Comprehension of metaphors and idioms in patients with Alzheimer’s disease
A longitudinal study

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Summary
Language in patients with Alzheimer’s disease has been extensively studied, with the exception of non-literal language comprehension. However, in our speech, we often make use of expressions, which are not necessarily interpreted on a literal ground. Comprehension of metaphors and idioms was examined in 39 patients with probable early Alzheimer’s disease. The results showed that the decline of figurative language is not an early symptom of dementia and can occur independently from the impairment of propositional language. It was also found that metaphors and idioms differ as far as the predominant kind of error is concerned.

Keywords: metaphors, idioms, Alzheimer’s disease

Abbreviations: MODA = Milan Overall Dementia Assessment; TT = Token Test

Introduction
In our speech, we make use of expressions, which are not necessarily interpreted on a literal ground; these are metaphors and idioms. For example, the Italian expression ‘Carlo è un coniglio’ (literally: ‘Charles is a rabbit’) is a metaphor meaning that he is a coward. Or ‘alzare il gomito’ (literally: ‘to lift the elbow’) is an idiom, which means ‘to drink too much’. There are several theories attempting to explain how metaphors (for example, see Blasko and Connine, 1993) and idioms (Swinney and Cutler, 1979; Cacciari and Tabossi, 1988) are understood. Two basic theoretical approaches have been taken for both.

In the case of metaphors, the first approach is a ‘direct’ one, suggesting a process immediately from the information at hand, without first requiring an initial literal interpretation to be computed and rejected. Two different processing mechanisms have been suggested: one theory proposes that highly salient features of the metaphor vehicle are compared with less salient features of the subject term (Ortony, 1979), while the second explains metaphor comprehension by a simple class inclusion process (Glucksberg and Keysar, 1990). In the first case, the metaphor ‘John is a rabbit’ may be comprehended by applying the main feature of the rabbit (fearful) to the subject (John). According to the inclusion model, the subject ‘John’ would be temporarily assigned to the ad hoc category exemplified by the vehicle ‘rabbit’ (entities that are extremely fearful). In other words, the metaphor vehicle (rabbit) is used to refer to the category of fearful creatures in general, not to the specific creature named ‘rabbit’. ‘Rabbit’ may be considered a conventional vehicle for attributing properties to a topic of interest. Such conventional vehicles form part of the set described by Lakoff and Johnson as ‘metaphors we live by’ (Lakoff and Johnson, 1980).

The second approach to explain metaphor comprehension is an ‘indirect’ one (Searle, 1979). First, an attempt is made to interpret the metaphor literally; if it is found to be defective, then a search for a non-literal interpretation is triggered.

A third possibility has been considered, namely that the context can help in discovering the metaphorical meaning before the incongruous literal meaning has been accessed (Gildea and Glucksberg, 1983). A context-dependent account of metaphor comprehension is also supported by an event-related potential study on normal subjects (Pynte et al., 1996). Event-related potentials were recorded while subjects were reading short familiar metaphors, unfamiliar metaphors or literal sentences, presented in isolation or preceded by either an irrelevant or relevant context. The final word of the metaphors elicited larger N400 components than the final word of the literal sentences did, suggesting that the incongruous literal meaning of metaphors was indeed
accessed at some point during comprehension. The analysis of the late positive components revealed no significant difference between metaphors and literal sentences. The manipulation of metaphor difficulty also failed to reveal any late effect specifically linked to metaphorical processing. An effect of the previous sentence context was found as early as 300 ms following the final word onset. These results are interpreted as supporting a context-dependent account of metaphor comprehension stating that when contextually relevant, the metaphorical meaning is the only one accessed.

In the case of idioms, there are two main theories. The ‘lexical representation hypothesis’ suggests that idioms are mentally represented and processed as lexical items, i.e. particularly long words (Swinney and Cutler, 1979). Alternatively, the ‘configurational hypothesis’ (Cacciari and Tabossi, 1988) proposes that idiomatic expressions may be mentally represented and processed not as words, but rather as configurations of words whose meaning becomes activated whenever sufficient input has rendered the configurations recognizable. Gibbs (1992) claims that idioms have complex figurative interpretations that are not arbitrarily determined and he suggests that people often infer specific meanings for idioms that are more complex than is implied when people read simple literal paraphrases of these expressions. It is also pointed out that when people understand non-literal expressions such as idioms, literal meanings need not be derived at all (Gibbs, 1984).

Metaphors and idioms are different aspects of figurative language. Actually, while idioms are strings of words whose meaning cannot be derived from the analysis of the words’ typical meaning (Gibbs, 1999), in other words they are ‘conventionalized’ (Nunberg et al., 1994); a metaphor is the use of language that designates one thing to represent another in order to characterize the latter in terms of the former (Glucksberg, 1999).

