Patterns of Discourse Production among Neurological Patients with Fluent Language Disorders

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Dissociations between impairments in microlinguistic and macrolinguistic abilities were examined in brain-damaged patients to assess whether these abilities are psychologically and neurologically distinct. The discourse productions of three groups of patients with equally severe fluent language disorders, but varying neuropathology and varying profiles of associated nonlinguistic cognitive impairments, were analyzed. Patients with fluent aphasia secondary to a single left-hemisphere CVA showed the greatest impairment on syntactic and lexical error measures taken to reflect microlinguistic abilities, but normal performance on measures of macrolinguistic organization (i.e., thematic coherence). Patients with probable Alzheimer's Disease were impaired on thematic coherence measures, but not on measures reflecting microlinguistic syntactic and phonological processes. Closed head injury patients whose primary clinical symptom was a fluent language disorder were impaired on both microlinguistic and macrolinguistic measures, which appears to parallel their deficits both in language-specific and in nonspecific, higher-order, diffusely organized cognitive processes. © 1991 Academic Press, Inc.

Fluent language disorders characterize several neurologic groups with varying neuropathology and associated cognitive disorders. Such language disorders are seen in aphasic patients with discrete lesions in the posterior regions of the left hemisphere, as well as in patients with generalized cognitive loss resulting from multifocal cerebral disease such as Alzheimer's Disease (AD).

Although superficially these fluent language disorders appear similar (e.g., Appell, Kertesz, & Fisman, 1982; Murdoch, Chenery, Wilks, & Boyle, 1987), qualitative analyses reveal differences in the linguistic performances of these patient groups. Studies of fluent aphasia (FA) patients with focal lesions in the left temporal-parietal areas have documented disturbances in phonological, lexical–semantic, and syntactic aspects of language production (e.g., Blumstein, 1981; Caramazza & Berndt, 1978). Several reports have indicated that despite these patients' impairments in language production and language comprehension at the single word and sentence level, they display remarkably intact skills for appreciating and conveying meanings at the suprasentential level of discourse (Stachowiak, Huber, Poeck, & Kerschensteiner, 1977; Ulatowska, Freedman-Stern, Doyle, & Macaluso-Haynes, 1983; Ulatowska, North, & Macaluso-Haynes, 1981; Wilcox, Davis, & Leonard, 1978). AD patients, by contrast, have been reported to show relatively preserved syntactic and phonological processing (Glosser & Kaplan, 1989; Kempler, Curtiss, & Jackson, 1987; Nebes, Martin, & Horn, 1984; Nicholas, Obler, Albert, & Helm-Estabrooks, 1985; Schwartz, Marin, & Saffran, 1979). Impairments in the conceptual, semantic, and pragmatic aspects of language appear to characterize the fluent language disorder of AD patients (Bayles & Kaszniak, 1987; Irigaray, 1973; Schwartz et al., 1979). Various investigators have observed that these patients display disproportionate deficits in maintaining cohesion (Shekim & LaPointe, 1984), coherence (Appell et al., 1982; Obler & Albert, 1984; Ripich & Terrell, 1988) and appropriateness (Hutchinson & Jensen, 1980; Obler & Albert, 1984) in conversations and narratives.

These observations may be summarized in two general proposals: It seems that whereas the language disorder in FA reflects disturbance of "language-specific" cognitive processes, the linguistic disorder in AD may result from impairments in higher-order, nonspecific, and more diffusely organized cognitive processes such as attention, semantic memory, and executive control. Furthermore, it would appear that the language-specific cognitive impairments of FA patients selectively disrupt "microlinguistic" abilities for processing phonological, lexical-semantic, and syntactic aspects of single words and sentences, but spare "macrolinguistic" abilities for maintaining conceptual and pragmatic organization at the suprasentential level. In AD, by contrast, there is selective dis-

ruption of macrolinguistic abilities, with relative sparing of microlinguistic abilities.

A direct demonstration of the proposed dissociations between impairments in microlinguistic and macrolinguistic abilities is of importance as it would support the claim that the computations necessary for the production and comprehension of suprasentential units do not completely overlap with those required for processing and producing individual words and sentences (Ulatowska et al. 1981, 1983; van Dijk, 1980). It would indicate that microlinguistic and macrolinguistic cognitive processes are separate psychologically and neurologically.

The purpose of this study was to test directly the hypothesis that different forms of brain injury produce dissociations between microlinguistic and macrolinguistic abilities. Analysis of discourse production was chosen as a means for testing this hypothesis. By virtue of its complexity, discourse entails integration of all types of linguistic knowledge (Bayles & Kaszniak, 1987). Thus, analysis of discourse production yields data regarding both microlinguistic and macrolinguistic impairments. It allows for simultaneous examination of the breakdown in "purely" linguistic functions (e.g., syntax) as well as in those language functions that interact with higher-order conceptual structures (e.g., thematic organization).

To test the hypothesized dissociations of microlinguistic and macrolinguistic abilities in different groups of brain-injured patients, we analyzed samples of discourse with respect to both intrasentential (microlinguistic) and suprasentential (macrolinguistic) organization and adequacy:

1. Coherence is a term which has been used to characterize conceptual organizational aspects of discourse at the suprasentential level. The coherence of a text or discourse depends, at least in part, on the speaker's ability to maintain thematic unity (Agar & Hobbs, 1982). Thematic unity is achieved by the integration of textual units or propositions which form a coherent representation because they denote conditionally related facts in the "real world" (Keenan, Baillet & Brown, 1984; van Dijk, 1977).

