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Memorability Functions in Verbal Memory: A Longitudinal Approach

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Middle-aged (N = 252, M = 39.91), young-old (N = 486, M = 60.77), and old-old (N = 137, M = 74.42) participants in the Seattle Longitudinal Study were tested on two occasions on their recall of a 20-item word list. Proportions of participants in each group correctly recalling each word-unit served as the dependent measure. Word-unit scores obtained in 1991 were regressed on those from 1984, yielding linear functions that varied by age group. Each set of word-unit scores (three groups on two occasions) was then regressed on word familiarity, imageability, primacy, and recency. The relative influence of each of these variables on memorability was then compared, both between and within cohorts. Primacy and familiarity were consistently strong predictors. Imageability and recency were predictive of memorability in the middle-aged group, but less so in the young-old, and not at all in the old-old group. Results and possible implications are discussed.

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List-learning performance has been shown to demonstrate the impact of aging and neurological dysfunction on memory performance (Buschke, 1984; Hultsch, 1975; Schmidt, Tombaugh, & Faulkner, 1992). Performance on list-learning tasks is usually represented quantitatively as the number of words correctly remembered by each participant. However, this approach may not be sensitive to subtle qualitative changes in verbal memory performance (Stine & Wingfield, 1988), especially longitudinal changes in performance. Relative memorability analysis allows for qualitative changes in memory performance to be discerned by treating the likelihood of recall for each to-be-remembered item as the unit of analysis (Rubin, 1985). This method is in contrast to the more traditional analyses in which the proportion of the total number of items correctly recalled by each participant is the variable of interest.

As noted above, age differences are likely to be observed in a list-learning task. Additionally, some studies have reported gender differences favoring women on performance of list-learning tasks (e.g., Hultsch, Hertzog, Small, McDonald-Miszczak & Dixon, 1992), and some studies have suggested a general advantage possessed by females in performance of verbal tasks (Maccoby & Jacklin, 1974), although the magnitude of such differences remains a point of contention (Hyde & Linn, 1988). Because age and gender were both at least somewhat likely to be related to performance, relative memorability analyses in this study were carried out taking both of these factors into account. Further, because age and gender are categorical rather than explanatory variables, cognitive process-related variables which might help to explain group differences were explored.

Prior studies have calculated relative memorability analyses cross-sectionally (e.g., Verhaeghen & Marcoen, 1993a, 1993b). Memorability functions in this study were calculated longitudinally, from the regression of probability of time 2 recall on probability of recall at time 1, as these probabilities were observed within age cohort and gender groups. These functions may be interpreted based on the resulting slope and *y*-intercept. Assuming a *y*-intercept of 0, a slope of 1.0 would suggest that at time 1 and time 2 each word-unit was recalled by an equal proportion of participants. Slope greater than 1.0 would indicate that at time 2 participants became more likely to recall some or all of the word-units from the list. On the other hand, a slope of less than 1.0 would suggest that at time 2, some or all of the words from time 1 decreased in likelihood of recall. Assuming a slope of 1.0, an increase in the *y*-intercept would indicate that all word-units became more likely to be remembered at time 2, and a decrease in *y*-intercept would be associated with a general decline in word-unit memorability.

The present investigation served three general purposes. First, the effects of age cohort, gender, and testing occasion on word-unit recall probabilities were examined. Second, qualitative longitudinal age differences in verbal memory over a 7-year interval for males and females and for three age groups (age range = 22–86 years) were investigated. Third, to determine the sources of the obtained age group and gender differences, a series of regressions was performed, regressing word-unit recall proportions on a set of variables reflecting the quality and quantity of cognitive processing that the word-units were likely to have invoked.

Several hypotheses were considered. Age group, gender, and testing occasion were all expected to affect word-unit recall. Mean recall proportion was expected to be highest among the middle-aged group, followed by the young-old, and least among the old-old group. Word-unit recall proportions were expected to be higher for females than for males. Aging effects were also expected, such that the two older age groups would exhibit some decline over the 7-year interval between tests, with the larger decline expected in the old-old group.

Regarding relative memorability functions, middle-aged adults were hypothesized to have a slope closer to 1.0 than young-old and old-old adults. Among the young-old and old-old, the slope was predicted to deviate more from 1.0 and to be smaller in magnitude, indicating declines in memorability for relatively high-probability word-units from time 1. The slope for females was predicted to be steeper than that obtained for males, indicating that relatively high probability word-units at time 1 would remain memorable for females, whereas decreasing in likelihood of recall for males.