As far as the anatomical correlates are concerned, a PET study in normal subjects (Bottini et al., 1994) has shown activation of both right and left hemisphere regions when normal subjects decide whether or not a sentence is plausible as a metaphor. Also, an investigation of semantic priming for literal and metaphoric associates presented to either the left or the right visual field supports a role of the right hemisphere in metaphoric comprehension (Anaki et al., 1998). In this study, priming effects were obtained for metaphorically related targets for the left visual field (right hemisphere), while literally related targets were primed solely for the right visual field (left hemisphere). No similar studies of idiom comprehension have been found.

Information available on non-literal language comprehension in brain-damaged patients is quite poor. Winner and Gardner found that aphasics patients (detailed data on aphasia are not available) were able to perform correctly when they had to associate metaphoric expressions with the corresponding picture; right brain-damaged patients, despite being able to give correct verbal explanations, chose the picture corresponding to the literal meaning (Winner and Gardner, 1977). Similar results were shown by later studies on non-literal language in brain-damaged patients, both for metaphors (Foldi, 1983) and idioms. Van Lancker and Kempler had patients with left damaged patients and patients with right hemisphere damage select the appropriate line drawing that corresponded to a sentence containing a figurative phrase (Van Lancker and Kempler, 1987). One drawing was related to the literal interpretation of the idiom and another to the figurative one. Another two drawings depicted a scene that was either opposite in meaning to the idiom or was irrelevant. Patients with left hemisphere damage (who presumably have impaired syntactic capabilities) outperformed the patients with right hemisphere damage on the figurative sentences (for a review on the cerebral asymmetries in metaphor and idiom comprehension, see Burgess and Chiarello, 1996). The interpretation of these data is that right brain damage impairs comprehension and use of contextual information to derive meaning. Taken together, these observations concur to suggest that right hemisphere processes are involved in the non-literal aspects of language.

Language in patients with Alzheimer’s disease has been extensively studied (for a critical review, see Luzzatti, 1990), verbal communication disorders are described as very frequent and early (Capitani et al., 1986). Alzheimer’s disease patients show impairment in spontaneous speech with prominent disturbances of communication and semantics, while phonematic structures are preserved (Romero and Kurz, 1996).

Some information is available on metalinguistic judgements in Alzheimer’s disease (Kemper, 1997), but there are no studies on non-literal language comprehension, except Winner and Gardner’s study on brain-damaged patients, where a third group of subjects, seven demented patients, was examined (Winner and Gardner, 1977). These subjects showed a response pattern similar to the right hemisphere damaged patients. However, it is not clear how the diagnosis of dementia was made and how severe the cognitive impairment was.

In the present study we investigated the impairment of figurative language comprehension in a group of 39 Alzheimer’s disease patients. Moscovitch and Umiltà have suggested that non-focal brain damage, such as dementia, may provide useful evidence for the modular view of the cognitive system (Moscovitch and Umiltà, 1990). They argue that if a function remains intact in spite of gross intellectual loss, the conclusion can be drawn that the function is informationally encapsulated, i.e. its output is unaffected by general knowledge. Furthermore, the degenerative pathology of Alzheimer’s disease allows the follow-up of the cognitive impairment. In this way, one can examine the consistency exhibited by Alzheimer’s disease patients in performing the tests over repeated administrations.

The aim of this study was: (i) to verify the level of impairment of figurative language in early dementia and the evolution of this aspect of language during the progression
of the disease [considering that mild Alzheimer’s disease usually involves the left hemisphere before the right (Capitani et al., 1990), we would expect a minor impairment of figurative language compared with literal language]; (ii) to look for single cases in order to detect different patterns of impairment in performance of linguistic tasks, namely a literal language comprehension deficit in the absence of an impairment of metaphor and idiom interpretation or vice versa; (iii) given that metaphors and idioms are different aspects of figurative language, to investigate a possible independent impairment of each of these two aspects of non-literal language.

Material and methods
Subjects
Subjects were sampled among a continuous series of 100 patients who came for a first evaluation at the Alzheimer Regional Centre of the San Paolo Hospital in Milan between May 1995 and June 1996.

