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AGING AND THE LOSS OF GRAMMATICAL FORMS: A CROSS-SECTIONAL STUDY OF LANGUAGE PERFORMANCE

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Current models of language development commonly assume that there are few changes in linguistic ability across the adult years (Menyuk, 1977). This assumption, however, is not based on actual research; as Cohen (1979) observed, 'Geriatric psycholinguistics is virtually an unexplored territory' (p. 412).

Some information about adults' linguistic abilities is provided by aphasia test norms. Typically, the normative data compares the performance of brain-damaged and age-matched normal adults (Schuell *et al.*, 1964; Swisher and Sarno, 1969; Duffy *et al.*, 1976; Schewan, 1979; Borod *et al.*, 1980); this research finds little appreciable decline across the life span on measures of spelling, color and body-part naming, picture description, sentence repetition, answering general-knowledge questions, and the comprehension of words and simple sentences. The normative data is limited to basic linguistic abilities and to normative samples averaging around 60 years of age (Davis, 1984).

Some investigators have examined the performance of adults on tests of specific linguistic forms. Comprehension does appear to drop off in the 60s and 70s for complex syntactic constructions (Walsh and Baldwin, 1977; Feier and Gerstman, 1980). Age-related declines in the ability to draw inferences from texts have also been observed (Cohen, 1979; Taub, 1979; Belmore, 1981; Cohen and Faulkner, 1981). Age-related effects have not typically been observed in sentence production tasks (Nebes and Andrews-Kulis, 1976; Yorkston and Beukelman, 1980; Walker *et al.*, 1981) although only a limited set of variables, e.g. speed, fluency and clarity, have been investigated.

The following research was undertaken as a detailed investigation of the spontaneous speech of active, healthy adults between the ages of 50 and 90 years. This age range was chosen to compare the performance of middle-aged (50 and 60 year olds) and elderly (70 and 80 year olds) adults (Kausler, 1982). Sixteen different measures of syntactic structure, verb tense, form class, lexical use and disfluency were examined. These variables were chosen to represent a range of linguistic skills and to provide a comprehensive profile of the adults' spoken language. Performance on the lexical and disfluency measures was not expected to vary with age (Schaie, 1980). Performance on the syntactic, tense and form class measures was expected to decline with age, reflecting attentional and memory limitations (Craik, 1977; Kausler, 1982).

Method

Thirty-two native speakers of English between the ages of 50 and 90 years were recruited as participants. There were four women and four men in each of the following age groups: 50–59 years, 60–69 years, 70–79 years, and 80–89 years. All of the participants were healthy,

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active adults who were living independently or with spouses or relatives. None reported any major debilitating medical problems or significant hearing loss. The adults were interviewed in their own homes or in the homes of relatives.

Educational and employment histories were elicited from each adult. Education was scored in terms of the number of years of schooling completed. The employment histories were scored on a 0–3 scale where 0 = domestic employment or farm work, 1 = factory work, 2 = office work and 3 = professional occupation. Age was significantly correlated with education, $r = -0.40$, but not with employment, $r = -0.06$. Education and employment were also correlated, $r = +0.64$. The middle-aged participants had completed more years of formal education and the better educated subjects had more highly rated occupations.

Each adult was given a shortened version of the vocabulary subtest of the Wechsler Adult Intelligence Scale (Wechsler, 1944). The adults were asked to define the following twelve words: winter, repair, breakfast, fabric, slice, assemble, conceal, enormous, hasten, sentence, regulate, commence. Their responses were initially scored by counting both partially and fully correct definitions. The standard procedure used to score WAIS vocabulary items assigns two points for each fully correct definition and one point for each partially correct definition for a possible total of 24. The responses were also re-scored by counting only fully correct definitions for a possible total of twelve. The two measures are highly correlated, $r = +0.85$. Only results of the standard scoring procedure were used.

Each adult provided a 20 min sample of speech. The interviewer asked the adults to relate some stories about their own lives such as their first job, war experiences, or marriage. The speech samples were audio recorded and transcribed. A sample of 50 consecutive utterances (McCarthy, 1930; Lee, 1974) was selected from the middle portion of the transcript. The middle portion was selected to avoid effects due to initial nervousness or those due to fatigue. The 50 utterances excluded full and partial repetitions of the interviewer's remarks, unfinished sentence fragments, and partial or complete repetitions of previous words or phrases. Filler expressions that were habitually used to start sentences, e.g. 'you know', 'well', or 'and then', were also excluded.

