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Oral Language and Alzheimer's Disease: A Reduction in Syntactic Complexity*

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ABSTRACT

Transcripts of interviews with 117 adults undergoing examination for possible Alzheimer's disease were analyzed. The length, fluency, semantic content, and syntactic complexity of the transcripts varied with the severity of dementia. Although there was a marked increase in the production of sentence fragments with dementia severity, approximately 60% of the utterances produced by the mildly demented adults were grammatically well formed, compared with 69% of those produced by the nondemented adults. The grammatical utterances of the mildly demented adults were shorter and syntactically simpler than those produced by the nondemented adults. These results add to the growing literature suggesting a relative preservation of some psycholinguistic functions in demented individuals.

Psycholinguistic changes may be an early sign of the onset of Alzheimer's disease. Spouses and other caregivers often note language impairments during the early stages of the disease (Bayles & Tomoeda, 1991; Orange, 1991). A variety of psycholinguistic changes are associated with dementia, including a disruption of verbal fluency, word finding problems, object naming difficulties, "empty" or uninformative speech, and comprehension difficulties (Appell, Kertesz, & Fisman, 1982; Bayles, Tomoeda, & Boone, 1985; Huff, Corkin, & Growdon, 1986; LaBarge, Balota, Storandt, & Smith, 1992; Murdoch, Chenery, Wilkes, & Boyle, 1987; Nicholas, Obler, Albert, & Goodglass, 1985; Ober, Dronkers, Koss, Delis, & Friedlan, 1986).

There is some evidence from other studies that the syntactic aspects of language may be protected or "buffered" from the effects of Alzheimer's disease (Irigaray, 1973; Kemper et al., 1993; Kempler, Curtiss, & Jackson, 1987; Schwartz, Marin, & Saffran, 1979; Whitaker, 1976). Kemper et al. (1993) suggested that there is a progressive decline in syntactic complexity with the severity of Alzheimer's dementia as well as a loss of informational content. They noted that mildly and moderately demented adults were capable of producing grammatically well-formed sentences, thus evidencing a sparing of syntactic ability by Alzheimer's dementia. Nonetheless, they also observed a decline in sentence length and in the use of complex syntactic structures, suggesting that performance factors related to the disease affect the expression of this preserved syntactic ability. Hence, although syntactic ability may be buffered from the effects of Alzheimer's disease, linguistic expression is nonetheless constrained by cognitive limitations on content and grammatical form and such cognitive limita-

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tions increase with the severity of the disease.

The present study sought to provide converging evidence for the conclusions of Kemper et al. (1993), who analyzed single-sentence data from a large number of individuals undergoing examination for possible Alzheimer's disease. Similar analytic techniques were used in this study; however, transcripts of oral interviews were analyzed. The analysis included measures of sentence length, verbal fluency, semantic content, and syntactic complexity. The focus of the analysis was the determination of the relationship between severity of dementia and syntactic complexity. We also sought to use available psychometric test data to determine the relationship between the psycholinguistic measures obtained from the transcripts and the psychometric measures. Psychometric measures of general cognitive ability, word retrieval ability, working memory, and complex cognitive operations were compared because cognitive functions are not uniformly affected by the early stages of Alzheimer's disease (Storandt, Botwinick, Danziger, Berg, & Hughes, 1984).

PARTICIPANTS AND METHOD

Sample

The participants for this study were obtained from the Patient Registry of the Washington University (St. Louis, MO) Alzheimer's Disease Research Center. Registrants are recruited through referral from St. Louis area physicians and announcements in the news media. Most are followed longitudinally and assessed annually; they participate in numerous studies conducted by the center. Registrants' research participation is approved by the Human Subjects Review Panel at Washington University.