The inclusion criteria were the following: (i) a score at a screening test for dementia (Milan Overall Dementia Assessment, Brazzelli et al., 1994) between 60 and 85. This is an index of mild to moderate degree of illness (normal score ≥89.1, pathological score ≤85); (ii) a normal comprehension of easy commands, such as ‘open the book’ or ‘lift your left hand’, taken from the Milan Aphasia Examination Battery (Basso et al., 1976); (iii) a minimum of 5 years of education; (iv) a premorbid use of language of a sufficient level (a score of at least 4 in a questionnaire of premorbid use of language, which demonstrates good knowledge of colloquial Italian); (v) no previous neurological or psychiatric illness; and (vi) no lesions detectable by CT-scan.

Sixty patients out of 100 were excluded from the study. The patients were excluded for different reasons. Twenty patients did not achieve the minimum score; 18 had a score over 85; eight patients did not complete the examination; in eight cases the diagnosis was a different one; five subjects were illiterate; one had psychotic symptoms and in one case each section has a range of 0 to 85; eight patients did not complete the examination; in five ve subjects answer is 5, with a total maximum score 8.61, range 54–84 years) and mean educational level was 8.2 years (SD 3.66, range 5–18 years).

Twenty-three patients from this group were submitted to a second evaluation 6–8 months later. Sixteen patients did not undergo the second examination for different reasons: (i) in four the cognitive impairment had become very severe, preventing any further testing; (ii) three patients refused a second examination; and (iii) nine patients could not be contacted again.

Material
The following tests were used.

Milan Overall Dementia Assessment (MODA) (Brazzelli et al., 1994)
This test includes three sections: the first part (score range 0–35) verifies temporospatial orientation and personal semantic memory (date and place of birth, personal address, etc.); the second (score range 0–15) evaluates the degree of autonomy of the patient; and the third (score range 0–50) examines cognitive abilities (attention, verbal intelligence, verbal memory, language, visuoperceptual abilities and constructional apraxia). Each section has its own score; the total score (range 0–100) is the sum of the partial scores and has to be adjusted for age and educational level.

Premorbid use of language (H. Spinnler, unpublished)
This test consists of a questionnaire, containing four sections about the use of language in the year before the onset of symptoms. The first part asks questions about oral language (use of correct Italian, use of Italian with dialect expressions, only dialect use, etc.). The second investigates the patient’s written language (no use at all, use for private reasons, for work, etc.). The third section of questions investigates the use of language in social life (e.g. political or religious activities, theatre, etc.). Finally, the last section is concerned with the use of television, radio and reading. For each question there is a different score, depending on whether the answer is ‘often’, ‘sometimes’ or ‘not at all’. The score for each section has a range of 0–5, with a total maximum score of 20. The questionnaire has to be performed with a relative.

Comprehension of oral commands (Basso et al., 1979)
This is a subtest of the Aphasia Examination Battery in use at the Milan Aphasia Rehabilitation Centre. It comprises 10 verbal commands that the subject has to perform immediately after presentation. No repetition of the order is admitted. A correct execution is scored 1, while an incorrect execution followed by a correct one is scored 0.5. The score varies between 0 and 10. Patients with an errorless performance were included in the study, to make sure that they were able to follow instruction.
Token Test (TT) (De Renzi and Faglioni, 1978)
The shortened version of the TT was used to assess oral comprehension of propositional language. This test has been shown to be a reliable measure of the aphasias aspects of language impairment in Alzheimer’s disease patients (Della Sala et al., 1993).

Verbal fluency (Novelli et al., 1986)
The patients were submitted to a test of verbal fluency on semantic cue to assess verbal production. A modified, shortened version of this task was used (normal value adjusted for age and educational level ≥9.5).

Metaphor comprehension (Papagno et al., 1995)
In this test, a nominal metaphor is presented to the subject who has to give a verbal explanation of its meaning. Common, conventional metaphors were used, as the goal of the study was to assess the comprehension of figurative expressions that are normally used in language and that Alzheimer’s disease patients should have known, but could have ‘lost’ in the progression of the disease. An example of a metaphor is ‘Marco è un leone’ (Mark is a lion). The test includes 20 items.

The score is 2 (strong and brave) or 1 (strong or brave) depending on how accurate the subject is, or 0 if a wrong or literal explanation is given. All the nominal metaphors allow an interpretation in terms of a conjunction of attributes or ‘power’ of the attribute (for example, in the case of ‘Marco è un top’, ‘good’ is scored 1 and ‘very good’ or ‘excellent’ is scored 2). The correct explanation is considered to be the one found in the common Italian dictionaries (e.g. see Zingarelli, 1978). Scores are adjusted for age and educational level (normal value ≥13).