Finally, cognitive processes are considered. It was expected that the relative position of words within the memory set would have a strong influence on word-unit recall likelihood for all three age groups and for both genders. Primacy was predicted to be significantly associated with word-unit recall likelihood for all groups of participants. Recency was expected to predict recall likelihood among the middle-aged, and to be less predictive of recall likelihood in the two older age groups. The other word-related variables, familiarity and imageability, were expected to be associated with word-unit recall for all of the participant groups. Comparison of the relative strength of these associations, both between and within age groups, and between genders, might yield insight into age and gender differences in the strategies employed on a list-learning task of this type.

METHOD

Participants

Participants in the present investigation were from the Seattle Longitudinal Study (SLS), a large scale longitudinal-sequential study examin-

ing adult cognitive development in more than 5000 participants between the ages of 22 and 86 since 1956 (Schaie, 1983, 1993, 1996). SLS participants are selected randomly from within gender and age-cohort groups from the membership of a large Health Maintenance Organization in the Seattle area. The sampling frame was a community-dwelling population representing a wide range of occupational, educational, and economic backgrounds. All participants in the present investigation took part in the 1984 and in the 1991 assessment sessions of the SLS.

Participants ($N = 875$; $n = 399$ males and $n = 476$ females) were divided into three age groups according to their age at the first assessment session (1984). The middle-aged group, consisting of 120 males and 132 females, ranged in age from 22 to 49 years old ($M = 39.91$, $SD = 6.74$, $n = 252$); the young-old group, consisting of 222 males and 264 females, ranged in age from 50 to 70 years old ($M = 60.77$, $SD = 5.75$, $n = 486$), and the old-old group, consisting of 57 males and 80 females, ranged in age from 71 to 86 years old ($M = 74.42$, $SD = 2.89$, $n = 137$). Table 1 contains a description of the sample by age and gender.

The age groups differed in their mean level of education and vocabulary ($p < .05$). Old-old adults had less education than young-old adults; young-old adults had less education than middle-aged adults ($p < .05$). Middle-aged adults and young-old adults had equivalent vocabulary scores, whereas old-old adults had lower scores than young-old adults ($p < .05$). However, the observed differences in education and vocabulary, although statistically significant, were small in absolute magnitude and thus were not expected to have excessive influence in the analyses performed, especially because the study is primarily concerned with qualitative differences in patterns of decline, rather than quantitative performance differences.

Participant Attrition

The sample in the present investigation ($N = 875$) consists solely of those participants who took part in both the 1984 and 1991 testing occasions (1494 individuals participated in 1984; of those, 619 did not return). Previous research on the SLS has shown that those participants who return to later assessment sessions tend to perform at higher levels on the study's measures than those participants who do not return to the later assessment sessions (Baltes, Schaie, & Nardi, 1971). In general, individuals who returned for the second testing occasion were better educated, obtained higher verbal scores, and correctly recalled more words on the immediate and delayed verbal memory tasks than those who did not return ($p < .05$). The effects of attrition can further be seen within each age group. Middle-aged adults who returned for the second assessment were more educated, obtained higher vocabulary scores, and

TABLE 1 Sample Description as a Function of Age and Gender

		Middle-aged			Young-old			Old-old			
		Males	Females	Total	Males	Females	Total	Males	Females	Total	Total
n		120	132	252	222	264	486	57	80	137	875
Age (in 1984)	mean	39.58	40.21	39.91	61.19	60.42	60.77	74.09	74.65	74.42	56.89
	(*SD*)	(6.13)	(6.87)	(6.74)	(5.42)	(5.78)	(5.63)	(2.89)	(3.07)	(2.99)	(13.10)
Education (in years)	mean	16.02	15.09	15.54	15.21	14.17	14.65	13.32	13.80	13.59	14.74
	(*SD*)	(2.51)	(2.60)	(2.59)	(3.03)	(2.61)	(2.86)	(3.71)	(2.60)	(3.12)	(2.89)
ETS vocabulary	mean	52.14	52.24	52.19	50.80	50.68	50.74	46.28	47.03	46.72	50.52
	(*SD*)	(8.93)	(8.61)	(8.74)	(9.73)	(9.55)	(9.62)	(11.44)	(9.80)	(10.48)	(9.67)

recalled more words on the verbal memory tasks than those who did not return ($p < .05$). Young-old adults who returned for the second assessment did not differ from the nonreturners on education, vocabulary, or verbal memory ($p > .05$). The old-old adults who returned for the second assessment had higher vocabulary scores and recalled more words on the verbal memory tasks than those who did not return ($p < .05$).

