

Change in Word Fluency over the Adult Lifespan: A Longitudinal Linguistic Analysis

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Abstract

Word Fluency serves as an assessment tool to examine many topics in the study of cognition, such as mental functioning, individual differences, and dementia. Most prior research on word fluency has been conducted using the total number of responses provided within a fixed time period. Most word fluency data are cross-sectional and a few studies do not control for educational differences between participants. This study contributed to the literature by examining word fluency from a linguistic perspective involving grammatical and morphological analyses. This study examined longitudinal change and qualitative differences in word production. A significant age difference in the usage of verbs was found, with a lower frequency in old age. However, a significant age by occasion interaction indicated that the morphological complexity of responses increased as participants aged.

Many researchers have used the Word Fluency Test (Thurstone & Thurstone, 1948) as an assessment tool for examining areas of cognition such as mental functioning, individual differences, and dementia in adults. Traditionally, word fluency has been evaluated cross-sectionally by analyzing the number of words produced quantitatively. Individuals with less education tend to produce fewer words. Therefore, education could be considered a confounding variable. It has been reported that there are gender differences favoring women in word frequency tasks (Alvis, Ward, & Dodson 1989; Buckelew & Hannay 1986). Additional research demonstrates that word fluency scores decline with age (Alexander, Langer, Newman, Chandler, & Davies 1989; McCrac, Arenberg, & Costa 1987; Obler & Albert, 1985).

An alternative approach to the quantitative analysis of word fluency involves a qualitative linguistic perspective. Linguistic analysis can be approached grammatically or morphologically. Grammatical analysis involves categorizing words into their parts of speech (e.g., nouns, verbs, adverbs and adjectives), while a morphological analysis characterizes words into the appropriate number of morphological parts. These methods examine not only the number of responses produced but also the types or categories of responses that subjects produce. Qualitative changes in word production can be measured using several language characteristics as opposed to one general score.

A morphological analysis of adult speech is a way to examine the complexity of one's word responses. The unit of analysis, a morpheme, is the smallest meaningful unit in any language. Its form and meaning are consistent throughout a language. Words can consist of either one or several morphemes. Words like *tree*, *cat*, *run*, *sad*, *nice*, and *think* all consist of one morpheme, and can not be broken down into smaller lexically meaningful segments. These words are called free morphemes because they can stand alone and

express their meaning. The other major type of morpheme is bound and can not express its lexical meaning without being attached to another word or root. Suffixes, prefixes, and roots (i.e., *-ed*, *-ment*, *-ing*, *-ly*, *sub-*, *per-*, *-mit*) can slightly change the meaning of the original word when they are attached to other forms. Newly formed words like *agree+ment*, *sad+ly*, and *sub+marine* have two morphemes. Words can contain several morphemes, like *un+happi+ness*, *un+lik+ly+ness*, and *non+pre+condition+al+ly*.

Morphemes are considered as a measure of complexity in child language acquisition studies (Brown, 1973). Morphological analysis is used as a developmental marker to determine if a child has acquired grammatical rules of their language (Berko, 1958). Basically, the more morphemes a word has the more different lexically meaningful parts it contains, and thus the more complex it becomes. The same type of measure can be applied to adult language. The present investigation used the average number of morphemes per word in the analysis of the data.

The present study was the first to examine word frequency responses longitudinally using grammatical and morphological methods. This investigation examined longitudinally how adults' word frequency responses change. Two hypotheses were proposed concerning longitudinal changes in word fluency responses. First, when subjects' responses were broken into grammatical categories it was hypothesized that age difference would be minimized. Second, although the number of words produced was assumed to decrease with age; the level of complexity of the words produced was hypothesized to increase.

Method

Participants

Participants were subjects from the Seattle Longitudinal Study (SLS) This large scale longitudinal-sequential study of adult cognitive development begun in 1956, has involved more than 5,000 participants (Schaie, 1983, 1993). All participants in the present investigation took part in the 1984 and the 1991 assessment sessions.