Idiom comprehension (Papagno et al., 1995)
This test includes 20 sentences (idiomatic phrases, as identified by Nunberg et al., 1994), which are opaque idioms (the meaning cannot be deduced from the figuration it involves) that the subject has to explain. Again, each item is scored 2 or 1 according to the accuracy of the explanation, and 0 if a wrong or literal explanation is given or no answer is produced. For example, the idiom ‘essere al verde’ (literally ‘to be at the green’) means ‘to be completely out of money’: this answer is scored 2. An answer such as ‘to be poor’ is scored 1. Like the previous test, the correct explanation is considered to be the one found in the common Italian dictionaries (e.g. see Devoto-Oli, 1967). Scores are adjusted for age and educational level (normal value ≥13).

Normative data were obtained from a sample of 321 normal subjects, with age and educational level ranges, respectively, of 20–79 years and 5–13 years of schooling (for further details, see Novelli et al., 1995). The normal subjects were sampled among the relatives of the patients admitted to the Policlinico of Milano; in order to complete the missing data of some cells of the sample, ~15% of the normal controls were sampled among the acquaintances of the authors. All were free of actual or past overt neurological diseases, and were not taking drugs active on the nervous system, except for 21 subjects who sometimes took low doses of benzodiazepines for the treatment of mild sleep disorders.

The non-parametric one-tailed lower 5% tolerance limit (with 95% confidence interval) (Wilks, 1941) is 13 for both, metaphors and idioms. Equivalent scores refer to corrected scores ranked in order of increasing magnitude, from 0 (the non-parametric one-tailed lower 5% tolerance limits) to 4.

Procedure
A cognitive–behavioural history of each patient was taken with a relative or somebody closely related to the patient to detect initial symptoms of Alzheimer’s disease. An interview about premorbid use of language was also carried out at this time. Finally, the subject was submitted to the MODA, in order to assess the level of cognitive impairment, and to the test of comprehension of oral commands to make sure that his/her comprehension allowed understanding of the instructions of each test. After this preliminary evaluation, if the criteria of inclusion were satisfied, the patient entered the study.

Twenty-three patients were submitted to a second evaluation after an interval of 6–8 months, to investigate the evolution of the cognitive deficits.

Results
First examination
Clinical data and neuropsychological scores of the 39 patients are given in Table 1. The MODA mean score of the Alzheimer’s disease patients included in the study was 74.72 (SD 5.57, range 62.8–85.7). Nineteen patients (48.71%) showed normal performance in all language tests. Two patients (5.12%) were globally impaired in production and comprehension. Two more patients (5.12%) showed an equivalent score of 0 in non-literary language comprehension tests. This means that only four patients out of 39 (10.25%) showed an impairment of figurative language comprehension (for the remaining distributions of patterns of impairment, see Table 2).

Eleven patients (28.2%) showed a double dissociation between propositional and figurative language comprehension. However, we decided to consider only the extreme values as dissociated, i.e. those cases with an equivalent score of 0 in one test and 3 and 4 in the other. We did this because we do not know the exact distribution in normal subjects of the differences between the original scores in the tests (Papagno et al., 1993). We then left a ‘no decision’ area, to make sure that only valid double dissociations would
In three cases (Cases 15, 17 and 18), there was a pathological impairment in figurative language (six with an impairment of propositional patterns of impairment). No. of patients

Table 2 Distribution of patterns of impairment

Patterns of impairment

<table>
<thead>
<tr>
<th>Normals</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT+/non-literal+/fluency−</td>
<td>1</td>
</tr>
<tr>
<td>TT+/non-literal−/fluency+</td>
<td>1</td>
</tr>
<tr>
<td>TT−/non-literal−/fluency−</td>
<td>0</td>
</tr>
<tr>
<td>TT−/non-literal−/fluency+</td>
<td>4</td>
</tr>
<tr>
<td>TT+/non-literal+/fluency−</td>
<td>5</td>
</tr>
<tr>
<td>TT+/non-literal−/fluency+</td>
<td>2</td>
</tr>
<tr>
<td>TT+/met+/idioms–/fluency−</td>
<td>1</td>
</tr>
<tr>
<td>TT+/fluency+/met+/idioms−</td>
<td>1</td>
</tr>
<tr>
<td>TT−/fluency+/met+/idioms−</td>
<td>1</td>
</tr>
<tr>
<td>TT−/fluency+/met+/idioms+</td>
<td>2</td>
</tr>
<tr>
<td>TT+/fluency+/met−/idioms+</td>
<td>1</td>
</tr>
</tbody>
</table>

For TT, verbal fluency, metaphor and idiom comprehension, scores are expressed as equivalent scores. Values in brackets = adjusted scores. F = female; M = male; Interval = interval (in months) between approximate onset of symptoms and first evaluation; PUL = premorbid use of language.

be included. Even with this constraint, eight patients still showed a double dissociation between propositional and figurative language (six with an impairment of propositional language only, and two with the opposite pattern). Finally, there was one patient (No. 29 in Table 1) showing preserved metaphor comprehension (score 3) and impairment in the TT and idiom comprehension (scores 0).