The data for the present study were obtained between May, 1990 and March, 1993 from interviews conducted at the time of the annual assessment. For some individuals, this was their first assessment; others had been seen for up to 10 years. The interview on which this report is based, however, was administered only once to any individual. The interviewer asked each registrant a series of questions about their family, current hobbies or activities, past employment, and recent trips or vacations. Registrants who were unable to respond to the interviewer's questions were excluded from the present analysis. Individuals were not included in the sample if they had reversible dementias or other neurological, psychiatric, or medical disorders that might contribute to dementia (Hughes, Berg, Danziger, Coben, & Martin, 1982).

Diagnostic and Staging Criteria

The clinical diagnosis of dementia of the Alzheimer type and the rating of the severity of dementia were based on a 90-minute semistructured clinical interview and neurological examination conducted by research physicians with the Alzheimer's Disease Research Center's Clinical Core. The clinical interview was conducted, in part, with the registrant and, in part, with a knowledgeable collateral source.

The criteria for the diagnosis of dementia of the Alzheimer's type included (a) impaired memory plus impaired cognitive ability in at least two of five areas (orientation, judgment and problem solving, community affairs, home and hobbies, and personal care), (b) gradual onset and progression of the disorder, and (c) duration of 6 months or longer (Hughes et al., 1982). These criteria have been validated by postmortem neuropathologic examination (Morris, McKeel, Fulling, Torack, & Berg, 1988). Of 106 cases diagnosed as having dementia of the Alzheimer's type in whom autopsies were performed as of July, 1992, the diagnosis was confirmed in 102 cases (96%) (Berg & Morris, 1994).

The severity of dementia was assessed using the Washington University Clinical Dementia Rating (CDR) (Berg, 1988; Morris, 1993). Reliability of the dementia severity rating is satisfactory, with weighted K values ranging from .75 to .94 (Burke et al., 1988). The CDR is a global clinical judgment based on the degree of impairment in each of six areas listed above. A CDR of 0 indicates no dementia; 0.5, questionable or very mild dementia; 1, mild dementia; 2, moderate dementia; and 3, severe dementia. The CDR scale is ordinal but not necessarily interval.

Psychometric Test Battery

The registrants were administered a battery of psychometric tests by trained psychometricians who also conducted the oral interviews used in the present analysis. The original version of this battery has been described previously (Storandt et al., 1984; Storandt & Hill, 1989). This battery has undergone several revisions as a result of ongoing research efforts. Selected tests from this battery are reported in this study for those registrants who were interviewed. The selection of tests was based on two criteria: (a) each test is widely used in studies of normal aging and language and (b) they provide a comprehensive profile of the registrants' cognitive and linguistic abilities. The tests were the Information, Block Design, and Digit Symbol subtests of the Wechsler Adult Intelligence Scale (Wechsler, 1955), the 60-item version of the Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983), the Digits Forward and Digits Backward tests from the Wechsler Memory Scale (Wechsler & Stone,
Fluency Test (Thurstone &
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All registrants were teste
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weeks of the clinical inter
battery required approximat

Table 1. Profile of the 117 R

	0
N	
Male	2
Female	4
Age	
M	76
SD	9.
Education	
M	14
SD	3.
Digits Forward	
M	6.
SD	1.
Digits Backward	
M	5.
SD	1.
Information	
M	21
SD	4.
Block Design	
M	32
SD	7.
Digit Symbol	
M	47
SD	12
Boston Naming	
M	55
SD	4.
Word Fluency	
M	17
SD	6.

* $p < .05$. ** $p < .01$. *** $p <$

Scale (Wechsler & Stone, 1973), and the Verbal Fluency Test (Thurstone & Thurstone, 1949). All tests except the Boston Naming Test were administered in the standard manner. A revised procedure was used to administer the Boston Naming Test: All items were administered beginning with the first item, and no phonemic cues were given.

All registrants were tested individually by trained psychometricians who were unaware of the diagnosis or stage of dementia. The psychometric battery was administered at the medical center within 1 or 2 weeks of the clinical interview. The psychometric battery required approximately 2 hours to administer. The interviews analyzed in the present analysis were conducted at this time. Data from individuals with moderate and severe dementia (CDRs of 2 or 3) were not used in the present study because many of these registrants were unable to respond to the interviewers' questions or complete the psychometric battery.

