Psychology and Aging
2015, Vol. 30, No. 4, 856–862

0882-7974/15/$12.00 http://dx.doi.org/10.1037/pag0000051

BRIEF REPORT

"Older Is Always Better": Age-Related Differences in Vocabulary Scores Across 16 Years

Boaz M. Ben-David
Interdisciplinary Center Herzliya, Herzliya, Israel, and University of Toronto

Hadas Erel
Interdisciplinary Center Herzliya, Herzliya, Israel, and Natanya Academic College

Huiwen Goy and Bruce A. Schneider
University of Toronto Mississauga

Cross-sectional studies of cognitive aging compare age groups at 1 time point. It is unclear from such studies whether age-related cognitive differences remain stable across time. We present a cross-sectional investigation of vocabulary scores of 2,000 younger and older adults collected across 16 years, using the same laboratory and protocol. We found a steady decrease with year of testing and an advantage for older adults. An additive relation between age group and year of testing implied that age-related differences in vocabulary are independent of changes over time, suggesting that younger and older adults are similarly affected by changes in word usage.

Keywords: aging, vocabulary, cognitive abilities, cohort, year of testing

Cross-sectional cognitive aging studies take a snapshot of age-related differences between two or more groups at a certain time (Cavanaugh & Whitbourne, 1999). Because the accumulated experiences of participants tested in a certain year may differ from the experiences of participants tested 15 years later, there is no guarantee that the same age-related differences will be observed at both times. Hence, one has to be cautious about assuming that age-related differences in cognition remain stable across time, given the rapid changes in social milieu, education, and even nutrition. Attempts to determine whether these age-related differences are unchanged over time have yielded inconclusive results, possibly because such studies are typically based on meta-analyses of data collected in different labs using different testing procedures (e.g., Uttl & Van Alstine, 2003). At the very least, variations in testing procedures and laboratory practices are likely to increase the variability of any age-related differences observed at different points of time. To minimize such sources of variation, in the current study, we examined how age-related differences in vocabulary have changed over time, using the same vocabulary test, administered in the same laboratory using the same protocol, with participants from the same population reservoir.

Standardized vocabulary scales gauge the lexicon of participants using different methods, such as asking participants to describe a word, as in the vocabulary subset of the Wechsler Adult Intelligence Scale (WAIS; Wechsler, 1997), or to choose the correct definition for a word out of a closed set, as in the abbreviated Mill Hill (aMH; Raven, 1965). Mean performance on these tests could decline (or improve) with the passage of time because of demographic changes. The rate of changes in scores over time could differ between age groups, because demographic factors may differentially affect older and younger adults.

Vocabulary Skills and Aging

Vocabulary scores are taken to reflect a long-term memory quality that is learned and accumulated with age (MacKay & Burke, 1990). Indeed, though other language skills have been found to deteriorate with aging (e.g., sentence complexity; Kemper, Kynette, Rash, O'Brien, & Sprott, 1989), vocabulary usually remains stable from adulthood (Alwin, 1991; Botwinick, 1967; but see old-old in the work of Singer, Verhaeghen, Ghisletta, Lindenberger, & Baltes, 2003) or even increases with age (e.g., Gold et al., 1995; Schaie, 1996). Several complementary hypotheses have been offered to explain why vocabulary is immune to age-related decline. Although general connectivity in the semantic network appears to decrease with age (Craik & Salthouse, 2011), everyday experience reinforces previously learned words in different contexts, enhancing their memory traces (Burke, MacKay & James, 2000). Accordingly, older adults' life experience generates enriched gist knowledge that can serve as an alternative route to the

Boaz M. Ben-David, Baruch Ivcher School of Psychology, Interdisciplinary Center Herzliya, Herzliya, Israel, and Department of Speech-Language Pathology, University of Toronto; Hadas Erel, Baruch Ivcher School of Psychology, Interdisciplinary Center Herzliya, Herzliya, Israel, and School of Behavioral Science, Natanya Academic College; Huiwen Goy and Bruce A. Schneider, Department of Psychology, University of Toronto Mississauga.

Correspondence concerning this article should be addressed to Boaz M. Ben-David, Baruch Ivcher School of Psychology, Interdisciplinary Center Herzliya, Herzliya, Israel. E-mail: boaz.ben.david@idc.ac.il

meaning of the word (dual-representation theory of knowledge; Brainerd & Reyna, 1992; McGinnis & Zelinski, 2003).