There were no cases where all three comprehension tests were impaired and controlled association normal, while there were two cases with normal lexical production and normal non-literal language comprehension tasks but a pathological TT score (Cases 30 and 36). In three cases (Cases 15, 17 and 20) lexical production and TT performance were impaired, but not metaphor and idiom comprehension, while in one case (Case 26) TT scores and controlled association were normal,
but not non-literal language comprehension. Finally, one subject (Case 13) had a normal TT score, but impaired performance on the other tasks.

Correlation coefficients between MODA and TT scores, idiom comprehension, metaphor comprehension and verbal fluency were, respectively: 0.13, 0.35, 0.31 and 0.33.

### Analysis of errors in non-literal language

Two raters further classified the errors (responses for which the patient obtained a score of 0), considering the characteristics of the response. Four categories were identified. For example, in the item ‘that woman takes bread out of her mouth for her children’, a response such as ‘she gives her bread to her children’ was considered a concrete/literal interpretation. ‘She is having much more bread than her children’ was considered the opposite interpretation. ‘Life is hard if you don’t have money for bread’ was simply a wrong/insufficient interpretation. Finally, in some cases the patients did not give any response. Approximately the same number of errors were found for both classes of non-literal expressions, but with a different distribution (see Table 3).

### Idioms

Three hundred and fifteen errors were distributed as follows: 129 (40.95%) were of the wrong/insufficient category, 149 (47.3%) were ‘literal or concrete’ interpretations, in 30 cases (9.52%) there was no response, and only seven (2.2%) opposite explanations to the correct one were given.

### Metaphors

From a total number of 293 errors, 171 (58.3%) were simply wrong or insufficient, 75 (25.59%) were literal interpretation, 27 (9.2%) were no-responses and 20 (6.8%) were opposite to the correct response.

An analysis of Brandt and Snedecor was performed in order to assess if (i) the difference in the type of errors between metaphors and idioms was significant, (ii) the difference between correct responses and errors for metaphors and idioms was significant and (iii) one error category was more frequent than others. The general $\chi^2(4)$ was 37.26 ($P < 0.001$), showing that the kind of answers varied between metaphors and idioms. Decomposition of the four degrees of freedom into additive components showed the following: (i) there was no significant difference between correct and incorrect answers to metaphors or idioms [$\chi^2(1) = 1.31$, n.s.]; (ii) for metaphors, wrong/insufficient answers or no response were more frequent than literal or opposite responses, when compared with idioms [$\chi^2(1) = 18.29, P = 0.001$]; (iii) literal answers were more frequent than opposite ones, and this was particularly evident for idioms [$\chi^2(1) = 15.88, P = 0.003$]; and (iv) there was no significant difference between wrong/insufficient and no response for metaphors and idioms [$\chi^2(1) = 1.77$, n.s.].

### Second examination

Twenty-three patients, 12 women and 11 men, underwent a second examination. Mean age was 74.3 years (SD 7.55, range 57–84 years), mean educational level 8.34 years (SD 3.63, range 5–18 years). The MODA mean score was 68.53 (SD 15, range 63.7–82). Clinical data and neuropsychological scores are given in Table 4.

Nine patients (39.1%) still showed normal performance on language tests, while two (8.69%) were impaired in all tests. Verbal fluency was impaired in nine patients, four of whom were normal at the first examination. One patient (No. 10 of Table 1 and No. 6 of Table 4) showed an impairment in metaphor comprehension and controlled association, while other tests were normal. Five patients showed a double dissociation between literal and non-literal language comprehension, and more precisely three had normal literal language but not figurative, while the other two showed the opposite pattern. However, only one patient (No. 20 in Table

### Table 3 Error distribution

<table>
<thead>
<tr>
<th></th>
<th>Correct</th>
<th>Wrong/insufficient</th>
<th>Literal</th>
<th>No answer</th>
<th>Opposite</th>
</tr>
</thead>
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<tr>
<td>Idioms</td>
<td>465</td>
<td>129</td>
<td>149</td>
<td>30</td>
<td>7</td>
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<tr>
<td>Metaphors</td>
<td>487</td>
<td>171</td>
<td>75</td>
<td>27</td>
<td>20</td>
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</table>