Materials and Procedure

The test of verbal memory was part of a 5-hour psychometric battery administered in 1984 and 1991. All tests were administered by a trained examiner, assisted by a proctor. The participants were tested in small groups at familiar sites close to their homes.

Verbal Memory Measure

Verbal memory is the ability to encode, store, and recall meaningful language units. Verbal memory was measured in 1984 and again in 1991 by an Immediate Recall test and a Delayed Recall test (Zelinski, Gilewski, & Schaie, 1993). Participants studied a list of 20 concrete nouns for 3.5 minutes and then engaged in free-recall. Immediate Recall was assessed immediately after the word list was removed from view and Delayed Recall was assessed after a 1-hour delay. The 2-week test-retest correlation for the Immediate Recall task was .820 and .732 for the Delayed Recall task (Schaie, Willis, Hertzog, & Schulenberg, 1987). The memorability functions and analyses reported in the following results section include only Immediate Recall performance.

Word Property Indices

One of the analytic methods employed in deriving the results required the use of normative data on the familiarity and imageability of the words presented in the verbal memory test. These norms were obtained from Coltheart's (1981) combined index, and were used to assess the relevance of these variables to recall likelihood.

Primacy and recency within the word list were also examined by assigning binary dummy codes, the higher value assigned to the first five and last five words in the list, respectively. It should be noted, however, that the word list was not presented in a serial fashion; each participant received the list of words arrayed in a single column in the center of an otherwise blank page. The instructions were to attempt to memorize the contents of the list without writing anything down.

RESULTS

The results are organized into three sections. The first section examines effects for age group, gender, and testing occasion via an analysis of variance (ANOVA) conducted on the proportion of participants recalling each of the 20 words in the stimulus set. The second section applies the technique of memorability analysis (Stine & Wingfield, 1988; Verhaeghen & Marcoen, 1993a) to longitudinal data, regressing word-recall proportions obtained in 1991 on those obtained in 1984 for each of the three age-groups and for each gender. The final section consists of an attempt to explain differences in memorability, by regressing word-recall proportions on the properties of the words themselves and their relative position of presentation within the stimulus set.

Age and Gender Differences in Word-Unit Recall Proportions

To investigate the role of age, gender, and testing occasion on the proportion of participants correctly recalling each of the 20 word-units in the test, a repeated measures 3 (age group) × 2 (gender) × 2 (occasion) ANOVA was calculated. All effects were treated as within-subjects, because the same 20 words were presented to all participants on both occasions of measurement. Tukey's honestly significant difference test was computed for the significant main effects and interactions. The ANOVA results are presented in Table 2, and the cell means obtained in this analysis are shown in Table 3.

Significant main effects were obtained for each of the predictor variables. The main effect of age-group ($p < .001$) and associated post hoc results indicated that mean word-recall proportions were significantly ($p < .001$) lower for each successive age group over middle-age. The significant effect of gender ($p < .001$) indicated that females consistently outperformed males on the recall task. Finally, a significant main effect ($p < .01$) of occasion was obtained. The age-by-occasion interaction was significant ($p < .001$), indicating a significant decline that occurred in the old-old cohort. Middle-aged and young-old participants did not show

TABLE 2 Word-Unit Recall Proportions as a Function of Age, Gender, and Occasion

	df	*F*
Age	2, 38	199.29***
Gender	1, 19	83.64***
Age × gender	2, 38	1.66
Occasion	1, 19	8.82**
Occasion × age	2, 38	15.08***
Occasion × gender	1, 19	.01
Occasion × age × gender	2, 38	.44

** $p < .01$; *** $p < .001$.

TABLE 3 Mean Proportion of Words Recalled in 1984 and 1991 Trials as a Function of Age and Gender

	Middle-Aged			Young-Old			Old-Old		
	Males	Females	Total	Males	Females	Total	Males	Females	Total
n	120	132	252	222	264	486	57	80	137
1984	.759	.819	.788	.631	.690	.661	.512	.594	.553
1991	.784	.833	.808	.609	.681	.645	.461	.538	.499
Total	.772	.826	.798	.620	.686	.653	.486	.566	.526

evidence of any decline over the 7-year interval between testing occasions.