Aging and Year of Testing

The general age-related advantage in vocabulary has been documented for over 50 years, with different scales (for a meta-analysis, see Verhaeghen, 2003). In 1995, Gold and colleagues found vocabulary scores to improve with age. The same pattern was noted in 2011 by Ben-David and colleagues (2011). Both studies compare performance between two groups of people in their 20s and 70s. The 1995 study compared participants born in the 1920s (older) and the 1970s (younger adults), and the 2011 one compared participants born in the 1940s (older) and the 1990s (younger). The question arises: Are these studies comparable? Did they capture the same stable age-related differences separated by 15 years, or do they reflect differences related to the year of testing?

The year of testing has an intricate effect on vocabulary scores, with some studies indicating a moderate increase (Gerstorf, Ram, Hoppmann, Willis, & Schaie, 2011) and others indicating a moderate decrease in scores as years advance (Alwin, 1991; Glenn, 1994). Generally, these inconsistencies were attributed to the differential impact of the year of testing on items used in the specific tests (Bowles, Grimm, & McArdle, 2005; Wilson & Gove, 1999). The relationship between the effects of year of testing and age on vocabulary is also unclear. Uttl and Van Alstine (2003) reported an interaction of the two effects in a meta-analysis of 1965–1995 studies, whereas a meta-analysis of 1986–2001 studies failed to show such an interaction (Verhaeghen, 2003; see also Zelinski & Kennison, 2007). These inconsistencies may be due to a mediating effect of years of education.

Years of Education

Formal education (school, college, etc.) is one of the main predictors of performance on vocabulary tests (Kaufman, Reynolds, & McLean, 1989). However, the number of years of education may have less of an impact on younger than on older adults' vocabulary, because the variability in years of education for younger adults is smaller than for seniors. Namely, younger participants usually comprise a rather homogenous group of undergraduates with at least 12 years of education (see Table 1 in Verhaeghen, 2003) who have not yet realized their full educational potential. However, older participants are more varied. After controlling for education, Uttl and Van Alstine (2003) found year of testing to affect age-related differences in vocabulary, and Wilson and Gove (1999) found age-related differences to remain stable over time. These inconsistencies call for a fresh examination.

The Current Study

The goal of the current study is to tease apart the effects of aging and year of testing on vocabulary scores. We analyzed data collected in the same lab using the same scale (aMH) across 16 years with over 2,000 younger and older participants, minimizing the contributions to error variance related to differences between labs, testing procedures and populations. As a first step, we showed that the aMH test provides equivalent results to the standardized vocabulary subscale of the WAIS–III. In the second step, we examined the data collected and aggregated across eight consecutive 2-year subgroups. We tested the main effects of age group (vocabulary changes across the life span) and year of testing (vocabulary changes over the years) as well as the interaction of the two (whether year of testing affects the vocabulary of younger and older adults differently), after controlling for the effect of education.

Experiment 1

The aMH has been widely used as a gauge of basic language skills (e.g., Ben-David, Tse, & Schneider, 2012). Sliwinski and Buschke (1997) found that scores on the aMH were correlated ($r = .60$) with scores on the standardized vocabulary subscale of the WAIS–R (Wechsler, 1981). Because the WAIS–R version of the test has been replaced by the WAIS–III, it was necessary in the current study to further validate the aMH test using the WAIS–III.

Method.

Participants. One hundred and 70 younger adults ($M = 19.2$ years old, $SD = 1.8$), undergraduates at the University of Toronto Mississauga, participated in this study. They either received course credit or were paid $10 per hour. All participants were native English speakers (who learned English before the age of 5 years and have been speaking it ever since) and had visual acuity within the normal range on the Snellen test.

Materials and procedure. Participants completed the two vocabulary tests in the same session, separated by a short break, with the test order randomized across participants.

aMH vocabulary test. Participants were asked to match each of the 20 test items with its closest synonym by choosing one of six presented alternatives, with no time constraints. Individual scores were calculated as the number of correct responses out of 20.

WAIS–III Vocabulary subtest. The experimenter read aloud 33 words, each of which the participant was asked to verbally define. Responses receive 0, 1, or 2 points on the basis of their quality, such that the total score ranges from 0 to 66, and responses were coded by two independent experimenters. See the manual for a detailed description (Wechsler, 1997).