### Table 4 Follow-up of 23 Alzheimer’s disease patients after 6–8 months

<table>
<thead>
<tr>
<th>Patients</th>
<th>MODA</th>
<th>Fluency</th>
<th>Token Test</th>
<th>Metaphor</th>
<th>Idioms</th>
</tr>
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<tr>
<td>1 (1)</td>
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<td>2 (31.5)</td>
<td>4 (26.75)</td>
<td>4 (34.5)</td>
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<tr>
<td>2 (5)</td>
<td>70.8</td>
<td>2 (12.5)</td>
<td>2 (30.5)</td>
<td>3 (20.75)</td>
<td>2 (19.5)</td>
</tr>
<tr>
<td>3 (7)</td>
<td>74.4</td>
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<td>1 (27.5)</td>
<td>4 (24.25)</td>
<td>3 (21.5)</td>
</tr>
<tr>
<td>4 (8)</td>
<td>72</td>
<td>0 (9.5)</td>
<td>1 (27.5)</td>
<td>3 (19.75)</td>
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<tr>
<td>5 (9)</td>
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<tr>
<td>6 (10)</td>
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<td>8 (12)</td>
<td>77.1</td>
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<td>4 (33.5)</td>
<td>3 (21.75)</td>
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<td>9 (13)</td>
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<tr>
<td>23 (39)</td>
<td>72</td>
<td>2 (10.5)</td>
<td>4 (33.75)</td>
<td>2 (18.75)</td>
<td>2 (17.5)</td>
</tr>
</tbody>
</table>

In the column headed ‘patients’ numbers in brackets correspond to the number of the patient in Table 1. For the other columns see Table 1 legend.
4, corresponding to No. 36 of Table 1) satisfied our condition of an ‘extreme’ dissociation, with a TT equivalent score of 0 and the other two equivalent scores of 3. The patient already showed this pattern at the first examination and his performance did not change significantly. His verbal production was still normal.

Correlations between level of cognitive impairment as assessed by MODA and TT, verbal fluency, metaphor comprehension and idiom comprehension were, respectively 0.04, 0.02, 0.36 and 0.19. As expected, a one-way ANOVA (analysis of variance) showed that Alzheimer’s disease patients underwent global cognitive decline over time \[F(1,44) = 11.749, P = 0.0013\]. Significant decrements were observed for verbal fluency \[F(1,44) = 6.332, P = 0.015\] and the decrement attained significance for metaphor comprehension \[F(1,44) = 4.484, P = 0.04, \text{ Fisher-test 3.425 significant at 95\%}\], while there was no significant difference between the first and the second examination for idioms \[F(1,44) = 0.967, P = 0.33\] and for TT \[F(1,44) = 3.346, P = 0.07\].

**Discussion**

In this study 39 Alzheimer’s disease patients were examined in order to assess non-literal language comprehension; 23 underwent a second examination to evaluate the progression of the disease. Language impairment did not appear to be an early symptom in our patients, and, in particular, figurative language comprehension was preserved in most of the Alzheimer’s disease subjects, even at a later stage. We will discuss the main results of this study in detail.

**Impairment of language in early dementia and evolution**

As already mentioned, language was not seriously impaired in our series of patients at a very early stage of the illness. Almost half of the Alzheimer’s disease patients had normal scores in all language tests, while only two showed an overall impairment and just four more patients were only defective on tests of propositional language. The least impaired linguistic ability appeared to be figurative language. One objection could be that patients were selected so as to have good comprehension in order to perform the test, and consequently there could be a bias in our sample. However, no patients had to be excluded from the study because of an insufficient performance at the verbal command comprehension test, as explained in the Material and methods section.

At the second examination, language had worsened; in particular, as expected, verbal fluency was reduced in a consistent number of patients and the decrement was significant, even if the global deterioration was still mild (no patient had a score in the global assessment for dementia lower than 63). The fact that mildly impaired Alzheimer’s disease patients have been found to show reduced production in tests of verbal fluency on semantic cue is well known (Martin and Fedio, 1983). Moreover, several studies have pointed to a greater impairment for semantic than for phonemic categories (e.g. see Monsch et al., 1994). However, Chertkow and Bub have suggested that verbal fluency reflects semantic memory loss only to some degree, being due to variable difficulties in semantic search (Chertkow and Bub, 1990). By contrast, comprehension did not significantly worsen, except for metaphors. The possible implications of this result are discussed in the next session.

**Dissociation between literal and non-literal language comprehension**

A dissociation between these two aspects of language was found. An impairment of propositional language with preservation of figurative comprehension appeared to be more frequent than the opposite pattern. But the fact that two patients with normal TT scores were impaired in non-literal language comprehension disproves the possibility that metaphor and idiom comprehension is simply an easier task than TT. Moreover, the fact that one of these two patients had normal verbal fluency rules out the objection that a deficit in production was the reason why subjects could not ‘explain’ metaphors and idioms.