Participants ($N = 409$; Males = 168, Females = 241) were divided into three age groups. The middle-aged group ranged in age from 43 to 63 years old ($M = 56.02$, $SD = 5.80$, $n = 153$), the young-old group ranged in age from 64 to 77 years old ($M = 70.5$, $SD = 3.86$, $n = 179$), and the old-old group ranged in age from 78 to 92 years old ($M = 81.66$, $SD = 3.53$, $n = 77$). The mean educational level was 14.61 years ($SD = 3.01$, range = 1-20), and the mean income was \$ 27,700 ($SD = \$8,160$, range = \$ 2,000 - \$ 34,000). A description of the sample found in Table 1 further divides participants by gender.

Insert Table 1 about here

Materials and Procedure

Participants were administered the Word Fluency Test from the Primary Mental Abilities battery (Thurstone & Thurstone, 1948) in 1984 and 1991. Word fluency is a task concerned with speeded verbal production. Participants were given five minutes to write down as many words as they could beginning with the letter 's'. Participants were instructed not to list proper nouns or the conjugation of verbs (i.e., not to include the present and past tense of the same verb) in their responses.

Each word was categorized by parts of speech and by number of morphemes. The parts of speech were determined by The English Oxford Dictionary (1973). Two independent raters trained in Linguistics divided the words into morphemes. When the raters did not agree on the morphological division, the etymology of the word was consulted to determine which morpheme value should be used. Raters disagreed on only 5 % of the corpus of responses. Only words found in the Oxford Dictionary were included in the analysis.

Results and Discussion

Tables 2 and 3 present by age and gender the number of words produced, the average number of morphemes per word, and the percentage of nouns, verbs, adjectives, and adverbs.

Insert Tables 2 and 3 about here

The results address three questions. The first question addresses the change in the number of words produced. The second question examining longitudinal changes in grammatical categories (i.e., parts of speech) of participants' responses. The final set of analyses reports changes in the number of morphemes. For each question age and gender differences were examined.

Number of Words Produced

To examine change in the number of words that participants produced, a repeated measures 2 (gender) x 3 (age) x 2 (occasions) Analysis of Variance (ANOVA) was calculated. Repeated measures 2 (gender) x 3 (age) x 2 (occasions) Analysis of Covariance (ANCOVA) was calculated separately to statistically control for education. Tukey's

honestly significant difference test (HSDs) for unequal η s was computed for the significant main effects and interactions. The ANOVA and ANCOVA results are presented in Table 4.

A significant main effect was found for gender ($p < .05$). Female participants had significantly more responses than males. The age main effect was significant ($p < .05$). The middle-aged group produced the highest number of responses, followed by the young-old group and then the old-old group. A significant gender by age interaction indicated that middle-aged and old-old women generated more words than men. However, young-old men scored higher than young-old women.

The significant occasion by gender interaction (see Figure 1) indicated that the number of responses for males decreased across occasions while the number of words produced by females was stable. The finding that number of responses differed by gender is consistent with previous research (Alvis et al. 1989; Buckelew & Hannay, 1986).

Insert Figure 1 about here

Insert Table 4 about here

Grammatical Analysis

For each part of speech (noun, verb, adjective, and adverb), a repeated measures 2 (gender) x 3 (age) x 2 (occasions) Analysis of Variance (ANOVA) was calculated. Repeated measures 2 (gender) x 3 (age) x 2 (occasions) Analysis of Covariance (ANCOVA) was calculated separately to statistically control for education. Tukey's HSD for unequal η s was computed for the significant main effects and interactions.