Coherence is more precisely quantified when "global" and "local" organization are separately computed (Agar & Hobbs, 1982; Kintsch & van Dijk, 1978; Tracy, 1984). Global coherence refers to the manner in which discourse is organized with respect to an overall goal, plan, theme, or topic. Agar and Hobbs (1982, p. 7) state that "the requirements of a global coherence say 'Given the overall goals I am trying to accomplish what can I say next that will serve them?' " Local coherence refers to the conceptual links between individual sentences or propositions which maintain meaning in a text or discourse. The requirements for local coherence are "Given what I just said, what can I say that is related to

it'' (Agar & Hobbs,\1982, p. 7). In this study measures of both local and global thematic coherence were taken as indexes of macrolinguistic abilities.

2. Cohesion refers to specific relations of meaning between elements within discourse. While the effect of coherence is sustained by an overall thematic unity, it is expressed linguistically through cohesive devices. Devices such as coreference and anaphora serve to produce the overall effect of coherence. They are the "glue" which binds the individual elements together to achieve the impression of coherence. Cohesive linguistic devices share the property that interpretation of one linguistic element, such as a pronoun, depends on or presupposes another linguistic element, such as a preceding noun. Of the four major types of cohesive devices outlined by Halliday and Hasan (1976), referential and lexical types of cohesion are the most commonly occurring in normal narrative discourse (Mentis & Prutting, 1987). In this study the occurrence of these types of cohesion was taken as a measure of suprasentential organization. Cohesion does not encompass as broad a scope of suprasentential meaning relations as coherence, but it appears to capture intersentential relations beyond the microlinguistic level.

3. Syntactic complexity (e.g., complexity of embeddedness of subordinate clauses) and the occurrence of syntactic errors (e.g., omissions of required morphosyntactic structures) are indexes of intrasentential organization. Such syntactic measures may be assumed to reflect microlinguistic abilities (Kempler et al., 1987).

4. Production at the single word level also may be taken as an index of microlinguistic ability. Lexical measures employed in this study included errors in phonemic realization (literal paraphasias) and errors in referential and semantic specification (verbal paraphasias and indefinite terms).

The aforementioned measures of discourse production were compared among three groups of patients who evidence equally severe fluent language disorders but who show different patterns of nonlinguistic cognitive and neuropathological changes: (1) Patients with fluent aphasia (Wernicke's and anomic aphasia) secondary to a single left-hemisphere infarct are assumed to have language-specific cognitive deficits. These patients were expected to show selective impairments on microlinguistic, but not macrolinguistic, measures of discourse production. (2) AD patients demonstrate disturbances in multiple higher-order cognitive processes. They have multifocal cerebral disease, though in the early stages of AD cortical areas specifically devoted to language functions are usually spared (Brun & Englund, 1981). These patients were expected to show substantial impairments on macrolinguistic measures of discourse production which assess integration of linguistic and nonlinguistic knowledge, but they were expected to show relative preservation on microlinguistic measures.

(3) Patients who have suffered a severe closed head injury (CHI) evidence impairments in both discrete cognitive domains as well as diffusely organized cognitive processes as a function of both the focal and multifocal nature of their cerebral injuries (Levin, Benton, & Grossman, 1982). CHI patients presenting with a severe fluent language disorder were examined. The disporportionate severity of these particular patients' language deficit (perhaps as a consequence of focal trauma to the left hemisphere) suggests that they would share features with the fluent aphasia group; their nonlinguistic deficits in attention, memory, and executive control would appear to be more closely related to characteristics of AD patients. Relative to normals, therefore, CHI patients might be expected to show impairments on *both* microlinguistic and macrolinguistic measures of discourse production.

METHODS

Subjects

Four groups of subjects participated. All were native English speakers, had at least an eighth grade education, and had no history of prior psychiatric disease, drug/alcohol abuse, or learning disabilities.

1. Fluent aphasia (FA). Nine right-handed patients evidenced a fluent aphasia secondary to a single left-hemisphere cerebrovascular accident (CVA) which occurred at least 1 month prior to participation in the study (mean months post CVA = 24.77). At the time of testing the linguistic profile (Goodglass & Kaplan, 1983) for four patients was consistent with an anomic aphasia and for five patients a Wernicke's aphasia. Subjects with a range of fluent aphasic disorders were chosen. This group closely matched the group of AD subjects in the range and severity of the linguistic deficits. The mean age of these subjects was 60.22.

2. Alzheimer's disease (AD). Nine patients met the clinical diagnostic criteria for probable Alzheimer's Disease (McKhann, Drachman, Folstein, Katzman, Price, & Stadlen, 1984). All had undergone medical, neurological, neuropsychological, and neurodiagnostic evaluations to assure that their dementia symptoms could not be attributed to any other neurological or medical problem. The mean duration of reported symptoms for the group was 4.88 years. These noninstitutionalized patients evidenced a mild–moderate dementia. The mean score on the Mini Mental State (Folstein, Folstein, & McHugh, 1975) for the group was 15.4 (range 13–21). The mean age of these subjects was 64.33.

3. Closed head injury (CHI). Nine hospitalized patients had suffered a severe closed head injury 2–14 months prior to testing (mean = 7.0 months). Length of coma varied from 1 hr to 6 weeks. At the time of testing ratings on the Ranchos Los Amigos Profile of Levels of Cognitive Functioning (Hagen, 1982) ranged from 5–7 (mean = 5.88). Although each of these patients evidenced impairments in multiple cognitive domains, the rehabilitation team concurred that the primary functional deficit in each case was a fluent language disorder. The mean age of this group was 24.33.

4. Normal control (NC). Seventeen healthy control subjects aged 43–72 were interviewed to determine that they were free of neurologic and psychiatric disease. Their mean age was 55.06.

The four subject groups did not differ in mean years of education (mean = 12.95). A significant difference in mean age among the groups ($F(3, 40) = 30.50$; $p < .001$) is completely accounted for by the fact that the CHI subjects were significantly younger than the three other groups. There were no significant differences in the mean ages of the NC, FA, and AD groups.