A preliminary analysis of the sample identified all grammatical errors including incorrect, missing, or extraneous morphemes. This analysis was performed by the two authors; consensus on all correct and incorrect utterances was required. This preliminary analysis also identified each noun and verb used in the sample. The sample of 50 utterances was then submitted to the LINGQUEST (Mordecai *et al.*, 1982) analysis program. LINGQUEST compares actual to corrected utterances; each utterance is then parsed based on the identified nouns and verbs and grammatical function words. The following measures were obtained from the parsed sample: the number of different simple syntactic structures (e.g. basic sentence types or sentences with relative clauses), the number of complex syntactic structures (e.g. sentences with multiple embeddings or embedding plus coordination), the percentage of simple structures correctly produced, the number of different verb tenses, and the percentage of verb tenses correctly produced, the number of different grammatical form classes, (e.g. singular nouns, demonstrative pronouns, or conjunctions), the percentage of different grammatical forms correctly produced, the mean length of utterance (MLU) computed first in terms of words and then in terms of grammatical morphemes, the total number of words in the sample, the type/token ratio of the number of different words to the total number of words.

Finally, the sentence fragments and fillers that had been excluded from the sample of

50 utterances were scored as measures of speech disfluency. Four measures were obtained: the total number of fillers, the total number of words used in the fillers, the number of sentence fragments, and the total number of words used in sentence fragments.

Results

A multivariate analysis of variance was used to analyse the data for each of five categories: syntactic, form class, tense, lexical and disfluency. Age group was a between subjects factor. Syntactic variables were: total simple structures used (simple), total complex structures used (complex), and the percentage of correct simple structures (structures). Tense variables were: total verb tenses used (tense no.) and percentage of correct tenses (tense %). Form class variables were: total grammatical forms used (forms no.), percentage of correct forms (forms %), mean length of utterance by words (MLU-words), mean length of utterance by morphemes (MLU-morphemes). Lexical variables were: standard score on the vocabulary test (WAIS), total words used (words), and type/token ratio (type/token). Disfluency variables were: total fillers (fillers no.), number of words used as fillers (fillers-words), total sentence fragments (fragments no.), and number of words used in fragments (fragments-words).

Table 1 presents the multivariate and univariate effects for age. The means for each age group are also given for the sixteen dependent variables. Duncan's Multiple Range Test with $\alpha = 0.05$ was used to compare the means for the four age groups.

Across this age range, there is a reduction in the variability and accuracy of syntactic structures, verb tenses, and form classes. The 50 and 60 year olds also used more simple syntactic structures ($M = 11$) than did the 70 and 80 year olds ($M = 9$). The 50 year olds

Table 1. Results of the multivariate and univariate analysis of variance for the syntactic, tense, form class, lexical and disfluency variables

Variables	*d.f.*	*F*	Means Fifty	Sixty	Seventy	Eighty
Syntactic	9,58	2.37*				
Simple	3,28	5.50†	11	11	9	8
Complex	3,28	3.49*	14	10	10	10
Structures %	3,28	3.82*	96	93	88	89
Tense	6,59	3.02*				
Tense No.	3,28	1.54	5	6	4	4
Tense %	3,28	3.11*	99	97	94	94
Form class	12,61	1.25				
Forms No.	3,28	4.38*	44	41	37	38
Forms %	3,28	3.40*	98	97	94	93
MLU-words	3,28	0.37	7.93	7.83	7.96	7.64
MLU-morphemes	3,28	0.46	8.85	8.83	8.86	8.51
Lexical	9,58	0.15				
WAIS	3,28	0.08	21	20	20	20
Words	3,28	0.36	396	391	388	380
Type/token	3,28	0.04	0.49	0.48	0.47	0.47
Disfluency	12,61	0.53				
Fillers No.	3,28	1.23	26	30	24	23
Fillers-words	3,28	0.50	34	36	31	33
Fragments No.	3,28	0.58	5	7	5	5
Fragments-words	3,28	0.48	30	40	28	30

* $p < 0.05$.
† $p > 0.01$.

used more complex structures ($M = 14$) than did the other adults ($M = 10$). There is a progressive loss of accuracy for syntactic structures from 50 to 90 years. Although the number of verb tenses used did not vary with age ($M = 5$), the accuracy of their use did. The 50 and 60 year olds used more grammatical forms ($M = 43$) and used them more correctly ($M = 98\%$) than did the 70 and 80 year olds ($M = 38$ with 94% correct). Mean length of utterance did not vary with age ($M = 7.84$ words and 8.78 morphemes).