One first issue to briefly point out concerns theoretical implications. The fact that metaphor comprehension is normal in the presence of impaired literal comprehension, makes Searle’s indirect hypothesis unlikely (Searle, 1979). However, the number of patients with a deficit on propositional tests and not on figurative tests is too small for these data to generate a definite conclusion.

A second issue concerns the different functional mechanisms involved in propositional as opposed to figurative language comprehension.

Regarding literal language comprehension, Alzheimer’s disease patients have been found to be impaired in comprehending referring expressions, such as pronouns, and this has been considered to be a consequence of normal discourse processing in the context of a working memory impairment (Almor et al., 1999). Alzheimer’s disease patients do indeed show a mild to moderate deficit of working memory (Morris and Baddeley, 1988). Recently, Bickel and colleagues have shown that German Alzheimer’s disease patients present difficulties with all types of syntactic structures and their performance is significantly influenced by the degree of cognitive impairment (Bickel et al., 2000). A pathological reduction in the capacity of phonological memory would interfere with the patient’s ability to process syntactic information (for review, see Caplan and Waters, 1990). In the case of a working memory impairment, sentence comprehension would be defective when the linear arrangement of words provides crucial information, and lexical–semantic analyses do not constrain meaning, such as in the TT tasks (Vallar and Papagno, 1995).
In the case of non-literal language, adequate comprehension does not only rely upon the processing of order-dependent syntactic information, and therefore working memory impairment is not sufficient to explain a deficit. Therefore, other factors should be taken into account.

A factor that has been advocated to explain new metaphor comprehension is episodic memory (for a discussion of this view, see Bottini et al., 1994). However, there is a general agreement that disorders of episodic memory are the earliest and most consistent deficit in Alzheimer’s disease (McKhann et al., 1984) and the reason why the patients came to observation. In contrast, as already mentioned, metaphor and idiom comprehension has rarely been found to be impaired at the beginning of the illness. Moreover, a recent study of metaphor and idiom comprehension in a patient diagnosed with Down’s syndrome did not suggest any relationship with episodic memory (Papagno and Vallar, 1994).

A recent investigation (Nebes and Halligan, 1996) has shown that Alzheimer’s disease patients retain knowledge of semantic attributes and these attributes are susceptible to contextual activation. The authors suggest that in Alzheimer’s disease patients, as in normals, sentence context can selectively prime certain aspects of a word’s meaning, transiently increasing the saliency of attributes that, while not central to the typical meaning of the word, are relevant to that particular context. In the case of figurative language comprehension, the sentence context would enable the patient to give the correct explanation, as has been suggested in normals, for idioms (Cacciari and Tabossi, 1988) and for metaphors (Pynte et al., 1996). Such activation, however, does not persist for a long time. As Alzheimer’s disease patients become increasingly demented, there may be a point at which context no longer selectively activates concept properties. This could perhaps explain why metaphor comprehension consistently decreased over time. The fact that idioms are typically associated with relatively informal or colloquial registers (Nunberg et al., 1994) could be the reason why they seem to be more resistant to cognitive decline.

A last point to be considered concerns the possible anatomical correlates of figurative language. Burgess and Chiarello reviewed evidence showing that the right hemisphere makes an important contribution to inferencing, and point to differences in how the two hemispheres initially retrieve information: the right hemisphere does not actively select information, but produces a broader field of semantic activation than the left hemisphere (Chiarello, 1985; Burgess and Chiarello, 1996). This process plays an important role in understanding figurative language, particularly when the metaphor is not supported well by context (Burgess and Chiarello, 1996). However, even if it seems apparent that without the contribution of the right hemisphere, language would be greatly impoverished, a strict dichotomy of figurative and literal language is likely to be false (Lakoff, 1994). The results with brain-damaged patients suggest that the right hemisphere is involved in comprehension and use of contextual information to derive meaning (Van Laecker and Kemper, 1987).