A one-way analysis of variance (ANOVA) revealed no differences among the three patient groups in mean severity ratings on the Boston Diagnostic Aphasia Examination (Goodglass & Kaplan, 1983). Overall, severity ratings ranged from 2 to 4.5 (mean = 2.9). Scores on a visual confrontation naming task (Glosser & Kaplan, 1989) were analyzed for the four groups in a one-way ANOVA. There was a significant group effect ($F(3, 40) = 6.73$; $p < .001$). Although each patient group was significantly impaired ($p < .05$) relative to the NC group, there were no significant differences in mean scores among the patient groups. There was also a significant group difference ($F(3, 40) = 11.20$; $p < .001$) in mean scores on Part 5 of the Token Test (DeRenzi & Vignolo, 1962). The FA and AD groups' scores were comparable and were significantly lower than those of the NC and CHI groups who did not differ on this measure of auditory comprehension. These findings of relatively spared auditory comprehension in CHI patients with severely impaired language production are consistent with other reports. Levin, Grossman, Sarwar, and Meyers (1981) found relative sparing of performance on the Token Test in a postacute group of CHI patients with language impairment, and concluded that the severity of comprehension impairment was related to generalized neuropathological and neuropsychological dysfunction in this group. Generalized neuropsychological dysfunction was minimized in the present study sample because of the criteria for selecting specifically language-disordered CHI subjects.

Procedures

Subjects were interviewed individually for 10–20 min and interviews were audiotaped. Each subject was first asked to describe his/her family and then a work experience from his/her past. Subjects were encouraged to speak about any aspect of the designated topic for as long as they wished. The interviewer attempted to minimize her oral–verbal participation in the communication exchange by confining her responses to continuation regulators such as "uh, uh" and general questions such as "What else did you do?"

Scoring

The subjects' and interviewer's utterances were transcribed in English orthography by the interviewer. Utterances which included unintelligible segments (accounting for less than 1% of the total transcriptions) were not scored. Transcriptions were scored by two independent raters (one of whom did not know the group membership of individual subjects). Subsequently, disagreements between the raters were reconciled through discussion.

To enable scoring of the transcribed protocols, verbal productions were first segmented into units termed "verbalizations." Verbalizations were defined according to principles discussed by Watts (1948), Loban (1963), and Hunt (1965). The actual segmentation of discourse into scorable units employed the criteria described by Glosser, Wiener, and Kaplan (1988). Briefly, verbalizations were identified principally by syntactic criteria. Prosodic and semantic features were used to demarcate verbalizations in cases where the syntactic form was distorted or ambiguous. Verbalizations were classified into four categories: (1) "Complete intelligible verbalizations" contained at least one independent clause plus any subordinate clauses or nonclausal structures attached to or embedded in the main clause. These utterances contained no syntactic or lexical errors and were scored on all linguistic measures described below. (2) Verbalizations that contained a subject and predicate, but which were otherwise syntactically incomplete or included an error in noncritical syntactic elements (e.g., omission or substitution of an auxiliary verb), were designated "incomplete intelligible verbalizations." These were meaningful utterances which contained sufficient syntactic structure to enable scoring on all measures described below. (3) "Incomplete utterances" were those where the syntactic frame could not be inferred because of omission or distortion of at least the complete subject or predicate. These utterances were not scored for syntactic complexity (i.e., the Weighted Index of Subordination) because of their insufficient syntactic structure, but they were scored on all other measures

described below. (4) All remaining utterances composed of only assent and denial in response to a question, eliptical responses to questions, and verbatim repetitions of the interviewer's immediately preceding statement were excluded from all subsequent scoring as were all filler words and phrases (e.g., "you know"), mazes (i.e., false starts), and contiguous perservations of words and phonemes.

Syntactic Measures

1. Proportion complete intelligible verbalizations. The proportion of all verbalizations that were syntactically complete and contained no syntactic errors or paraphasias was computed.

2. Weighted index of subordination. Complete intelligible verbalizations and incomplete intelligible verbalizations were each scored for syntactic complexity using the guidelines described by Loban (1963). This scoring system assigns a greater weighting to recursively embedded subordinate structures. A mean score was computed for each subject.

3. Syntactic errors. Each omission of (a) the subject, (b) main verb, (c) required functors, and (d) other grammatical morphemes within a verbalization was scored as a syntactic error. The frequency of occurrence of each type of syntactic omission was computed as a proportion of the total words (excluding non-English fillers such as "Um") spoken by that subject.

Lexical Errors

The following errors were taken as indexes of impairments in lexical production:

1. Verbal paraphasia. An uncorrected substitution of a lexical item by another English word was scored.

2. Literal paraphasia. Recognizable English words containing substitution or omission of phonemes were scored if the error was not immediately self corrected.

3. Indefinite terms. Nonspecific nouns or pronouns (e.g., "whatever," "something," "stuff") which made ambiguous or general reference were scored.

The frequency of occurrence of each of the lexical error measures was computed as a proportion of total spoken words for each subject.

Cohesion

Using the system described by Halliday and Hasan (1976) occurrences of the following types of cohesive ties were identified. Scores were computed as a proportion of total spoken words.

1. Appropriate closed class lexical cohesion. (a) Personal pronouns (other than the first or second person singular) which indexed an unambiguous lexical referent within the preceding three verbalizations were scored. (b) Demonstrative pronouns (other than "the") were scored if there was an explicit linguistic antecedent within the preceding three verbalizations. (c) Definite articles which had an unambiguous lexical referent in the preceding three verbalizations were scored.