Table 1 presents a profile of the 117 registrants. Table 1 also reports (a) the results of a series of one-way analyses of variance for the psychometric scores with CDR as the between-subjects factor and (b) the r_s obtained from a Spearman rank-order correlation of each measure with the CDR ratings. Rank-order correlations were used because the CDR scale cannot

Table 1. Profile of the 117 Registrants.

	CDR stage			CDR	r_s
	0	0.5	1	$F(2,115)$	
N					
Male	27	10	9		
Female	48	12	11		
Age				ns	−.07
M	76.2	75.3	74.3		
SD	9.5	11.5	8.0		
Education				5.62**	−.29**
M	14.3	12.0	12.1		
SD	3.4	3.8	3.8		
Digits Forward				4.23*	−.17
M	6.9	6.1	6.6		
SD	1.1	1.3	1.2		
Digits Backward				15.61***	−.43**
M	5.0	4.2	3.3		
SD	1.4	0.9	1.5		
Information				49.13***	−.63**
M	21.9	16.2	11.4		
SD	4.4	5.0	4.4		
Block Design				44.71***	−.54**
M	32.8	25.5	17.5		
SD	7.5	8.4	8.2		
Digit Symbol				32.05***	−.61**
M	47.7	33.8	26.6		
SD	12.1	12.4	9.5		
Boston Naming				40.22***	−.58**
M	55.9	48.8	41.1		
SD	4.5	9.7	10.8		
Word Fluency				12.61***	−.42**
M	17.4	13.3	10.3		
SD	6.3	5.6	3.7		

* $p < .05$. ** $p < .01$. *** $p < .001$. ns: $p > .05$.

be assumed to be interval. The main effect for CDR was significant at $p < .01$ or less and CDR was negatively correlated with education, performance on the WAIS Digits Backwards, Information, Block Design, and Digit Symbol subscales, and performance on the Boston Naming and Verbal Fluency tests. (The data from the psychometric battery have been reported elsewhere for other overlapping samples from the Center.)

Transcript Analysis

The primary data for this analysis were transcripts of the interviews conducted with each registrant as part of the psychometric assessment. The interviews were transcribed and verified for accuracy using standard procedures for language sample analysis (Kemper, Kynette, Rash, Sprott, & O'Brien, 1989; Kemper, Rash, Kynette, & Norman, 1990). The interview was first segmented into utterances and then each utterance was coded. Utterances were segmented based on conventional sentence boundaries as well as intonation contour. Sentence fragments corresponding to incomplete sentences, rephrasings or revisions of a previous utterance, and additions to the previous utterance following a pause were considered as separate utterances. Utterances in which the same basic thought or idea was completed following a pause (which might have been filled with a nonlexical *um* or other filler) were considered to be one utterance, whereas continuations that added new information to a previously completed sentence following a filled or unfilled pause were considered to be separate utterances. Mean length of utterance in words (MLU) was computed for each transcript.

Lexical fillers such as *well*, *yeah*, or *let's see* were transcribed as separate utterances if they occurred at the beginnings or ends of another utterance. Lexical fillers that occurred within another utterance were transcribed as part of that utterance. The percentage of utterances containing lexical fillers (%FILLERS) was computed for each transcript as a measure of verbal fluency.

Each utterance was coded as a complete sentence or sentence fragment. The percentage of complete sentences (%COMPLETE) and the percentage of sentence fragments (%FRAGMENTS) in the transcript were computed as additional measures of verbal fluency. Because there were many sentence fragments in these transcripts and the fragments tended to form extended series or "runs", sequential fragments were enumerated and the mean length of each series or run of fragments (LENGTH FRAGMENT RUNS) was also computed as a measure of fluency.