Results and discussion. The results of the WAIS–III vocabulary subtest in this study ($M = 40.8$, $SD = 8.5$) were similar (within interquartile boundaries) to those of 380 participants of the same age group in another study ($M = 36.0$, $SD = 12.7$; Ardila, 2007). Similarly, the average aMH score ($M = 12.4$, $SD = 2.3$) was within the range reported by our lab in the past 5 years (e.g., Ben-David & Schneider, 2010, $M = 13$, $SD = 2.7$; Ben-David et al., 2012, $M = 12.8$, $SD = 2.8$). The aMH in our sample was found to be reliable (Cronbach's alpha = .57). Figure 1 shows that scores on the aMH test were significantly correlated with scores on the WAIS–III ($r_p = .61$, $p < .01$). This comparison replicates the results of Sliwinski and Buschke (1997) using a different version of the WAIS (WAIS–R).

Experiment 2

The results of Experiment 1 showed that the aMH can be used as a valid measure of vocabulary skill. In Experiment 2, aMH scores and the number of years of education of older and younger

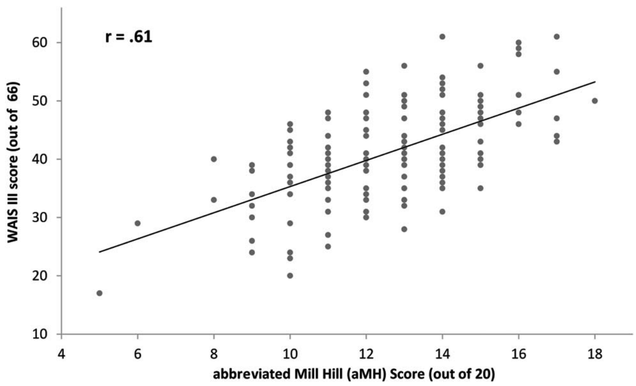

Figure 1. Comparison of scores on the abbreviated Mill Hill (aMH) and the Wechsler Adult Intelligence Scale (WAIS–III) vocabulary tests in Experiment 1. Scores on the aMH (*Y* axis) scale are presented as a function of the WAIS–III (*X* axis). The continuous line represents the linear trend.

adults were collected from the archives of the same laboratory across 16 years.

Method.

Data collection. Basic demographic information (age, gender, and years of education) and aMH scores were gathered for 2,036 older and younger participants, tested in the laboratory between 1995 and 2010, with measures implemented to verify transcription accuracy.

Participants. Data were collected from 1,299 younger adults (18–35 years old, $M = 21$ years old, $SD = 2.3$) and 737 older adults (60–94 years old, $M = 71.4$ years old, $SD = 5.9$). Participants to the lab were recruited through ads placed within the university and in the local media, through posters and brochures, or by word of mouth. Participants received either course credit or $10 per hour. Participants reporting health, sensory, or mobility issues were not recruited, and participants who learned to speak English after the age of 5 years were excluded from our analysis. The proportion of female participants in the older age group (62.0%) was slightly lower than in the younger group (69.7%, $\chi^2_1 = 12.2$, $p < .001$), but gender was not found to have a significant impact on aMH scores in our study and will not be further discussed. The average number of years of education for both age groups did not differ significantly ($F < 1$). The data were divided into 2-year subgroups on the basis of the year of testing. The average age of older participants did not change significantly as a function of year of testing, and the age of younger adults varied by no more than 1 year between consecutive 2-year subgroups.

Results. Table 1 presents the average aMH scores for each 2-year subgroup of older and younger adults. An examination of the table shows that aMH scores were higher for older adults on all eight 2-year subgroups, and that there was a gradual decline in aMH scores as the year of testing advanced. To check for any age by year of testing interaction, with respect to the contribution of education to aMH scores, we regressed aMH scores against years of education separately for each of the 16 combinations (2 ages × 8 testing years).

$$\begin{cases} aMH_{younger,i} = c_{yi} + b_{yi} * years\_of\_education \\ aMH_{older,i} = c_{o,i} + b_{o,i} * years\_of\_education \\ \qquad\qquad \text{i = Year of Testing } (1...8) \end{cases} \tag{1}$$

This 32-parameter model accounted for 24% of the variance in aMH scores (see the Appendix). Next, we showed that a model in which the intercepts of these functions declined in a linear fashion as a function of year of testing provided as good a fit as the full model. Namely, we could not reject the null hypothesis that the slope of the function relating aMH scores to years of education was the same for all year of testing subgroups (see the Appendix). Hence, the 6-parameter model

$$\begin{cases} aMH_{younger} = c_y + a_y * 2yearsubgroup \\ \qquad + b_y * years\_of\_education \\ aMH_{older} = c_o + a_o * 2yearsubgroup \\ \qquad + b_0 * year\ s\_of\_education \end{cases} \tag{2}$$

provided almost as good a fit (23% of the variance) as the full model that allowed for Age × Year of Testing interactions with respect to the contribution of years of education to aMH score. Note that the parameters of this model are allowed to differ across the two age groups.