2. Appropriate open class lexical cohesion. Each noun which was an exact repetition, synonym, superordinate designate, or subordinate exemplar of a noun or pronoun that occurred in the preceding discourse was scored.

3. Incomplete cohesion. Occurrences of personal pronouns, demonstratives, and definite articles which did *not* have an unambiguous lexical referent in the preceding three verbalizations were scored as errors.

Thematic Coherence

Coherence was defined as the appropriate maintenance of some aspect of the topic within the discourse. Judgments of coherence were based on raters' impressions of the meaning

of the *whole* verbalization with respect to meaning in the adjoining discourse, irrespective
of lexical or syntactic errors. Global and local coherence were scored separately for each
verbalization using a five-point rating scale. A higher score indicates greater coherence.
Discourse coherence was scored only for the first 20 verbalizations in each subject's family
and work narratives. This was done so as not to penalize those subjects who produced
lengthier discourse which is more likely to veer away from the designated topic, that is,
to become less coherent globally.

  1. Global coherence. This was defined as the relationship of the meaning or content of
a verbalization with respect to the general topic of conversation. The topic was determined
by the last question asked by the interviewer. Higher global coherence ratings were assigned
to verbalizations which provided substantive information directly related to the designated
topic.

  2. Local coherence. This was defined as the relationship between the meaning or content
of a verbalization and that in the immediately preceding utterance produced either by the
interviewer or by the subject. Local coherence included relationships of continuation,
repetition, elaboration, subordination, or coordination with the topic in the immediately
preceding verbalization.

Scoring Reliabilities

  Interrater scoring agreements were computed prior to discussion and reconciliation of
scores. Interrater agreement for segmenting the verbal productions into scorable verbal-
izations and determining completeness of the syntactic form was 98%; scoring syntactic
errors and paraphasias was 93%; scoring the Weighted Index of Subordination was 90%;
scoring lexical cohesion was 86%; and scoring thematic coherence was 79%.

RESULTS

  No group difference in the length of discourse was found in a one-
way ANOVA of total spoken words. The mean number of spoken words
was 443.9 for the NC group, 529.2 for the FA group, 432.4 for the AD
group, and 474.2 for the CHI group.

  Four one-way multivariate analyses of variance (MANOVA) assessed
group differences on the six syntactic measures, on the three lexical
error measures, on the three measures of discourse cohesion, and on
the two discourse coherence measures. For each MANOVA three
planned comparisons were subsequently performed to test for differences
between each of the patient groups and the NC group. Univariate
ANOVA's of individual dependent measures are reported where rele-
vant. Bonferroni correction was used in establishing the significance
levels for these multiple nonindependent univariate comparisons.

  Preliminary analyses indicated no significant interactions between sub-
ject groups and the topic of discourse (family and work) for any of the
dependent measures. Therefore, all analyses to be reported involve com-
bined scores for the two discourse topics.

Syntactic Measures

  The overall MANOVA of the six syntactic measures (i.e., Weighted
Index of Subordination and proportions of complete intelligible verbal-

izations, omissions of subject, omissions of main verb, omissions of functors, and omissions of other required grammatical morphemes) indicated a significant group effect ($F(18, 99) = 2.69$; $p < .001$). The planned comparisons revealed that both the FA ($F(6, 35) = 4.75$; $p < .01$) and CHI ($F(6, 35) = 3.16$; $p < .05$) groups were impaired relative to the NC group (Table 1). Individual ANOVA's further indicated that the FA group was significantly impaired relative to normals on all syntactic measures, except for subject and functor omissions. Compared to normals the CHI group was also significantly impaired on measures of syntactic errors (i.e., proportions of complete intelligible verbalizations and omissions of the subject, main verb, and other required grammatical morphemes), but the CHI group was not impaired on the measure of syntactic complexity (i.e., the Weighted Index of Subordination). The AD group did *not* differ significantly from the NC group on any of the syntactic measures. These results indicate disproportionate syntactic impairments for patients with more focal lesions in the left hemisphere.

Lexical Errors

The lexical error measures (proportions of verbal paraphasias, literal paraphasias, and indefinite terms) are presented in Fig. 1. There was a significant overall group effect in the MANOVA of these three lexical error measures ($F(9, 93) = 6.13$; $p < .001$). In the subsequent planned comparisons significant overall differences were found between each of the patient groups and the NC group (p's $< .01$). Individual ANOVA's, however, revealed qualitatively different error types among the three groups of brain-damaged patients: The FA group produced significantly more verbal paraphasias and indefinite terms than normals. FA subjects also made a small number of literal paraphasic errors, but this was not a reliable difference statistically. The AD subjects produced significantly more indefinite terms than normals, but no more verbal paraphasias than normals; and like normals, AD patients produced *no* literal paraphasias. The CHI group produced significantly more verbal paraphasias, but no more indefinite terms than normals. CHI subjects produced a few literal paraphasias, but there was no statistically significant difference on this measure between CHI and NC groups. As would be expected, all the patient groups were impaired in lexical specification, but only the patients with focal left-hemisphere lesions produced literal paraphasias, and these patients also showed the highest proportions of verbal paraphasias.