Both complete sentences and sentence fragments were carefully scrutinized for possible violations of grammatical rules such as word-order inversions, errors of subject-verb agreement, incorrect or missing auxiliary verbs, and incorrect or missing noun and verb inflections. Such markers of agrammatic speech were not observed. Both complete sentences and sentence fragments conformed to basic grammatical rules governing morphology and syntax.

Each utterance was also coded as to the types of clauses it contained. Clauses were coded as main, embedded, or subordinate. Main clauses have both a subject and a predicate, are inflected for tense, and can be linked together in a series with conjunctions. Within utterances, only the initial verb of coordinate predicates sharing a common subject was coded as the main clause. Subordinate clauses are marked by a conjunction such as *since*, *because*, or *although* and have a subject and predicate as well as tense. Embedded clauses include that-clauses, wh-clauses, relative clauses, infinitive complements, and gerunds. Embedded clauses are commonly introduced by a grammatical marker such as the word *to*, which marks infinitives or the relative pronouns which mark relative clauses. Embedded clauses are typically uninflected for tense. Subordinate and embedded clauses were coded as left- or right-branching with regards to the predicate of the main clause. Left-branching clauses included relative clauses modifying the sentence subject, e.g., "The park *where I run* is crowded," and wh-clauses serving as the sentence subject, e.g., "*Where we used* to live is now a parking lot." Right-branching clauses included infinitive complements, e.g., "I wanted *to do it*," and that-clause complements, e.g., "She thought *I was OK*." The percentages of main clauses (%MAINS), left-branching clauses (%LEFTS), and right-branching clauses (%RIGHTS) in each transcript were computed as measures of grammatical complexity. In addition, the mean number of clauses per utterance (MCU) was also computed as a measure of length.

Three additional analyses were also performed on these transcripts to parallel the previous single-sentence analysis (Kemper et al., 1993). Type-token ratios (TTR) of the number of different words to the total number of words in each transcript were computed as a measure of lexical diversity or semantic content. The Developmental Sentence Scoring (DSS) (Lee, 1974) system was used to supplement the analysis of clause structure. This system assigns points to each utterance with respect to the occurrence and complexity of indefinite pronouns, personal pronouns, main verbs, secondary or embedded verbs, negatives, conjunctions, yes-no questions, and wh-questions. A final point is awarded if the utterance is a complete, grammatical sentence. Because this analysis is very time-consuming to perform and many of the transcripts were rather lengthy, 25 utterance segments were selected from the middle portion of each transcript and analyzed. A total DSS point count (TOTAL DSS) was tallied for each segment and a profile of these constituents was generated for each registrant. The use of indefinite and definite pronouns and the use of yes-no and wh-questions were collapsed so that six types of constituents were pro-

filed: pronouns, main verbs
tives, conjunctions, and qu
per constituent category wa
ment.

Finally, a second measu
tual content was computed
utterance from these 25-
propositionalized (Kintsch
& Greene, 1977). A prop
basic idea, typically a verb
ments, an adjective or ad
phrase. Propositions, wheth

Table 2. Extract from One
lexical fillers (FIL
(RIGHT) clauses a

My mother was still able [M
[RIGHT subordinate clau
My mother didn't always kn
Lil who wasn't there [LEFT
She [FRAGMENT 1]^
Lil [FRAGMENT 2]^
Well [FILLER] [FRAGMEN
Since she and my brother-in
She was [MAIN] in one of t
She was having [MAIN] a l
Well [FILLER] [FRAGMEN
Swallowing [LEFT gerund]
We tried [MAIN] to be [RIC
ly by herself [RIGHT sub

Table 3. Illustration of the D

Sentence
DSS points
Pronouns
Main verbs
Secondary verbs
Negatives
Conjunctions
Questions
Complete sentence
Total DSS points
Propositions

filed: pronouns, main verbs, secondary verbs, negatives, conjunctions, and questions. The mean points per constituent category was computed for each segment.