We then tested three null hypotheses with respect to this six-parameter model: (1) $c_y = c_o$; (2) $a_y = a_o$; and (3) $b_y = b_o$. The

Table 1
Summary of Data Collected for Experiment 2

	Younger adults				Older adults			
Year	*N*	Age	Years of education	aMH score	*N*	Age	Years of education	aMH
1995–1996	43	22.0 (1.7)	15.5 (1.7)	14.5 (.3)	57	71.1 (4.3)	15.0 (3.1)	16.1 (.3)
1997–1998	55	21.8 (1.8)	15.1 (1.7)	14.2 (.2)	49	72.1 (4.9)	14.7 (2.7)	15.9 (.3)
1999–2000	64	21.8 (2.4)	15.0 (2.0)	13.8 (.2)	75	71.4 (5.5)	13.8 (3.2)	15.0 (.2)
2001–2002	145	21.6 (2.3)	14.9 (1.7)	13.7 (.2)	81	72.0 (5.8)	14.2 (3.1)	14.9 (.2)
2003–2004	219	21.4 (2.6)	14.6 (2.2)	13.6 (.2)	98	70.6 (5.3)	14.7 (3.3)	14.5 (.3)
2005–2006	196	20.9 (2.1)	14.2 (1.8)	13.6 (.2)	160	71.6 (6.4)	15.1 (3.0)	14.2 (.2)
2007–2008	343	20.7 (2.2)	14.0 (1.8)	13.0 (.1)	119	71.1 (6.2)	14.7 (3.5)	14.5 (.2)
2009–2010	234	19.6 (1.9)	13.5 (1.3)	12.6 (.2)	98	72.9 (6.9)	15.3 (3.6)	14.7 (.3)
Sum	1299	*20.9 (2.3)*	*14.3 (1.9)*	*13.2 (.1)*	***737***	*71.4 (5.9)*	*14.8 (3.3)*	*15.0 (.1)*

Note. Data are given as means with standard deviations in parentheses, when available. Age is given as years, and aMH as total score out of 20. AMH = Abbreviated Mill Hill (aMH) Vocabulary test.

first hypothesis ($c_y = c_o$) was rejected, $F(1, 2030) = 15.69$, $p < .0001$, but the second ($a_y = a_o$) and third ($b_y = b_o$) hypotheses could not be rejected, $F < 1$ and $F(1, 2030) = 2.79$, $p = .095$, respectively. Hence, in Model 2, the relationships between aMH scores, years of education, and year of testing were assumed to be independent of age group. The null hypothesis that both $b_y = b_o$ and $a_y = a_o$ could not be rejected, $F(2, 2030) = 1.52$, $p = .2$. Namely, Model 3, depicted next, provided as good a fit to the data as Model 1.

$$\begin{cases} aMH_{younger} = c_y + a * 2yearsubgroup \\ \qquad + b * years\_of\_education \\ aMH_{older} = c_o + a * 2yearsubgroup \\ \qquad + b * years\_of\_education \end{cases} \quad (3)$$

Two null hypotheses were tested and rejected with respect to Model 3: (1) $b = 0$ and (2) $a = 0$, $F(1, 2032) = 195.86$ and 52.77, respectively, $p < .0001$. Hence, we concluded that Model 3 is the minimum parameter model that provides as good a fit to the data ($r^2 = .229$) as the full model specified in Model 1 ($r^2 = .230$). Consequently, the relationships between aMH scores, years of education, and year of testing appear to be the same for both younger and older adults, but the aMH scores were consistently higher for older adults than for younger adults.