Memorability Analyses

To assess qualitative differences in word-unit recall from a longitudinal perspective, simple regressions were calculated for each age-group, regressing word-recall proportions obtained in 1991 on those obtained in 1984, and comparing the slope values obtained for each group. Additionally, to examine overall gender differences in memorability, word-recall proportions for each gender, collapsed over the three age groups, were calculated and again 1991 proportions were regressed on those obtained in 1984. The slopes of these regressions were also compared. Table 4 contains the proportion of participants within each group correctly recalling each of the 20 words, which are listed in their order of presentation. To assess whether particular word-units maintained congruency in rank for memorability between participant groups, correlations (Pearson's *r*) were calculated. They ranged from .88 to .97 ($p < .001$), indicating high rank-order congruency in difficulty.

Figure 1 illustrates the memorability functions for the middle-aged, young-old, and old-old cohorts. The abscissas represent proportions recalled in 1984, and the ordinates represent proportions recalled in 1991. Points represent individual word-units, and the lines were obtained by least-squares regression of 1991 proportions on 1984 proportions.

Additional memorability functions were independently created for each gender across age groups, and these are presented in Figure 2. Again the abscissas and ordinates represent proportions of participants correctly recalling each word-unit in 1984 and 1991 respectively, and the points represent the individual word-units.

Table 5 contains the parameter estimates and correlations obtained in the regressions. The slopes for the memorability functions were compared using *t* tests. The slope for middle-aged participants was significantly different from the slope for the young-old group ($t(18) = 2.3$, $p < .05$). Examination of the intercept values obtained in these regressions suggests that middle-age participants became more likely at the

TABLE 4 Individual Word-Unit Recall Probabilities in 1984 and 1991

	Middle-aged ($n = 252$)		Young-old ($n = 486$)		Old-old ($n = 137$)		Females ($n = 476$)		Males ($n = 399$)	
	1984	1991	1984	1991	1984	1991	1984	1991	1984	1991
home	.929	.909	.889	.852	.869	.745	.895	.866	.900	.835
flag	.889	.937	.817	.776	.723	.664	.834	.834	.810	.769
bird	.873	.885	.706	.737	.693	.569	.775	.792	.724	.707
ocean	.897	.905	.739	.741	.620	.591	.775	.794	.754	.729
dirt	.861	.857	.776	.770	.774	.672	.817	.807	.779	.747
woman	.877	.873	.798	.815	.708	.730	.826	.832	.784	.802
exam	.683	.671	.461	.481	.401	.299	.521	.542	.509	.466
kettle	.869	.837	.739	.747	.657	.657	.796	.788	.724	.724
tank	.615	.710	.399	.389	.307	.301	.477	.494	.411	.436
painter	.750	.770	.584	.570	.431	.350	.626	.597	.586	.589
lemon	.786	.810	.650	.619	.518	.445	.737	.697	.586	.586
jury	.683	.746	.556	.588	.474	.343	.609	.626	.544	.559
star	.683	.710	.541	.518	.380	.365	.605	.601	.499	.489
money	.746	.754	.578	.576	.431	.489	.616	.611	.589	.617
alcohol	.734	.794	.673	.607	.555	.547	.706	.676	.632	.622
vest	.790	.790	.601	.535	.423	.358	.660	.607	.589	.549
iron	.758	.786	.636	.636	.431	.438	.662	.647	.612	.649
rattle	.627	.663	.506	.486	.365	.314	.563	.555	.466	.456
garden	.873	.873	.767	.702	.650	.562	.821	.773	.729	.677
church	.881	.913	.850	.815	.788	.672	.872	.836	.822	.802

Note. Words are listed in their order of presentation.

TABLE 5 Parameter Estimates and Correlations for Memorability Functions by Age and by Gender

	Intercept	*B*	*r*
Middle-aged	.163[a, a]	.818[a]	.954
Young-old	.020[b]	.947[a]	.974
Old-old	.015[c]	.877	.942
Females	.053	.936	.982
Males	.035	.900	.979

Note. Like superscripts indicate a statistically significant difference ($p < .05$).