Finally, a second measure of semantic or conceptual content was computed for each transcript. Each utterance from these 25-utterance segments was propositionalized (Kintsch & Keenan, 1973; Turner & Greene, 1977). A proposition corresponds to a basic idea, typically a verb with one or more arguments, an adjective or adverb, or a prepositional phrase. Propositions, whether stated or inferred, also establish causal, temporal, and identity relations among other propositions. The mean number of propositions per utterance (PROPOSITIONS) was computed for each transcript.

Table 2 illustrates the analysis of an extract from one transcript. Table 3 illustrates the DSS and propositional analyses.

Reliability

Reliability for three aspects of the transcription and coding was determined. First, transcription reliability was assessed by comparing three transcripts prepared

Table 2. Extract from One Transcript. Fragments (FRAGMENT) are tagged with a ^ and numbered in a series; lexical fillers (FILLER), MAIN clauses (main), left-branching (LEFT) clauses, and right-branching (RIGHT) clauses are coded.

My mother was still able [MAIN] to talk [RIGHT infinitive complement] up until a few days before she died [RIGHT subordinate clause].
My mother didn't always know [MAIN] who I was [RIGHT wh-clause].
Lil who wasn't there [LEFT relative clause] felt [MAIN] bad.
She [FRAGMENT 1]^
Lil [FRAGMENT 2]^
Well [FILLER] [FRAGMENT 3]^
Since she and my brother-in-law lived in California [LEFT subordinate clause] we were [FRAGMENT 4]^
She was [MAIN] in one of those lounge chairs and couldn't do anything for herself.
She was having [MAIN] a lot of trouble swallowing [RIGHT gerund].
Well [FILLER] [FRAGMENT 1]^
Swallowing [LEFT gerund] was [MAIN] her biggest problem.
We tried [MAIN] to be [RIGHT infinitive complement] with her as much as possible because she was very lonely by herself [RIGHT subordinate].

Table 3. Illustration of the Developmental Sentence Scoring (DSS) and Propositional Analyses.

Sentence	Lil who wasn't there felt bad.	She was having a lot of trouble swallowing.
DSS points		
Pronouns	who = 6	she = 2
		lot = 2
Main verbs	felt = 3	was having = 6
Secondary verbs	relative clause = 7	gerund = 6
Negatives	wasn't = 4	0
Conjunctions	0	0
Questions	0	0
Complete sentence	1	1
Total DSS points	21	17
Propositions	4	3
	1: Lil was there	1: She has trouble
	2: not 1	2: trouble = a lot
	3: Lil felt bad	3: trouble = swallowing
	4: 3 because of 1	

by two different individuals working individually. Both were blind with regards to the diagnosis of dementia or staging of severity of dementia of the speakers. Interjudge reliability for the word-for-word transcription was high, averaging 97% agreement. Second, reliability for segmenting these transcripts into utterances and identifying each utterance as a fragment or a complete sentence was also assessed. Interjudge agreement was better than 94% for all three decisions. Third, reliability was assessed for the coding of fillers, main clauses, left- and right-branching clauses, DSS points, and propositions. Interjudge reliability for the fillers and syntactic judgments was better than 92%; interjudge reliability for the propositional analysis was 86%.

RESULTS

Because of the large number of sentence fragments, each measure was computed first based on all utterances in each transcript or all 25 utterances in the extract used for the DSS and propositional analyses and then recomputed based on complete sentences only. Because these analyses yielded equivalent results, only the analysis based on total utterances is reported here. Table 4 shows the results of the transcript analysis and presents (a) the results of a one-way analysis of variance with CDR as the between-subjects factor and (b) the r_s for regressing each measure on CDR rating. The primary finding is that there was a decline in sentence

Table 4. Results of the Transcript Analysis.