Cohesion

In the MANOVA of the three measures of discourse cohesion (appropriate closed class, appropriate open class, incomplete cohesion) the overall group difference was significant ($F(9, 93) = 3.71$; $p < .001$). Neither AD nor CHI patients differed significantly from normals on any

TABLE 1
SYNTACTIC MEASURES IN DISCOURSE PRODUCTIONS

| Groups	Proportion of complete intelligible verbalizations	Weighted Index of Subordination	Proportion Syntactic Omissions			
			Subject	Verb	Functor	Other
	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)	mean (SD)
Normal control n = 17	.78 (.07)	.43 (.26)	.006 (.006)	.003 (.003)	.004 (.004)	.001 (.002)
Fluent aphasia n = 9	.56 (.15)	.19 (.10)	.014 (.011)	.012 (.010)	.009 (.009)	.007 (.007)
Closed head injury n = 9	.64 (.12)	.29 (.25)	.013 (.008)	.012 (.009)	.009 (.006)	.006 (.007)
Alzheimer's disease n = 9	.70 (.12)	.24 (.13)	.004 (.004)	.002 (.002)	.002 (.003)	.002 (.002)
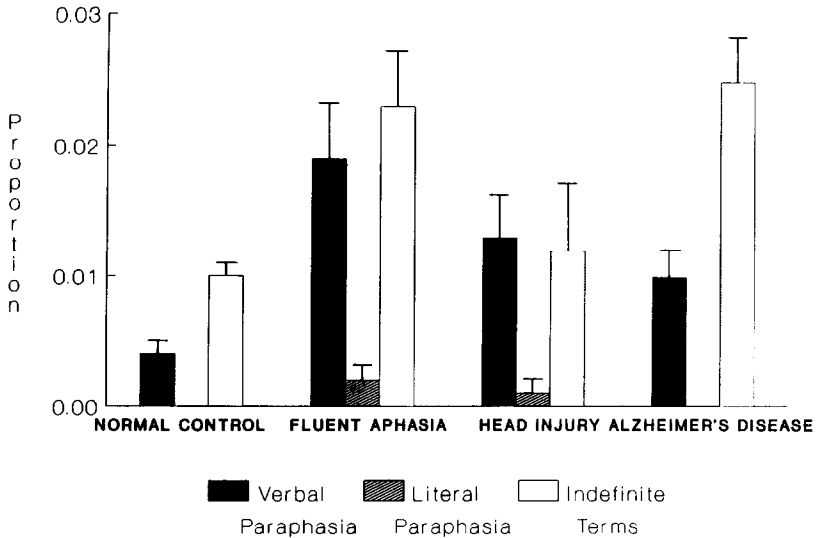
FIG. 1. Mean proportions of lexical errors (with SEM indicated) for normal controls and for three groups of brain-damaged patients with fluent language disorders.

of these measures (Fig. 2). The overall comparison of the FA and NC groups was significant ($F(3, 38)$ = 6.23; $p < .01$). As illustrated in Fig. 2, individual ANOVA's indicated that, relative to normals, FA subjects were significantly impaired *only* in incomplete cohesion, not on measures of appropriate lexical cohesion.

Coherence

There was a significant overall group effect in the MANOVA of global and local coherence ratings ($F(6, 78)$ = 3.78; $p < .01$). Subsequent comparisons revealed *no* significant differences between NC and FA subjects in ratings of either global or local coherence (Fig. 3). Overall, AD patients' verbalizations were significantly less coherent than those of normals ($F(2, 39)$ = 3.25; $p < .05$). Individual ANOVA's showed this group difference to be significant for global but not for local coherence ratings. CHI patients were significantly impaired relative to NC subjects in the planned comparison using MANOVA ($F(2, 39)$ = 11.17; $p < .001$), as well as in the univariate comparisons of local and global coherence ratings. In contrast to analyses of the microlinguistic measures presented above, analyses of discourse coherence revealed the greatest impairments for patients with multifocal neuropsychological deficits. Figure 3 further shows that the CHI and AD groups' impairments were greater for global as compared to local coherence ratings.

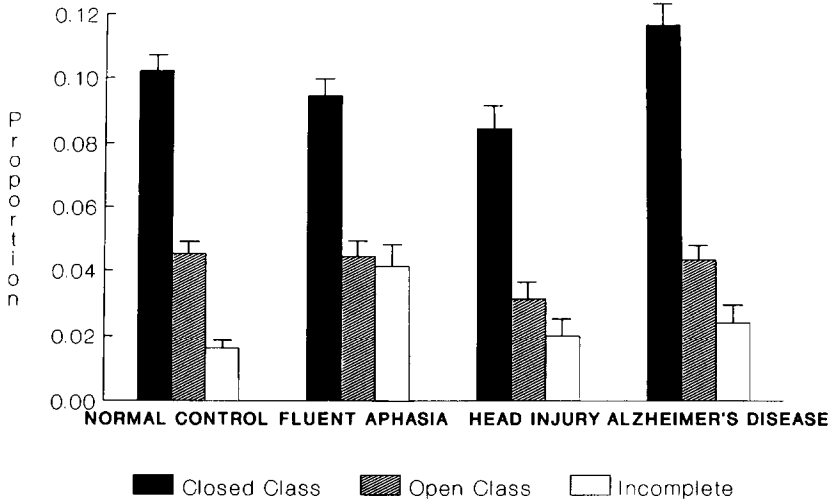Table 2 presents two examples of disrupted discourse coherence, one

FIG. 2. Discourse cohesion for three groups of brain-damaged patients with fluent language disorders and for normal controls. Mean appropriate closed class and open class lexical discourse cohesion and incomplete discourse cohesion are expressed as proportions of total spoken words, with SEM indicated.

from a patient with probable AD and one from a CHI patient. In the first excerpt global coherence is disproportionately impaired, while in the second excerpt local coherence is disrupted.

Factor Analysis

The hypotheses for this study were derived from a general notion that language production may be parsed into separate components which are susceptible to dissociation with different types of brain damage. A factor analysis of the discourse production measures was conducted as another empirical test of the proposed distinction between microlinguistic (intra-sentential lexical and syntactic forms) and macrolinguistic (suprasentential cohesion and coherence) abilities. This factor analysis also provides additional confirmation for the method by which individual dependent measures were combined to assess different components of discourse production (i.e., syntax, lexical–semantics, macrolinguistic organization).