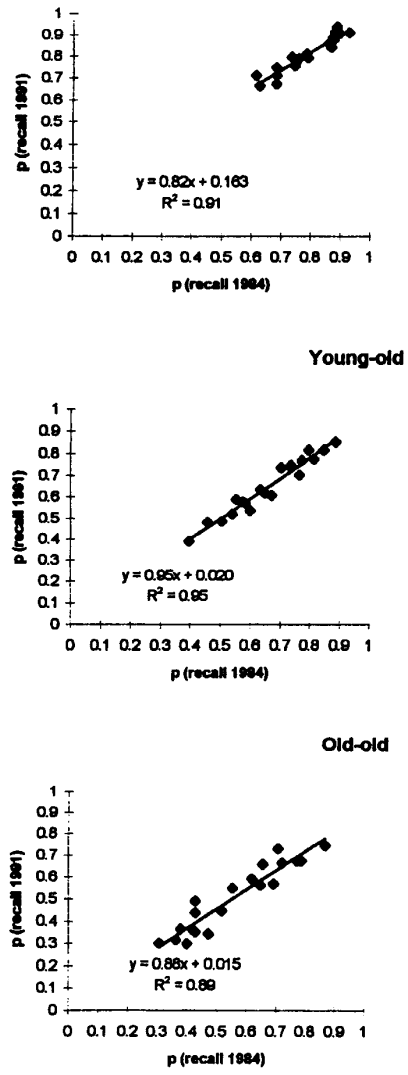

FIGURE 1 Memorability functions for middle-aged, young-old, and old-old groups.

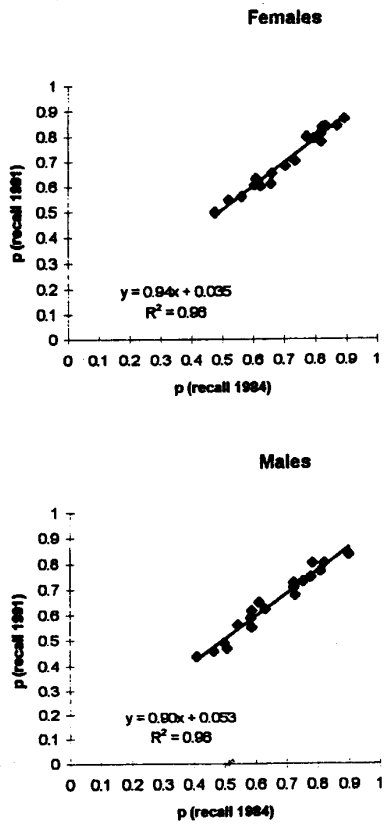

FIGURE 2 Memorability functions for females and males.

second occasion to recall the word-units that had relatively lower likelihood to recall on the first testing occasion, thus approaching ceiling level overall. The slopes for the young-old and old-old were not significantly different ($p > .05$), nor was there a significant difference between the slopes obtained for middle-aged and old-old participants. The slopes obtained by each gender overall were also compared, and no significant difference was observed ($p > .05$). Intercepts were also compared using t tests, revealing a significant ($p < .05$) difference between the middle-aged and young-old, and between the middle-aged and old-old, suggesting higher mean performance for the middle-aged group. No difference in intercept was observed between the young-old and old-old.

Analyses of Mediating Mechanisms

A series of simultaneous regressions was performed, again using proportions of participants in each group correctly recalling each word-unit as the outcome measure. Several predictor variables were considered for inclusion in the regressions. Table 6 consists of the correlation matrix obtained, listing the set of potential predictor variables in the first column and their bivariate correlations with word-unit recall proportions obtained within each of the participant groups. With the exception of recency, these predictors obtained consistently high correlations with the outcome. Based on Coltheart's (1981) index, frequency and familiarity were somewhat redundant ($r = .57$). Because familiarity correlated more strongly than frequency, on average, with the outcome measures, it was decided that familiarity would be used in the regressions, thus eliminating potential problems associated with collinearity between these two variables. Thus, all of the regressions were carried out with the same set of four predictor variables: familiarity, imageability, primacy, and recency. The primacy and recency variables were constructed using a binary dummy code with the higher value assigned to the first five and last five word-units in the list, respectively. Regression weights associated with each of the four predictors, carried out for each age group on each occasion, and by gender overall, are presented in Table 7.