	CDR stage			CDR	r_s
	0	0.5	1	$F(2,115)$	
Length					
MLU				14.26***	−.49**
M	9.1[a,b]	7.6[a]	6.4[b]		
SD	2.2	1.5	2.2		
MCU				13.27***	−.46**
M	1.4[a,b]	1.1[a]	1.0[b]		
SD	0.4	0.3	0.2		
Fluency					
%COMPLETE				7.66**	−.34**
M	69.3[a,b]	61.2[a]	60.1[b]		
SD	11.7	10.6	11.2		
%FILLERS				ns	+.25**
M	14.2	17.1	18.7		
SD	11.9	10.1	8.8		
%FRAGMENTS				7.66**	+.34**
M	30.7[a]	38.8[a,b]	39.4[b]		
SD	10.7	11.2	12.5		
LENGTH FRAGMENT RUNS				3.21*	+.19
M	1.6	1.8	1.8		
SD	0.4	0.5	0.6		
Content					
TTR				ns	+.07
M	.46	.45	.47		
SD	.06	.07	.06		
PROPOSITIONS				6.43**	−.40**
M	2.7[a]	2.1	1.6[a]		
SD	1.4	1.1	1.1		

Table 4 (continued)

Grammatical complexity	
%MAINS	
M	
SD	
%LEFTS	
M	
SD	
%RIGHTS	
M	
SD	
DSS TOTAL POINTS	
M	
SD	
PRONOUNS	
M	
SD	
MAIN VERBS	
M	
SD	
SECONDARY VERBS	
M	
SD	
NEGATIVES	
M	
SD	
CONJUNCTIONS	
M	
SD	
QUESTIONS	
M	
SD	

Note. Means with the same s
comparisons. MLU = mean
type-token ratio of the numb
Sentence Score.
* $p < .05$. ** $p < .01$. *** p

length, grammatical co
tional content with the s
dementia as well as a de
The utterances produce
registrants were less lik
tences than those produc

Table 4 (continued)

	CDR stage			CDR	r_s
	0	0.5	1	$F(2,115)$	
Grammatical complexity					
%MAINS				14.88***	−.44**
M	88.7[a,b]	77.2[a]	68.6[b]		
SD	16.1	14.7	14.5		
%LEFTS				5.22**	−.37**
M	7.2[a]	3.9[a]	4.1		
SD	5.6	2.7	5.1		
%RIGHTS				5.93**	−.35**
M	43.9[a]	34.3	27.9[a]		
SD	21.6	13.3	18.6		
DSS TOTAL POINTS				8.61**	−.39**
M	11.6[a]	9.3[a]	8.1		
SD	3.7	2.8	4.0		
PRONOUNS				4.82*	−.29**
M	3.0[a]	2.7	2.2[a]		
SD	1.1	1.0	1.2		
MAIN VERBS				4.63*	−.29**
M	2.2[a]	2.0	1.8[a]		
SD	0.6	0.8	0.7		
SECONDARY VERBS				7.88**	−.17**
M	3.2[a]	2.1[a]	2.0		
SD	1.6	1.1	1.4		
NEGATIVES				ns	+.16
M	0.2	0.3	0.4		
SD	0.2	0.3	0.2		
CONJUNCTIONS				7.25**	−.37**
M	2.1[a,b]	1.6[a]	1.2[b]		
SD	1.1	0.7	1.0		
QUESTIONS				3.67*	+.15
M	.04[a]	.03[b]	.09[a,b]		
SD	.08	.16	.04		

Note. Means with the same superscript differ significantly with alpha = .05 using the Scheffe procedure for post hoc comparisons. MLU = mean length of utterance in words; MCU = mean number of clauses per utterance; TTR = type-token ratio of the number of different words to the total number of words in the transcript; DSS = Development Sentence Score.
* $p < .05$. ** $p < .01$. *** $p < .001$. ns: $p > .05$.

length, grammatical complexity, and propositional content with the severity of Alzheimer's dementia as well as a decline in verbal fluency. The utterances produced by mildly demented registrants were less likely to be complete sentences than those produced by the nondemented registrants (60% versus 69%) and they were shorter and simpler than those produced by the nondemented registrants. This loss of length and syntactic complexity was evident in the significant main effects for CDR and the significant negative correlations with CDR for main,

left- and right-branching clauses, DSS total points, and DSS main verbs, secondary verbs, and conjunctions. Multiple comparisons using a Scheffe procedure were used to compare the CDR groups on each measure. In general, these comparisons indicated that the CDR = .5 and CDR = 1 groups differed significantly from the CDR = 0 group in the length and complexity of their oral language. The two dementia groups, however, did not differ from each other.