Eight dependent measures, two from each of the categories of syntax, lexical errors, cohesion, and coherence, were entered into a principle components factor analysis using the data from all 44 subjects (Table 3). The two syntactic measures used were the mean Weighted Index of Subordination and the summed proportions of all syntactic errors. The proportion of complete and intelligible verbalizations was not included as a measure in the factor analysis as it overlaps in scoring with the
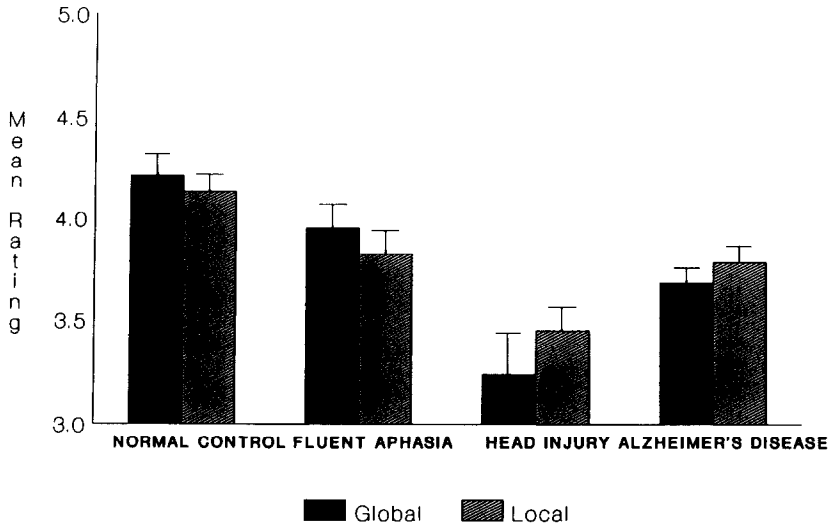
FIG. 3. Local and global thematic coherence ratings of discourse for three groups of brain-damaged patients with fluent language disorders and for normal controls. Mean values and SEM are shown. A higher rating indicates greater coherence.

measure of syntactic omissions. The proportions of verbal paraphasias and of indefinite terms were included as lexical error measures. Literal paraphasic errors were not included in the analysis, since they occurred infrequently across all groups. Cohesion measures for the factor analysis consisted of the summed proportions of appropriate open plus appropriate closed class cohesion and the measure of incomplete cohesion. Finally, mean local and global coherence ratings were each entered into the factor analysis.

In the principal components factor analysis with varimax rotation three factors with eigenvalues greater than 1 were extracted which accounted for 71% of the total variance (Table 3). Factor 1 accounted for 40% of the variance. High loadings of both coherence measures as well as the measure of appropriate cohesion suggest that this factor captures suprasentential organization. Factor 2 accounted for 17% of the variance. Contributing to this factor were lexical error measures, including verbal paraphasias, indefinite terms, and incomplete cohesion. Factor 3 accounted for 14% of the variance. This factor is comprised of syntactic measures, both syntactic complexity and syntactic omission errors.

DISCUSSION

Three groups of brain-damaged patients with equally severe fluent language disorders demonstrated different patterns of impairment in discourse production. The different performance profiles of the groups with

TABLE 2
EXAMPLES OF DISRUPTED DISCOURSE COHERENCE[a]

Disrupted global coherence in discourse about work by a patient with probable
Alzheimer's Disease

Coherence rating

Global	Local	Verbalizations
5	5	I was mostly into retailing type of work
1	1	And I didn't get married until I was thirty-six
1	5	And I had a child right away
1	4	I was lucky
1	1	She's just graduating college

Disrupted local coherence in a closed head injury patient's discourse about family

Coherence rating

Global	Local	Verbalizations
4	3	My sister's husband has been my friend for about 20 years
3	5	I went to school with him
3	5	We were in the same class in Woonsocket Junior High School
3	1	And my mother has been very good for me the last 2 months, because she paid some of my bills that have come in my mailbox
1	1	I haven't been to Woonsocket since

[a] Global and local coherence are each scored on a five-point rating scale. A rating of 5 indicates very high thematic coherence, and a rating of 1 indicates no thematic relationship or coherence.

TABLE 3
ROTATED FACTOR PATTERN OF DISCOURSE MEASURES[a]

	Factor 1	Factor 2	Factor 3
Global coherence	.761	−.291	−.287
Local coherence	.799	−.171	−.406
Appropriate cohesion	.780	.014	.115
Incomplete cohesion	−.079	.806	.345
Verbal paraphasia	−.004	.690	.406
Infinite terms	−.293	.767	−.241
Weighted Index of Subordination	.001	−.203	−.765
Syntactic errors	−.323	.051	.782

[a] $N = 44$.

focal neuropsychological disorders and those with multifocal disorders are consistent with the hypothesized dissociations between microlinguistic and macrolinguistic abilities.

In agreement with previous reports (e.g., Gleason, Goodglass, Obler, Green, Hyde, & Weintraub, 1980; Martin & Blosson-Stach, 1986), the group of patients with fluent aphasia was found to be impaired on measures of the complexity and completeness of intrasentential syntactic form. In contrast, the AD subjects did not differ from normals on any of the syntactic measures. Preservation of intrasentential syntactic form has been a repeated finding in analyses of spontaneous speech (Ripich & Terrell, 1988; Schwartz et al., 1979) as well as performance on formal tests by AD patients (Nebes et al., 1984; Kempler et al., 1987). As expected several fluent aphasics produced literal paraphasias in their spontaneous discourse whereas no such errors were made by normals or AD patients. This result is also consistent with reports which have suggested impaired phonological processing for at least some patients with fluent aphasia, but relatively preserved abilities for processing phonological aspects of language for AD patients (Blumstein, 1981; Glosser & Kaplan, 1989; Nebes et al., 1984).