No significant main effects or interactions were found for the categories of nouns, adjectives, or adverbs. There was a significant age main effect for verbs ($F = 4.48, p < .01$). With increasing age participants showed a decrease in the number of verbs produced over time. The age main effect for verbs remained when education was statistically controlled ($F = 4.05, p < .05$). When education was statistically controlled, age and gender interacted significantly ($F = 2.94, p < .05$). The gender difference in the old-old age group appears to be higher, but there is little gender difference in the middle-aged and young-old age groups. No other significant main effects or interactions were found.

Morphological Analysis

A repeated measures 2 (gender) x 3 (age) x 2 (occasions) Analysis of Variance (ANOVA) was calculated on the average number of morphemes per word. Repeated measures 2 (gender) x 3 (age) x 2 (occasions) Analysis of Covariance (ANCOVA) was calculated separately to statistically control for education. Tukey's HSD for unequal μ s was computed for the significant main effects and interactions. The ANOVA and ANCOVA results are presented in Table 5.

Insert Table 5 about here

There were no significant main effects for age, gender, or age by gender. A main effect for occasion indicated that at the second testing period, participants' responses included more complex words (i.e., greater number of morphemes per word) than during the first testing session. The occasion by age interaction was significant as shown in Figure 2. The middle-aged and old-old aged groups increased in the average number of morphemes per word, but the young-old group remained the same. During the first testing

occasion, an age difference was present for the middle-aged and young-old age groups; however this age difference was not significant for the second testing occasion. When education was statistically controlled, only the occasion by age interaction remained.

Insert Figure 2 about here

Conclusion

The previous research on the Word Fluency task provides quantitative information including that the number of responses decreases with age and that women perform better than men on the task. This investigation used a qualitative approach, examining specifically changes in grammar and word complexity that occur as participants age. Our hypotheses were partially confirmed. First we hypothesized no age differences or changes in the grammatical parts of speech. No significant age, gender or occasion main effects or interactions were found for nouns, adjectives or adverbs. However, there was an age main effect for verbs with the number of verbs produced decreasing with age.

The decrease in the number of verb responses could be due to the lexical rule placed on verbs (no conjugations). A lexical rule such as no proper nouns effects a smaller portion of the noun category than the portion effected by the lexical restriction on verbs. This could make the category of verbs more limited or difficult to produce. Additional research needs to be conducted to examine whether this difficulty increases with advancing age.

Our second hypothesis was that the complexity of words generated (i.e., number of morphemes per word) would increase with age. The significant age by occasion interaction supports this hypothesis.

Further research should employ a qualitative approach and examine other linguistic characteristics of word production. The ratio of complex words (words that contain more than one morpheme) to the number of simple words (words containing only one morpheme) warrants additional explanation. The etymology of responses, and the origins of the words could also be examined.

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Table 1.
Sample by gender and age cohort.

	Middle-Aged		Young-Old		Old-Old	
	M	T	F	T	M	F
N	56	153	81	98	31	46
Age	56.46	56.08	70.30	70.70	81.18	82.02
SD	5.90	5.80	4.01	3.75	3.70	3.41
Range	43-63	43-63	64-77	64-77	78-92	78-92
Education	14.58	14.43	15.31	13.85	14.79	13.51
SD	3.35	2.35	2.64	2.36	4.05	2.81
Range	4-20	11-20	10-20	8-20	1-20	8-18

Table 2.

Language Variables (Frequency): Age Cohort, Gender, Occasion

	Middle-Aged						Young-Old						Old-Old					
	1984		1991		1984		1991		1984		1991		1984		1991			
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F		
X # Words	43.84	45.46	43.34	47.39	42.24	39.84	40.44	40.02	34.00	39.36	31.13	38.73						
SD	12.28	12.70	11.85	12.28	11.59	12.24	12.86	12.69	11.96	12.15	13.28	12.87						
Range	23-77	14-80	22-67	20-80	13-71	4-75	13-79	8-72	14-70	16-62	9-67	10-67						
X Morphemes /per word	1.12	1.15	1.17	1.18	1.16	1.18	1.16	1.18	1.30	1.14	1.70	1.16						
SD	.08	.09	.11	.10	.10	.10	.10	.11	.09	.10	.11	.11						
Range	1-1.31	.98-1.40	1.03-1.58	1-1.53	.93-1.50	1-1.62	.95-1.50	1-1.75	.88-1.29	1-1.38	1.03-1.50	1-1.39						

Note. M = male; F = female.