To investigate the relationships between the psychometric measures and the psycholinguistic measures of length, fluency, grammatical complexity, and semantic content, a series of regression analyses was performed. At issue is whether psycholinguistic performance can be predicted by cognitive ability. (The DSS measures for negatives, conjunctions, and questions were not subjected to the regression analyses due to the low incidence of these constituents in many of the transcripts.) A hierarchical regression procedure was used to control for problems of multicollinearity. For each language measure, predictors were entered sequentially according to an a priori theoretical model derived, in part, from Cheung and Kemper (1992). This analysis, based on language samples from healthy aging adults, suggests that the length, semantic content, and syntactic complexity of adults' utterances reflect the separate contributions of general cognition, word retrieval, and working memory factors. In the present analysis, two demographic measures, age and educational level, were entered first as general measures of cognitive ability. Second, two measures of word retrieval ability, performance on the Boston Naming Test and the Verbal Fluency Test, were added. Third, the two working memory measures, Digits Forward and Digits Backwards, were added to the regression model. Finally, the three remaining measures of complex cognitive operations, Digit Symbol, Block Design, and Information, were added. At each step, the only variables that were retained in the regression model were those whose partial correlation with the psycholinguistic measure was significant at $p < .05$ or better for the *F-to-enter* statistic. Thus, at each step, any improvement in prediction reflects the contribution of that step after the effects of all previously entered variables have been partialed out.

Table 5 reports the results in terms of the percentage of variance accounted for by the significant predictors for each language measure at each step in the hierarchical analysis. A reverse series of regressions was also performed in which the predictors were entered in the reverse order. The ability to retrieve words, as measured by the Boston Naming Test and the Verbal Fluency Test, did not predict any of the psycholinguistic measures obtained from the transcript analysis. Nor did Working Memory, as measured by the WAIS Digits Forward or Backward subscales, predict any of the psycholinguistic measures of length, fluency, content, or grammatical complexity. Chronological age accounted for 4 – 6% of the variance in the production of main clauses, left-branching clauses, pronouns, and main verbs and the Digit Symbol and Information tests predicted an additional 9 – 21% percent of the variance in these measures. Chronological age was not associated with any of the measures of sentence length, fluency, or content, or with the right-branching, total DSS points, and secondary verb measures of grammatical complexity; however, Digit Symbol and Information tests of complex cognitive operations predicted 6% to 24% of the variance for the psycholinguistic measures of length, fluency, content, and grammatical complexity.

DISCUSSION

This study supports the findings from a previous analysis of single sentences produced by dementing adults (Kemper et al., 1993). Whether single, written sentences are considered or transcripts of oral interviews, syntax ability appears to be buffered from the effects of Alzheimer's disease but constrained by cognitive limitations. Both studies demonstrate that there is a progressive decline in the length and complexity of the language of dementing adults with possible Alzheimer's disease. The oral language samples of very mildly and mildly demented adults contained a mix of sentence

Table 5. Results of the Hier
Each Significant P

Length
MLU
MCU
Fluency
%COMPLETE
%FILLERS
%FRAGMENTS
LENGTH FRAG RUNS
Content
TTR
PROPOSITIONS
Grammatical complexity
%MAINS
%LEFTS
%RIGHTS
DSS TOTAL POINTS
PRONOUNS
MAIN VERBS
SECONDARY VERBS

fragments and well-form
syntactically simpler a
produced by nondement
the oral language sampl
in that many aspects of
even in the speech of adu
They correctly observe
word order, subject-ve
tense, aspect, and mo
reference as well as gra
ing sentence embeddi
However, the demented
to produce complete sen
use multiclause sentenc
adults.