Thus, in terms of these language-specific, microlinguistic, aspects of discourse production, AD patients showed normal performance. In contrast, fluent asphasics as a group were impaired on measures of microlinguistic aspects of discourse production. It should be noted that the syntactic and phonological impairments were not characteristic of all the individual patients in the fluent aphasia group. Some of these patients presented clinically only with an anomia and would not have been expected to show significant phonological or syntactic impairments.

The CHI patients were expected to perfom at an intermediate position between the AD and FA patients, sharing features with both groups. Like AD subjects, CHI patients demonstrated a normal range of complexity of intrasentential syntactic forms, as inferred from their normal scores on the Weighted Index of Subordination. But like the fluent aphasics, CHI patients produced significantly more syntactic errors than normals. This interesting profile agrees with Peach and Schaude's (1986) report that CHI patients (without severe language disorders) make more grammatical errors than normals, although they show an adequate range of grammatical constructions in their spontaneous speech. On the index of phonological impairment, literal paraphasias, CHI patients also appear to fall between FA and AD groups. As a group, CHI patients with selective language disorders have not been reported to produce literal paraphasias (Levin et al., 1981), but this may vary as a function of individual patients' pathology. In our sample we found that unlike normals and AD patients who make no such errors, some CHI patients produced uncorrected literal paraphasias.

It was not surprising to find that all three brain-damaged groups pro-
duced errors indicating impaired lexical–semantic abilities, as subjects
were chosen for inclusion in the study on the basis of their naming
disorder. Previous studies (Glosser & Kaplan, 1989; Nicholas et al., 1985)
have reported that fluent aphasics tend to produce more semantically
unrelated verbal paraphasias than AD patients, whose naming errors
tend to be semantically related to the target item, but are referentially
nonspecific. Although we did not perform detailed semantic analyses of
the lexical errors, the pattern of our results may be interpreted as con-
sistent with previous reports. FA subjects produced high proportions of
both verbal paraphasias and indefinite terms. AD subjects did not differ
from normals in their rate of production of verbal paraphasic substitu-
tions, but they used many more referentially nonspecific indefinite terms
in their spontaneous speech. The pattern for CHI subjects on lexical
error measures, which were taken as instances of impaired microlinguistic
abilities, was again found to be most similar, but not identical, to that
for the FA patients (i.e., high proportions of verbal paraphasias).

Whereas the aforementioned results assessing microlinguistic abilities
indicate disproportionate impairments for patients with fluent aphasia
secondary to a focal left-hemisphere lesion, and to some extent also for
CHI patients, the analyses of discourse coherence revealed significant
impairments for the AD and the CHI groups, and *normal* performance
by aphasics. We should emphasize that the ratings of discourse coherence
were based on written transcripts which contained no explicit information
about accompanying paralinguistic and nonlinguistic behaviors. Thus,
the finding of normal coherence scores for fluent aphasia subjects indi-
cates an area of relatively preserved *linguistic* functioning. Our results
are consistent with those reported by Ulatowska and her colleagues
(1981, 1983) who have shown relative preservation of the suprastructure
and the essential informational content of narrative and procedural dis-
course among mixed groups of aphasics. The striking preservation of
thematic coherence among our FA subjects, who also evidenced signif-
icant syntactic, phonological, and lexical disorders, provides compelling
evidence for the proposed dissociation between microlinguistic and ma-
crolinguistic processes. Clearly, macrolinguistic organization does not
depend completely on intact microlinguistic abilities.

AD patients, who were relatively unimpaired on microlinguistic mea-
sures, were impaired on ratings of thematic coherence. This finding
agrees with the results of the experimental analysis conducted by Ripich
and Terrell (1988), as well as with the many anecdotal descriptions of
disordered discourse among AD patients. The ability to organize textual
information coherently and to maintain thematic coherence throughout
a narrative appears to require systems different from those required for
the construction and production of individual sentences. A text is said

to be coherent to the extent that a listener, who shares a linguistic–cultural–social context with the speaker, perceives it to be. Textual coherence is achieved not only by use of shared linguistic forms, but also by explicit or implicit reference to shared concepts and world knowledge and to shared goals and pragmatic functions. Coherence, therefore, entails some intact knowledge base of related facts and concepts. Coherence also implies logical sequential ordering and hierarchic organization of textual units to realize a theme, goal, or plan. And coherence requires adherence to the pragmatic principle of conversational relevance (Grice, 1975). That is, in order to achieve coherence a speaker must have some appreciation of the listener's perspective. The presumed knowledge base of the listener must be integrated with the organization of what is being expressed to maintain perceived coherence. Translating these descriptions of coherence into a cognitive processing model, one might hypothesize that coherence depends at least in part on intact access to semantic memory representations of real world facts, concepts, and relationships. Perceptual and conceptual integration are necessary to maintain the plan and overall organization of the discourse. Intact abilities for simultaneous attention and mental manipulation of several items of-information are also required for coordinating and integrating the speaker's plan and the listener's perspective to produce discourse which is perceived to be coherent. AD patients, of course, show disruptions in all of these cognitive processes which may contribute to their impaired ability to maintain coherence.

AD and CHI patients' apparently greater impairment in maintaining global coherence, as compared to local coherence, suggests that their disordered discourse stems less from a disruption in relationships of meaning between contiguous concepts and more from their impaired macro-organizational abilities. This apparent difference in the degree of disruption in local and global coherence would be consistent with the view that local and global coherence are not completely overlapping constructs (Kintsch & van Dijk, 1978). The factor analysis indicates commonality of variance between local and global coherence, but the profiles of performance of the different groups suggest that these two constructs may represent more distinct points on a continuum of the macrolinguistic description of discourse.