Performance on the three lexical measures, i.e. WAIS, total words, and type/token ratio, remained constant across the age range. Disfluencies such as sentence fillers and sentence fragments do not increase with age.

To further clarify the relationship between age and the dependent variables, partial correlations were computed removing the linear effects of education and employment. The half-matrix of partial correlations is presented in Table 2.

The three syntactic variables are significantly correlated; the two tense variables and the four form class variables also correlate with these syntactic variables.

Although the two measures of mean length of utterance are strongly correlated, these variables are not correlated with the number of form classes used nor with the accurancy of their use. The number of form classes used does correlate with the percentage used correctly.

The lexical variables of WAIS vocabulary score, number of words used, and type/token ratio are not correlated with their association with education partialled out.

All four measures of disfluency, i.e. number of fillers and fragments and the total words used as fillers or in fragments, are highly correlated. The disfluency variables are not correlated with the syntactic, tense, form class and lexical variables.

With the effects of education and employment statistically removed, age is significantly correlated with the number of simple and complex syntactic structures used, the percentage of simple structures used correctly, and the number of different tenses used, the number of different grammatical forms used and the percentage of forms used correctly.

Discussion

Nine different simple syntactic structures and three different complex constructions were common to all the adults. These included simple sentences with copulas and auxiliaries, simple sentences with infinitive complements, object-relative clauses, and co-ordinate objects and predicates, and some complex structures with multiple embeddings. The complex structures were sentences with relative clauses modifying the objects of infinitive complements, coordinate infinitive complements, and coordinate objects of relative clauses. The 50 and 60 year olds also used simple syntactic structures with modals, subject-relative clauses, coordinate subjects, subordinate clauses and noun–phrase complements. They used a greater range of complex structures with multiple embeddings, embedding plus coordination, and complex combinations of structures. The 70 and 80 year olds made more errors in their use of the simple syntactic structures. These errors included the omission of obligatory grammatical morphemes such as complementizers and relative pronouns.

The 70 and 80 year olds produced more errors such as incorrect past tense inflections, mis-matches of subject and verb person and number, and omissions of articles and possessive markers.

At all ages, the most common grammatical forms were singular and plural nouns, personal and demonstrative pronouns, past tense verbs, copulas, verb forms of 'to do' and 'to have',

Table 2. Half-matrix of partial correlations after removing the linear effects of education and employment

	Simplex	Complex	Structures	Tenses No.	Tenses %	Forms No.	Forms %	MLU-words	MLU-morphemes	WAIS	Words	Type/token	Fillers No.	Fillers-words	Fragments No.	Fragments-words
Syntactic																
Simple	———															
Complex	+0.37*	———														
Structures	+0.43*	+0.38*	———													
Tense																
Tense No.	+0.40*	+0.35*	+0.69†	———												
Tense %	+0.37*	+0.21	+0.29	+0.23	———											
Form class																
Forms No.	+0.09	−0.24	+0.71†	−0.05	+0.37*	———										
Forms %	+0.50†	+0.41*	+0.57†	+0.79†	+0.23	+0.65†	———									
MLU-words	+0.52†	+0.56†	+0.16	+0.50†	+0.22	−0.42*	−0.14	———								
MLU-morphemes	+0.34*	+0.52†	+0.19	+0.08	+0.32*	+0.05	+0.27	+0.82†	———							
Lexical																
WAIS	+0.17	+0.17	+0.33*	+0.04	+0.21	+0.19	+0.08	+0.07	+0.10	———						
Words	−0.13	+0.03	+0.06	−0.27	+0.13	+0.14	+0.20	0.0	+0.63†	+0.18	———					
Type/token	+0.11	+0.44*	−0.11	+0.01	+0.14	+0.13	+0.14	+0.85†	−0.42*	+0.03	0.0	———				
Disfluency																
Fillers No.	+0.03	+0.15	+0.21	+0.11	+0.23	+0.16	+0.09	+0.31*	+0.17	+0.23	+0.43*	−0.38*	———			
Fillers-words	−0.11	−0.12	−0.04	−0.07	−0.10	−0.19	+0.03	+0.09	−0.03	−0.06	+0.24	−0.31	+0.75†	———		
Fragments No.	−0.14	+0.25	−0.15	+0.27	−0.04	+0.09	+0.06	−0.05	−0.15	+0.12	+0.02	−0.26	+0.49*	+0.57	———	
Fragments-words	−0.09	−0.09	+0.26	+0.23	−0.02	+0.03	−0.01	+0.05	−0.07	+0.05	+0.08	−0.33*	+0.45*	+0.53†	+0.92†	———
Age	−0.52†	−0.41*	−0.39*	−0.46*	−0.26	−0.57†	−0.37*	−0.11	−0.04	−0.18	−0.18	+0.09	−0.23	+0.01	−0.07	−0.07