The observed decli
complexity of the oral
adults appear to be rela

Table 5. Results of the Hierarchical Regression Analyses in Terms of the Percentage of Variance Accounted for by Each Significant Predictor.

	Demographic	Verbal ability	Working memory	Complex operations
Length				
MLU	ns	ns	ns	Information: 24%
MCU	ns	ns	ns	Information: 15%
Fluency				
%COMPLETE	ns	ns	ns	Digit Symbol: 9%
%FILLERS	ns	ns	ns	ns
%FRAGMENTS	ns	ns	ns	Digit Symbol: 9%
LENGTH FRAG RUNS	ns	ns	ns	Digit Symbol: 6%
Content				
TTR	ns	ns	ns	ns
PROPOSITIONS	ns	ns	ns	Information: 13%
Grammatical complexity				
%MAINS	AGE: 5%	ns	ns	Digit Symbol: 9% Information: 21%
%LEFTS	AGE: 5%	ns	ns	Information: 9%
%RIGHTS	ns	ns	ns	Information: 11%
DSS TOTAL POINTS	ns	ns	ns	Information: 11%
PRONOUNS	AGE: 6%	ns	ns	Digit Symbol: 15%
MAIN VERBS	AGE: 4%	ns	ns	Information: 11%
SECONDARY VERBS	ns	ns	ns	Information: 8%

fragments and well-formed sentences that were syntactically simpler and shorter than those produced by nondemented adults. Nonetheless, the oral language samples were not agrammatic in that many aspects of syntax were preserved even in the speech of adults with mild dementia. They correctly observed grammatical rules for word order, subject-verb agreement, marking tense, aspect, and modality, and pronominal reference as well as grammatical rules governing sentence embedding and subordination. However, the demented adults were less likely to produce complete sentences and less likely to use multiclause sentences than the nondemented adults.

The observed declines in the length and complexity of the oral language of demented adults appear to be related to general cognitive decline associated with Alzheimer's disease. In contrast to the single-sentence analysis (Kemper et al., 1993), the decline in the syntactic complexity and propositional content of these oral language samples was not attributable to the demented adults' working memory impairments, as measured by the digit span tests, nor to their impairments of word retrieval ability, as measured by the Boston Naming and Verbal Fluency tests. Rather, it seems that the ability to sustain a conversation and to produce extended discourse is related to general abilities associated with age as well as to complex cognitive operations, as measured by the WAIS Information and Digit Symbol tests. It may be that the demands of comprehending and responding to the examiner's questions and formulating a coherent reply mask problems of word retrieval

or working memory problems. Psycholinguistic impairments due to working memory and word retrieval ability may be more evident when task demands are lessened as when only a single, written sentence is elicited. Alternatively, it may be that other measures, such as sentence speaking span measures (Daneman & Green, 1986), might be better indicators of the utilization of working memory during discourse.

This study also suggests that psycholinguistic changes may be a subtle but reliable marker of the onset of Alzheimer's disease. The sharpest decline on these measures of syntactic complexity occurred between CDRs of 0 and .5 as indicated by the Scheffe tests. The syntactic complexity of very mildly demented adults, with CDRs of .5, was, on average, 79% of that of the nondemented adults with CDRs of 0. In contrast, the syntactic complexity of mildly demented adults, with CDR scores of 1, was 69% of that of the nondemented adults. For example, whereas the MCUs of nondemented adults averaged 1.4, those of very mildly demented adults averaged 1.2, a decline of 16%, and those of mildly demented adults averaged 1.1, a decline of an additional 10%. DSS total points declined from an average of 11.6 for nondemented adults to 9.4 for those with very mild dementia (CDR = .5), a decline of 18%, and 8.3 for those with mild dementia (CDR = 1.0), an additional 10% decline. Longitudinal analyses of language samples collected from older adults are required in order to confirm this hypothesis by monitoring the production of complex grammatical constructions by adults who do not develop dementia as they age and by adults who do develop progressive dementia.

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