Table 3.
Language Variables (Percent): Age Cohort, Gender, and Occasion.

	Middle-Aged						Young-Old						Old-Old					
	1984		1991		1984		1991		1984		1991		1984		1991			
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F		
% Nouns	.56	.55	.55	.56	.56	.56	.55	.55	.54	.55	.56	.55	.54	.55	.56	.56		
<u>SD</u>	.09	.10	.09	.09	.10	.11	.11	.11	.09	.10	.14	.10	.09	.10	.14	.12		
Range	.41-.81	.14-.79	.37-.78	.35-.80	.36-.90	.32-.81	.16-.93	.34-.88	.33-.72	.31-.76	.22-.74	.31-.76	.33-.72	.31-.76	.22-.74	.30-.80		
% Verbs	.44	.43	.45	.44	.42	.42	.43	.42	.36	.43	.42	.43	.36	.43	.42	.42		
<u>SD</u>	.10	.10	.10	.10	.11	.12	.10	.12	.10	.12	.13	.12	.10	.12	.13	.12		
Range	.19-.70	.20-.68	.21-.72	.21-.68	.14-.63	.16-.62	.07-.65	.13-.82	.08-.50	.10-.61	.08-.62	.10-.61	.08-.50	.10-.61	.08-.62	.13-.67		
% Adjectives	.17	.17	.18	.18	.18	.18	.18	.18	.19	.19	.22	.19	.19	.19	.22	.18		
<u>SD</u>	.07	.08	.08	.06	.08	.08	.09	.10	.08	.09	.11	.08	.08	.09	.11	.09		
Range	.03-.33	.03-.44	.04-.42	.05-.33	0-.40	0-.40	0-.50	0-.50	0-.07	.03-.51	0-.10	.03-.51	0-.07	.03-.51	0-.10	.04-.46		
% Adverbs	.01	.01	.01	.02	.01	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.01		
<u>SD</u>	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.03	.02	.02	.02	.03	.02		
Range	0-.06	0-.06	0-.09	0-.08	0-.08	0-.10	0-.11	0-.08	0-.07	0-.06	0-.10	0-.07	0-.07	0-.06	0-.10	0-.09		

Note. M = male; F = female.

Table 4.
ANOVA and ANCOVA Results for Words.

	<u>Number of Words</u>			<u>Education Covaried</u>		
	MS	F	P	MS	F	P
Gender	1079.13	3.94	>.05	1875.96	7.14	>.01
Age	3762.90	13.73	>.01	3612.40	13.75	>.01
Gender x Age	899.14	3.28	>.05	800.52	3.05	>.05
Occasion	116.58	3.47	NS	.26	.01	NS
Occasion x Gender	143.46	4.27	>.05	137.23	4.09	>.05
Occasion x Age	88.91	2.65	NS	78.94	2.35	NS
Occasion x Gender x Age	4.99	.15	NS	5.39	.16	NS

Table 5.
ANOVA and ANCOVA Results for Morphemes.

	<u>Number of Words</u>			<u>Education Covaried</u>		
	MS	F	P	MS	F	P
Gender	.01	.86	NS	.01	.98	NS
Age	.02	1.68	NS	.02	1.70	NS
Gender x Age	.01	.29	NS	.01	.43	NS
Occasion	.07	10.22	>.01	.01	.54	NS
Occasion x Gender	.01	1.84	NS	.01	1.65	NS
Occasion x Age	.02	3.11	>.05	.02	3.18	>.05
Occasion x Gender x Age	.01	.21	NS	.01	.31	NS

Table 3.
Language Variables (Percent): Age Cohort, Gender, and Occasion.