The best-fitting parameter values for Model 3 are

$$\begin{cases} aMH_{younger} = 10.29 - .18 * 2year\_subgroup \\ \qquad + .27 * years\_of\_education \\ aMH_{older} = 11.86 - .18 * 2year\_subgroup \\ \qquad + .27 * years\_of\_education \end{cases} \quad (4)$$

The model describes three main trends: (1) an age-related advantage in aMH scores of about 1.6/20 points (means of 14.98/20 and 13.17/20, for older and younger adults, respectively), $t(2031) = 7.14$, $p < .001$, after controlling for the effects of year of testing and education; (2) a linear relationship between aMH scores and year of testing, with a decrease of 0.18/20 every 2 years, which does not differ between age groups; and (3) a significant effect of education, with an increase of 0.27/20 points for each additional year of education, in both age groups.

Figure 2 plots the linear regression lines described in Equation 4 for aMH scores as a function of 2-year subgroups (after removing the effect of years of education). In summary, our data show an additive effect of age group and year of testing on vocabulary scores, after controlling for education. The advantage of older over younger adults of 1.6/20 aMH points remained stable across 16 years, with a linear decrease in vocabulary scores for both groups. Note that the analysis did not involve adjustments to counteract the Flynn effect (Agbayani & Hiscock, 2013; Dickinson & Hiscock, 2010) because the effect typically does not involve crystallized intelligence factors such as vocabulary (Flynn, 1994).

General Discussion

This study investigated the influences of aging and year of testing on vocabulary knowledge as a measure of cognitive ability. Specifically, these variables were tested using scores on the aMH scale collected in a single laboratory, across 16 years, with over 2,000 younger and older adults. Analyses of the data led to several

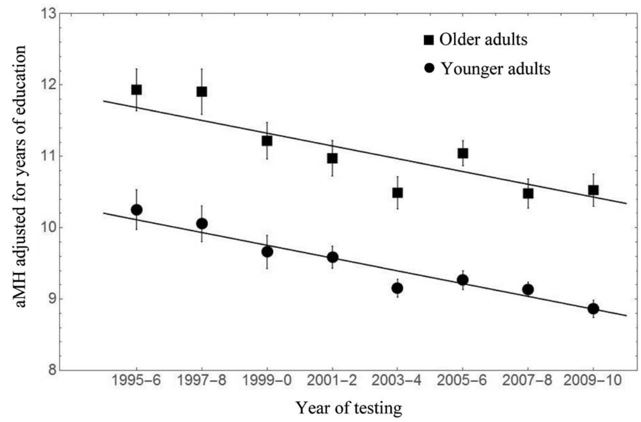

Figure 2. The abbreviated Mill Hill (aMH) average scores per 2-year cohort for the two age groups (younger/older adults, after adjusting for education level). The continuous line presents the linear regression for each age group.

conclusions: First, there is an advantage in vocabulary scores for older adults over younger adults of about 1.5 out of 20 tested words. Second, vocabulary scores decreased steadily across these 16 years, with about 0.2 fewer words correctly identified for every 2 years that passed. Third, the two age groups had the same rate of decline as the year of testing advanced, indicating a stable age-related advantage across 16 years. Fourth, the number of years of education had a significant inflating effect on vocabulary scores.

Age-Related Increase in Vocabulary

An overall analysis of our data showed a significant advantage in aMH scores favoring older adults, after controlling for years of education (and year of testing). This age-related enhancement in performance is consistent with other findings (e.g., Gold et al., 1995; Schaie, 1996), suggesting that the lexicon improves from young adulthood to older age and counteracting the negative stereotype that all cognitive abilities decline in aging (Bell & Stanfield, 1973). Older adults are better than younger adults with respect to knowledge gained from past experience and accumulated with age (MacKay & Burke, 1990), such as vocabulary. In contrast, younger adults outperform older adults when tasks emphasize speed of processing or the inhibition of irrelevant information (Ben-David, Eidels, & Donkin, 2014; Ben-David et al., 2012; Schneider, Pichora-Fuller, & Daneman, 2010).

A decline in vocabulary as year of testing advanced. Alongside the age-related increase in vocabulary, we found a steady decline in scores as the year of testing advanced, for both younger and older adults. This decline may involve environmental changes such as a gradual reduction in reading habits (Glenn, 1994) and in motivation and values (Alwin, 1991). Alternatively, the decline in scores with year of testing may merely reflect a change over time in the validity of the aMH itself. However, given the results of our study, this hypothesis does not seem likely. In Experiment 1, we found a strong and significant correlation (of .61) between the aMH and the highly validated WAIS–III vocabulary subscale. A high degree of correlation was also found in a 1997 study between the aMH and a previous version of the WAIS test by others ($r = .60$, Sliwinski & Buschke, 1997; WAIS–R).