Comparison of the p values associated with each predictor across age groups provides a cross-sectional view of the relative importance of these factors in predicting the likelihood of word-unit recall. Comparison within age groups across occasions provides a longitudinal perspective for addressing the same question. Finally, cross-gender comparisons yield insight into the sources of gender differences in memorability. In general, the values in Table 7 reveal that a strong serial position effect

TABLE 6 Correlations (Pearson's r) of Predictor Variables with Likelihood of Recall as a Function of Age Group and Occasion

	Middle-Aged		Young-Old		Old-Old	
	1984	1991	1984	1991	1984	1991
Word frequency	.41	.38	.52*	.51*	.53*	.52*
Familiarity[1]	.47*	.43	.49*	.53*	.49*	.61**
Imageability[1]	.47*	.49*	.44	.40	.36	.41
Primacy[2]	.60**	.63**	.54*	.57**	.63**	.55*
Recency[2]	−.03	−.04	.04	−.06	−.10	−.14

[1] $N = 19$ due to unavailability of rating data on "exam" word-unit.
[2] $N = 20$.
* $p < .05$; ** $p < .01$.

TABLE 7 Standardized Regression Weights and Associated t Values for Variables Potentially Affecting Recall

Group	Occasion		Familiarity	Imageability	Primacy	Recency
Middle-aged	84	*B*	.34	.37	.63	.36
		t	1.98†	2.23*	3.93**	2.08†
	91	*B*	.26	.41	.67	.31
		t	1.50	2.59*	4.24***	1.83†
Young-old	84	*B*	.42	.31	.56	.41
		t	2.23*	1.82†	3.27**	2.23*
	91	*B*	.43	.26	.57	.31
		t	2.42*	1.50	3.21**	1.66
Old-old	84	*B*	.38	.23	.62	.28
		t	1.98†	1.29	3.53**	1.46
	91	*B*	.50	.23	.49	.22
		t	2.63*	1.30	2.81*	1.18
Females		*B*	.35	.36	.58	.31
		t	1.88†	2.08†	3.33**	1.66
Males		*B*	.49	.22	.59	.35
		t	2.74*	1.31	3.59**	1.98†

* $p < .05$; ** $p < .01$; *** $p < .001$; † $.05 < p < .10$.

occurred for words appearing early in the stimulus list, as evidenced by the small p values and positive beta estimates associated with the primacy variable. The primacy effect was significant ($p < .05$) in all three age groups over both testing occasions, and in each gender.

Age and Aging-Related Comparisons

It appears that the familiarity variable was a fairly good predictor of recall likelihood, both cross-sectionally and longitudinally, especially in the young-old cohort. Imageability had a significant ($p < .05$) association with recall probability longitudinally among the middle-aged participants and cross-sectionally in 1984 for the middle-aged and young-old. The p values suggest that imageability is not predictive (in the presence of the other variables) of likelihood of recall for the oldest age group. Primacy in the word list, as mentioned above, was strongly predictive of recall likelihood, longitudinally and cross-sectionally, in all three cohorts. Finally, the effect of recency approached significance longitudinally in the middle-aged group. There was some evidence of the effect of recency cross-sectionally for the middle-aged and the young-old groups in 1984. It was not significant for the old-old group.

Gender Comparisons

Comparing the predictive capacity of the variables across genders reveals no reliable differences, except a potential disparity in the association between imageability and likelihood of recall. For females, image-

ability had a borderline significant ($p < .10$) association with likelihood of recall, whereas for males, there was no significant association. Familiarity, primacy, and recency had comparable effects (or lack thereof) for both groups.

DISCUSSION

Age and gender differences in list-learning performance were examined in this study, both longitudinally and cross-sectionally, using the technique of relative memorability analysis (Stine & Wingfield, 1988). This technique, which is essentially characterized by analyses performed on proportions of participants exhibiting correct recall of each given unit (in this case word-units), enables investigation of qualitative differences in memory performance.

Age-cohort differences in overall memorability were observed in this study, with mean word-unit recall proportion highest in the middle-aged group and lowest in the old-old group. Longitudinally, the old-old group exhibited performance decline over the 7-year interval between tests, whereas the middle-aged and young-old groups remained stable. There is some possibility that the greater decline exhibited by the old-old group was related to their lower overall level of education. This result may also have been influenced by some older participants experiencing terminal decline, although data on the longevity of participants were not available for this analysis.