Based on anecdotal reports (e.g., Groher, 1977; Levin, Grossman, Rose, & Teasdale, 1979) CHI patients were expected to show impairments in discourse coherence. In fact, they showed very significant impairments on ratings of both global and local coherence. The magnitude of CHI patients' impairments in the macrolinguistic organization of discourse is probably underestimated in the present data. The CHI subjects in this study were compared to a group of normal controls who were on average 30 years older and who may have been experiencing changes

in certain discourse abilities that occur with normal aging (Glosser & Deser, 1990; Ulatowska, Hayashi, Cannito, & Flemming, 1986). Except for the mean age of the group, the CHI group we evaluated is not representative of the general population of head-injured adults. CHI subjects were chosen for this study specifically because of their disproportionate language disorder. None-the-less the subjects interviewed represent a diverse group in terms of the severity and breadth of their linguistic and nonlinguistic cognitive impairments. The generality of impaired discourse coherence among CHI patients suggests that this group of patients may offer interesting opportunities to examine specific relationships between components of impaired discourse and other linguistic and nonlinguistic cognitive deficits.

Contrary to our prediction, we did not find changes in the use of either appropriate or inappropriate cohesion among the AD and CHI subjects who showed disrupted discourse coherence. Mentis and Prutting (1987), for example, previously found that, compared to normals, three CHI patients produced less appropriate lexical cohesion, more elliptical cohesion, and more inappropriate cohesive ties. Ripich and Terrell (1988) in their study of AD patients also reported an apparent shift to discontinuity in coherence; but on specific measures of appropriate and inappropriate cohesion, the AD patients they assessed did not differ significantly from elderly normals (but see Shekim & LaPointe, 1984). In the present study we found that relative to normals only the FA patients produced more inappropriate cohesive items. That is, they used a normal range of lexical open- and closed-class items indexing referential cohesion, but at times there was no unambiguous proximal antecedent linguistic referent for these items.

How can these apparently diverse findings be reconciled? As others (e.g., Joanette, Goulet, Ska, & Nespoulous, 1986) have noted, cohesion appears to have an intermediate status between traditionally defined formal linguistic structure (here termed microlinguistic) and supralinguistic (macrolinguistic) structure in discourse. Our findings suggest that at least some measures of cohesion may be more related to microlinguistic aspects of discourse, rather than to macrolinguistic organization. In the present study, as in the reports of Mentis and Prutting (1987) and Ripich and Terrell (1988), disrupted cohesion occurred primarily in the form of inappropriate substitution of lexical items and use of referentially nonspecific lexical terms. The factor analysis indicated that incomplete cohesion is strongly related to lexical error measures (verbal paraphasias and indefinite terms), but not to coherence measures. Disrupted cohesion, therefore, seems to reflect in large part impaired lexical retrieval rather than impaired intersentential organization. Unlike coherence, lexical cohesion may be more driven by automatized linguistic processes, rather than by higher-order conceptual processes.

What is most important to note is that referential cohesion does not appear to be a prerequisite for establishing and maintaining thematic coherence. As Keenan, Baillet, and Brown (1984) concluded, textual coherence does not depend solely on the linguistic cohesion of a text, but rather on conceptual links within a text that may or may not be linguistically explicit. Our findings are certainly consistent with this claim. FA patients who were impaired in discourse cohesion obtained normal coherence ratings, and AD and CHI patients who were normal on measures of cohesion evidenced incoherent discourse. Further analyses may answer the interesting questions of how it is possible that fluent aphasics achieve normal coherence in discourse despite their severe intrasentential lexical and syntactic deficits, while the AD and CHI patients with less obvious lexical–syntactic deficits fail to maintain coherence, particularly at the global organizational level.

The findings of the present study support the hypothesized distinction between microlinguistic and macrolinguistic abilities. Microlinguistic and macrolinguistic abilities were shown to be reliably quantified. The results of the factor analysis support the conceptually driven methodological distinction between microlinguistic and macrolinguistic measures. And the double dissociations demonstrated between spared and impaired performances among neurologically distinct groups are consistent with the claim that microlinguistic and macrolinguistic abilities are independently organized (e.g., Ulatowska et al., 1983, 1981; van Dijk, 1980), rather than merely hierarchically organized (e.g., Lahey, 1984).

Data from brain-damaged patients allow us to speculate as to the neurological basis of the psychological distinction between microlinguistic and macrolinguistic abilities. It is generally agreed that microlinguistic abilities depend on the integrity of function in focal systems within the left cerebral hemisphere. Macrolinguistic abilities may be more difficult to localize. Two possibilities are suggested: (1) The literature on the language abilities of patients who have suffered a focal lesion in the right cerebral hemisphere sugggests that at least certain macrolinguistic processes are dependent on the integrity of the right hemisphere. Patients with right-hemisphere damage, for example, show impairments in the inferential abilities necessary for comprehension of connected narratives, in their appreciation of intrasentential coherence, and in their use of linguistic and pragmatic context to interpret discourse (Molloy, Brownell, & Gardner, 1989). In a narrative production task Joanette et al. (1986) also found impaired informational content, but not structural linguistic impairment, for some right-hemisphere-damaged patients. It is possible that the impairments in macrolinguistic aspects of discourse production for the AD and CHI patients, who have multifocal cerebral dysfunction, are referable to specific damage in the right hemisphere. (2) Alternately, it is possible that macrolinguistic processes rely on the integrity of neur-

ally distributed systems which may be nonspecifically disturbed with different kinds of multifocal or diffuse cerebral pathology. We may begin to assess these alternative hypotheses by examining microlinguistic and macrolinguistic aspects of discourse production in patients with focal right-hemisphere lesions.

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