	Middle-Aged						Young-Old						Old-Old					
	1984		1991		1984		1991		1984		1991		1984		1991			
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F		
% Nouns	.56	.55	.55	.56	.56	.56	.55	.56	.55	.54	.55	.56	.56	.56	.56	.56		
<u>SD</u>	.09	.10	.09	.09	.10	.11	.11	.11	.11	.09	.10	.14	.14	.12	.12	.12		
Range	.41-.81	.14-.79	.37-.78	.35-.80	.36-.90	.32-.81	.16-.93	.34-.88	.33-.72	.31-.76	.22-.74	.30-.80	.22-.74	.30-.80	.22-.74	.30-.80		
% Verbs	.44	.43	.45	.44	.42	.42	.42	.43	.42	.36	.43	.42	.42	.42	.42	.42		
<u>SD</u>	.10	.10	.10	.10	.11	.12	.12	.10	.12	.10	.12	.13	.12	.12	.12	.12		
Range	.19-.70	.20-.68	.21-.72	.21-.68	.14-.63	.16-.62	.07-.65	.13-.82	.08-.50	.10-.61	.08-.62	.13-.67	.08-.62	.13-.67	.08-.62	.13-.67		
% Adjectives	.17	.17	.18	.18	.18	.18	.18	.18	.18	.19	.19	.22	.22	.18	.18	.18		
<u>SD</u>	.07	.08	.08	.06	.08	.08	.09	.10	.08	.08	.09	.11	.09	.09	.09	.09		
Range	.03-.33	.03-.44	.04-.42	.05-.33	0-.40	0-.40	0-.50	0-.50	0-.07	.03-.51	0-.10	.04-.46	0-.10	.04-.46	0-.10	.04-.46		
% Adverbs	.01	.01	.01	.02	.01	.02	.02	.02	.02	.02	.02	.02	.02	.01	.01	.01		
<u>SD</u>	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02	.03	.02	.02	.02	.02		
Range	0-.06	0-.06	0-.09	0-.08	0-.08	0-.10	0-.11	0-.08	0-.07	0-.06	0-.10	0-.09	0-.06	0-.09	0-.10	0-.09		

Note. M = male; F = female.

Figure 1. Average Number of Word Responses by Gender and Age Cohort.

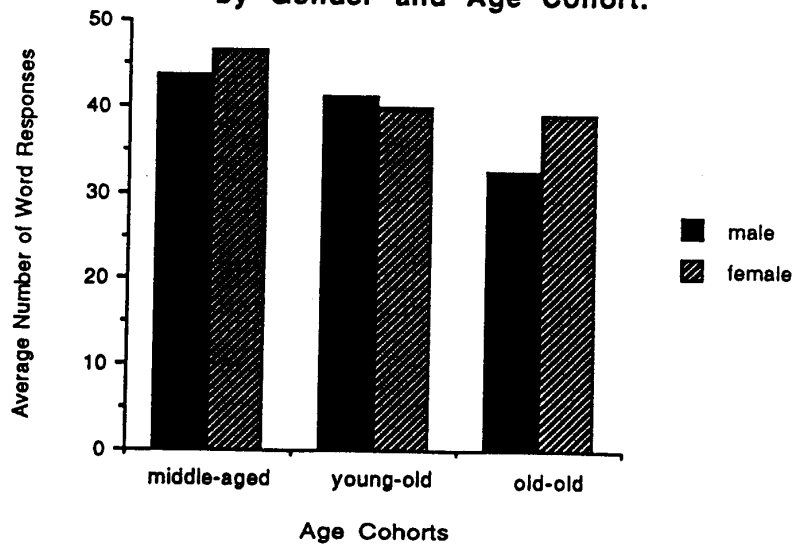


Figure 2. Average Number of Morphemes Per Word by Occasions and Age Cohort.

