary experiment was 40/42; she failed to provide an answer for one sentence and made only a single error producing a word which would fit the sentence, were there another preposition. Both errors occurred in the condition of Idiomatic Figurative prepositions.

EXPERIMENT 5: POLAR VS. NON POLAR RELATIONS

The aim of this last experiment was to evaluate L's sensitivity to polar and non-polar relations marked by prepositions. In doing so we decided to avoid creating too large a trap, which would have led her to errors she would not have made under normal circumstances.

Materials and procedure

L was presented with a picture and a choice of four sentences which differed only with respect to the preposition used. 10 pictures featured conceptually non-polar relations (e.g. *L'écharpe est autour du cou* 'The scarf is *around* the neck') and the choice consisted of the correct preposition and of three relationally inappropriate prepositions. 10 pictures featured polar conceptually reversible relations (e.g. *Le lampadaire est derrière le fauteuil* 'The lamp is *behind* the armchair') where the choices consisted of the correct preposition, the reverse relation preposition, and two relationally inappropriate prepositions. The patient was requested to make her choices on silent reading.

Results and discussion

L made only a single error (90% correct) on conceptually non-polar relations and 7 errors (30% correct) on polar, conceptually reversible relations, choosing each time the reverse relation foil. This latter finding suggests that L was sensitive to prepositions indexing polar reversible relations and was able to select the proper relational axis. But in contrast to conceptually non-polar relations, where the determination of the relational axis may suffice for correct interpretation, in the case of polar relations she had to go beyond the mere identification of the relational axis and orient it properly. L was apparently unable to conduct successfully this latter operation, even under the testing condition of a picture-to-sentence matching task, which is generally believed to be easier than a sentence-to-picture task. Thus, although the small amount of data gathered does not allow us to make any strong statements on this issue, the possibility that the relational axis of concrete relational prepositions is accessible to agrammatic patients even when they are unable to grasp its proper direction (and thus eventually choose the reverse relation preposition, but not a different relation preposition) merits further examination.

GENERAL DISCUSSION

The present study should be viewed in two ways. Part of it is mainly informative, describing a configuration of deficit and preservation in reading (e.g. silent vs. oral reading behavior, semantic paralexias in spite of the ability to identify letters) as yet unreported in the literature. This configuration is not only informative as regards our knowledge of the variety of reading disorders, and appears to be relevant to the issue of the modality-dependent

character of deficits in language comprehension, but it also opens new avenues for the study of acquired dyslexias and comprehension disorders. For instance, much as the discovery that patients unable to identify letters may nevertheless be able to read content words bolstered the dual-route models of word recognition, postulating a direct uptake of orthographic information, the finding that the ability to identify letters does not prevent the appearance of semantic paralexias may prompt new studies into the way global (orthographic) and local (sublexical) processes interact in visual word recognition. Rosenthal (2004) actually took up this issue to develop a microgenetic theory of reading based on the idea of a global-to-local development, in which meaning goes hand in hand with perceptual categorization, developing from vague and general to definite and specific (Rosenthal 2004).

The other part of this study is exploratory, and as such is meant to be suggestive rather than demonstrative. The small amount of empirical data clearly does not allow us to make strong statements on any issue taken up in Experiments 1-5, and indeed all of the above-reported results need to be independently corroborated in a more elaborate fashion. Yet, on the one hand, some of these findings (e.g. sensitivity to number agreement and to tense marks) coincide with other reported data, while on the other, the patient's behavior appears to be too systematic, both in terms of correct vs. incorrect performance and in terms of the nature of the errors produced, not to give some credence to the present results. In particular, we submit that the idea of the indexical-integrative character of agrammatic disorders in comprehension determined by the developmental hierarchy of indexical processes deserves further investigation. We also predict a developmental hierarchy, whereby verb-plus-particle constructions will be best preserved in the language comprehension of (English and German-speaking) agrammatics, concrete relational prepositional phrases partly preserved (at a minimum the relational axis), and idiomatic figurative prepositions the least preserved.

The question arises as to whether the issue of agrammatic comprehension in reading is at all pertinent, given, as Caramazza and his colleagues affirmed some time ago, the very dubious character of the concept of agrammatism. Note that the thrust of the whole crusade against the concept of agrammatism was based on the alleged empirical demonstrations of huge between-patient differences. But this raises several problems. For instance, while the earlier (criticized) studies bore on agrammatic comprehension, Caramazza and his colleagues chose production studies for their demonstration of variability. Part of the problem with this is that, due to the immense variability in vocabulary and syntactic structures produced by normal speakers, it may first be necessary to provide an account of the variations in normal language production prior to taking up between-patient variations in aphasics' productions as evidence sustaining the claim that agrammatism is an empty category. Moreover, it may have been more judicious to choose comprehension rather than production studies, as the former tend to mini-

mize between-subject variations[5], and consequently the finding of important variations (in spite of the minimizing effect) would thus be highly significant to their proposal. Lastly, patients should be compared on the same tasks (fragmented spontaneous speech recordings done in different contexts hardly qualify for the same tasks), and the body of data for various items of comparison should be roughly equivalent in size. Unfortunately, this is not what Caramazza and his colleagues provided in their case against agrammatism[6].

We are thus still tempted to believe that agrammatism is a theoretically pertinent though clinically variable phenomenon. This variability, instead of being an obstacle to research, may rather be instrumental (via comparative studies) to meaningful investigation of the developmental hierarchy of interpretive processes. In any case, it is only on the basis of an articulate theory of language comprehension (or production) that one will be able to specify which patterns of language breakdown constitute a meaningful category.

ACKNOWLEDGEMENTS

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[5] Comprehension studies tend to minimize between-subject variations due to their necessarily rigid structure, whereas production studies tend to maximize such variations, if only because there is an indefinite number of ways to say roughly the same thing.

[6] A closer look at the empirical demonstrations of variability offered by Caramazza and his colleagues unveils rather curious methodological principles. For instance, Table 6 in Miceli et al. shows that patient A.A. makes 66.7% errors on prepositions, whereas patients G.D.C. and E.D.U., respectively, 83.3% and 10.9%. So far so good. However, looking at the number of contexts where prepositions were obligatory according to Miceli et al.'s analysis, it turns out that there were 9 contexts in the speech of A.A., 18 in the speech of G.D.C., and 110 in the speech of E.D.U.! That indeed makes a huge variation. Kolk and Heeschen also point to such "innovative" use of statistical arguments by Badecker and Caramazza.

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