* $p < 0.05$.
† $p < 0.01$.

articles, possessives pronouns, adjectives, prepositions, conjunctions and negatives. Thirty-five different grammatical forms were used by all 32 subjects in this study. However, the 50 and 60 year olds also used gerunds, reflexive pronouns, modal auxiliary verbs, and participles. The middle-aged adults were also more accurate in their use of the common grammatical forms.

It is not immediately obvious that differences in topic are responsible for the observed differences in performance. One exception may be the failure of the 70 and 80 year olds to use modal auxiliary verbs and, hence, syntactic structures and verb tenses with modals. Modals in English are typically used to mark the future tense, e.g. 'will'. Thus, their absence may indicate that the elderly adults were less likely to discuss future events than the 50 and 60 year olds.

The elderly adults did not use grammatical forms and syntactic structures that impose high memory demands (Craik, 1977; Cohen, 1979, Cohen and Faulkner, 1981). Gerunds, participles, subject-relative clauses, coordinate subjects, subordinate clauses, and complex structures with multiple embeddings involve 'centre-embedded' and 'left-branching' grammatical structures in which one constituent interrupts another. 'Centre-embedded' and 'left-branching' structures are more difficult to understand and produce than 'right-branching' structures as they require more memory to process the interruption. [For a discussion of the difficulties imposed by such structures for comprehension, see Fodor *et al.* (1974).] By using simpler 'right-branching' grammatical structures, the adults were able to preserve the length of their utterances and to avoid an increase in disfluency. These substitutions and compensations were not completely successful in that the elderly adults did make more errors with those grammatical forms and syntactic structures they did use.

Prior research on healthy, elderly adults' production, comprehension, and memory of complex syntactic structures is very limited. Feier and Gertsman (1980) compared adults' comprehension of sentence-initial and sentence-final relative clauses. Although performance did decline with age, there was no interaction between sentence type and age. The task required the adults to act out the sentences with toy figures. Any effects of sentence type in this study may have been obscured by attentional and motivation consequences of the task; elderly adults may be disinterested in artificial tasks requiring them to act out sentences. Noll and Randolf (1978) have compared the performance of adults between 29 and 76 years on the Token Test (DeRenzi and Vignolo, 1962). This test also requires adults to act out instructions involving 'centre-embedded' and 'left-branching' constructions. Noll and Randolf did not report any age-related declines on this test; however, few 70 year olds and no 80 year olds were tested.

Further research on the linguistic skills of healthy, elderly adults is indicated. The differences between middle-age and elderly adults in syntactic structures, verb tenses, and form classes are reminiscent of those reported for written oral language and for formal vs informal speech (Chafe, 1982). The middle-aged adults may use the more complex syntax and more elaborated grammar of formal and written language while the elderly adults may use a more informal style of speech. To investigate this possibility, spoken and written language samples must be compared for both middle-aged and elderly adults. Elderly adults may have difficulty comprehending complex syntactic constructions involving 'centre-embedded' and 'left-branching' constructions. Natural tasks using dependent measures appropriate for elderly adults must be employed to evaluate adults' comprehension of both oral and written sentences.

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