Female participants in this study consistently outperformed males in all three age-groups and over both testing occasions. This result, although consistent with the notion that females possess superior verbal skills (Maccoby & Jacklin, 1974), was somewhat surprising due to the strength of the relationship observed. Most prior research has indicated only a slight, if any, advantage for females on tasks of this type (e.g., Hultsch et al., 1992; Hyde & Linn, 1988). The results from the regression analyses, which are discussed below, may help to shed some light on the sources of the observed gender differences.

From the modeling of 1991 word-unit recall likelihood based on 1984 recall, the following conclusions can be drawn. First, the relative memorability of word-units remained stable over the interval between testing sessions, as evidenced by the high correlations obtained through simple regressions. In other words, word-units that were relatively difficult (correctly recalled by the fewest participants) in 1984 remained difficult in 1991, and easy word-units remained easy, relative to other words on the list. Second, the pattern of longitudinal change in memorability exhibited by the middle-aged participants differed from those of the young-old and old-old. It appears that relatively difficult word-units became somewhat easier for the middle-aged participants to recall on the second testing occasion. Overall performance among the middle-aged participants thus approached ceiling level, as evidenced by the tight clustering of points near the high end of both axes in Figure 1 (top graph). In contrast, young-old participants had a slope near 1.0 with an intercept near 0, indicating little change over time. The slope for old-old participants was somewhat less than 1.0 with the intercept near zero, suggesting memorability declines for the relatively easy word-units. Thus, three different trends were observed for the three age-groups as a result of the relative memorability analysis.

Finally, the discussion turns to the results of the series of multiple regressions of word-unit recall proportions on primacy, recency, familiarity, and imageability. These results must be interpreted with caution, because they are based on a sample of only 20 words. In order to reliably evaluate the effects of these variables, several lists, designed to optimize the range of familiarity and imageability values taken by the word-units, would need to be presented. However, the results obtained in these analyses do allow for some interesting speculation.

First, the consistently strong primacy effect obtained for all groups on both occasions supports the notion that most participants adopted a strategy wherein word-units appearing near the top of the list received the most processing and hence were most memorable. The specific nature of this processing, i.e., whether rehearsal or other strategies were adopted to produce this effect, cannot be determined from these data. Familiarity, in a similar manner, was a fairly good predictor among all participants, indicating a general memorial advantage for commonly encountered nouns.

The effect of recency, on the other hand, approached significance for middle-aged participants, reached significance on the first occasion in the young-old group, dropping below significance on the second testing occasion, and dropped out entirely among the old-old participants. This pattern of results is somewhat consistent with prior studies indicating poorer working memory performance among older individuals (see Light, 1996, for a review). However, the primacy and recency results obtained in this study must also be interpreted carefully, because as mentioned in the methods section, the words on the list were presented all at once, rather than serially.

Imageability, like recency, had stronger effects among the middle-aged and young-old participants. Imageability was also a stronger predictor among females, who outperformed males. One interpretation might be that older individuals (and males) were less likely to adopt the strategy of visualizing the word-units in their attempts to memorize the list. Alternatively, the old-old (but presumably not males in general) may have been less able to adopt such a strategy as a result of the aforementioned potential processing limitations. Again, the data are insufficient to distinguish between these alternatives, but there is some support for a strategy-based interpretation. Several studies (Kliegl, Smith, & Baltes,

1989; Baltes & Kliegl, 1992; Yesavage, Rose, & Bower, 1983) have demonstrated the effectiveness of interventions providing training in the method of loci, a highly visual mnemonic strategy, in improving list-learning among the elderly. It may be the case that older individuals typically tend toward less use of visualization as a mnemonic technique, and interventions might either initiate or restore the use of such strategies. Further longitudinal research could distinguish whether observed age differences in the utilization of visualization techniques are related to decline or are the result of disuse or perhaps some other effect.

In summary, the data suggest that older participants relied on fewer strategies and/or abilities to recall the words from the 20-item list. For middle-aged participants, all four factors (familiarity, imageability, primacy, and recency) were associated with recall. In the young-old group, there was still some evidence of association with all four factors, but primarily at the first occasion. For the old-old, only familiarity and primacy were associated with recall. These results are supported by prior data suggesting that decline in working memory and other processing abilities occur late in life, whereas long-term memory remains unaffected among normal, healthy individuals.

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