Impaired figurative language comprehension in our subjects could reflect the degenerative process in the right hemisphere. The fact that metaphor and idiom comprehension proved to be the least impaired task in our series, could be interpreted in line with a sparing of the right hemisphere structures in the early stage of Alzheimer’s disease. Right hemisphere impairment was evident in only a minority of subjects. However, an inspection of the records for the screening of dementia (which include ‘right hemisphere tasks’) did not show any significant difference in visuospatial abilities between those patients who were or were not impaired in non-literal language. Furthermore, there were no elements in the clinical history of these patients pointing to a particular damage of the right hemisphere, such as perceptual deficits or constructional difficulties. Moreover, the unique role of the right hemisphere in the activation of metaphoric meaning has been challenged in a recent study (Faust and Weisper, 2000), investigating hemispheric asymmetries in metaphoric word meanings comprehension within a sentence context. Participants were presented with incomplete priming sentences followed by (literally) true, false or metaphoric lateralized target words and were asked to decide whether each sentence was literally true or false. Results showed that responses to metaphoric sentences were slower and less accurate than to false sentences when target words were presented to the right visual field as well as to the left. It was suggested that the understanding of lexical metaphors within a sentence context involves left hemisphere as well as right hemisphere processing mechanisms, and the role of each hemisphere in processing non-literal language is flexible. It could be suggested that a distributed neural network subserving different aspects of figurative language comprehension, rather than a single brain region, is responsible for understanding metaphors and idioms, analogous to the hypothesis suggested for literal language (Grossman et al., 1998). A regional cerebral perfusion study on non-literal language comprehension in Alzheimer’s disease patients could help to clarify the topic.

**Figurative language comprehension: differences between metaphors and idioms**

As explained in the introduction, metaphors and idioms are different aspects of figurative language. Therefore, they may be expected to be impaired independently. Only one patient with normal metaphor comprehension and impaired idiom interpretation was observed. No patients with the opposite pattern were seen (if we consider ‘strong’ dissociations).

However, as shown in the Results section, metaphors and idioms differed as far as the predominant kind of error was considered. While for idioms the literal interpretation was the most frequent wrong answer, for metaphors an attempt was made to search for a figurative meaning, but this proved
to be only partial or incorrect. We must be cautious, however, in interpreting these data. Indeed, seven idioms were ambiguous (e.g. ‘to put his/her hands in his/her hair’), and they could have enhanced a literal interpretation more easily than metaphors. The incongruity of the metaphor would perhaps trigger an alternative interpretation. Future research should concentrate only on non-ambiguous idioms to avoid this possibility.

Both these two aspects of figurative language could be damaged in our patients perhaps because they both require the integrity of semantic memory, but the procedures to apply are different. In the case of idioms, one needs to access and retrieve the expression as a whole (Swinney and Cutler, 1979) or after a word in a ‘key position’ has been found (Tabossi and Zardon, 1995). In the case of metaphors, it is necessary to detect a specific salient semantic feature of the vehicle (Ortony, 1979). Therefore, metaphor comprehension (if the specific semantic trace of that metaphor is degraded and the metaphor has become a ‘new’ one) should be more linked to an active search of the specific semantic attribute, while an idiom needs to be present as a whole in the subject’s semantic store and to be correctly accessed and retrieved. In the case of metaphors, the subject can devise strategies for outlining the specific feature of the vehicle, relevant for the metaphor, among different ones. In addition he/she must know therefore the semantic attributes of the vehicle. In the case of opaque idioms, one needs to retrieve the meaning of that particular phrase, without additional strategies. The idiom may or may not be part of his/her general knowledge and this will determine the result. If that particular item is lost, there are no possible strategies to find out its meaning. In other words, the subject has still a chance to find the answer in the case of metaphors, but not in the case of idioms.

It can be added that normal subjects produced insufficient/inaccurate responses in metaphor and idiom comprehension, but never literal interpretations, knowing that the task was to give a non-literal interpretation. In a non-salient number of cases, few metaphors and idioms were unknown to control subjects.

Conclusions
In summary, this study has shown that non-literal language is a relatively preserved function in very mild Alzheimer’s disease patients. It has also been found that metaphors and idioms differ as far as the kind of errors produced are concerned. Finally, a certain decrement over time has only been shown for metaphors. The data are not sufficient for further discussion or for attempting assumptions. We believe that studying these aspects of language in patients with semantic dementia and frontal lobe dementia, will help to clarify which components, such as semantic memory or executive functions, could be involved in non-literal language comprehension.

Acknowledgements
I wish to thank Professor Erminio Capitani for his insightful comments on a previous version of the paper and for performing the Brandt and Snedecor’s analysis and Claudia Vergot for testing some of the patients, Dr Carla Stangalino and Dr Federica Lucchelli who helped in recruiting the Alzheimer’s disease patients and Chris Bird for editing the English. The study was funded through a grant of the Ministero dell’Universita’ e della Ricerca Scientifica e Tecnologica 40% and a grant ex-60% from the University of Palermo.

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Second revision March 15, 2001. Accepted March 15, 2001