As outlined earlier, the inconsistent evidence for changes in vocabulary as a function of year of testing may be due to a mediating effect of years of education (Uttl & Van Alstine, 2003). In line with this, our regression model found an effect of year of testing after removing the effect of years of education. We also note that the design of our study carefully controlled for other sources of error variance (scale, protocol, and population) that may have an impact on meta-analyses of studies.

Additive effects of aging and year of testing. In the 16-year span of data collection, there have been many changes that could have influenced older and younger adults' vocabulary in different manners (Jensen, 1998). The most important finding in our study is the additive impact of age group and the year of testing on vocabulary scores. The same slope relating aMH scores to the year of testing was found for older and younger adults. That is, the advantage for older over younger adults in vocabulary was stable across the 16 years. This additive effect of year of testing and age group has practical implications. When aggregating information from younger–older comparisons of behavior across a 20-year span, do these comparisons reflect the same age-related cognitive effects, or different effects reflecting comparisons of different populations? Our study provides some support for the ability to accumulate results across years, as age-related differences on one such cognitive test (vocabulary scale) were found to be impervious to the year of testing.

From a broader viewpoint, this result shows that older adults are just as susceptible to changes in the environment as younger adults. Although the effect describes a decline in vocabulary as years advance, this result may demonstrate older adults' sensitivity to the changes in the language spoken around them and their ability to adapt to these changes. This view is in line with Wister's (1989) suggestion that older adults can accommodate to psychological and environmental changes that do not involve increased physical challenges. In other words, our data reflect an adaptive quality of older adults.

Limitations

One of the goals of our study was to test a homogeneous population of older and younger adults, across 16 years. These groups well represent the pool of participants in university studies (undergraduates and cognitively high-functioning older adults). This choice also presents a limitation of our study, as our conclusions might not be generalized to the population at large. We further acknowledge that our study includes a validation of the aMH against the WAIS vocabulary subscale only for younger adults. However, as Model 3 of Experiment 2 shows that different factors (year of testing and education) have the same effect on aMH scores for older and younger adults, the generalizability of Experiment 1's data is supported. Future studies may wish to examine this link directly. Finally, we do not examine the environmental factors that lead to the decline in vocabulary with year of testing, and our study design cannot completely isolate the effects of education from those of aging. Our study calls for further investigations of the effects of education and year of testing on vocabulary in older and younger adults, considering other factors such as culture (see Icht & Ben-David, 2014).

Summary

In a cross-sectional investigation of vocabulary scores (aMH) of over 2,000 older and younger adults collected across 16 years, we found an advantage in vocabulary for older adults and a steady decline in scores with year of testing. Whereas the former is a common finding in the literature, the decline in scores as a function of the passage of time has been debated in the literature. The most important finding in our study is a clear additive relation between age group and year of testing, implying that age-related effects on the lexicon are independent of the effects of demographic changes over time. Our data also suggest that aggregating knowledge collected in cross-sectional studies over time will reflect age-related factors. Finally, it is notable that older adults appear to be affected by lexical changes in their environment just as much as younger adults, reflecting an adaptive quality in older age.

References

Agbayani, K. A., & Hiscock, M. (2013). Age-related change in Wechsler IQ norms after adjustment for the Flynn effect: Estimates from three computational models. *Journal of Clinical and Experimental Neuropsychology, 35,* 642–654. http://dx.doi.org/10.1080/13803395.2013.806650

Alwin, D. F. (1991). Family of origin and cohort differences in verbal ability. *American Sociological Review, 56,* 625–638. http://dx.doi.org/10.2307/2096084

Ardila, A. (2007). Normal aging increases cognitive heterogeneity: Analysis of dispersion in WAIS–III scores across age. *Archives of Clinical Neuropsychology, 22,* 1003–1011. http://dx.doi.org/10.1016/j.acn.2007.08.004

Bell, B. D., & Stanfield, G. G. (1973). Chronological age in relation to attitudinal judgments: An experimental analysis. *Journal of Gerontology, 28,* 491–496. http://dx.doi.org/10.1093/geronj/28.4.491

Ben-David, B. M., Chambers, C. G., Daneman, M., Pichora-Fuller, M. K., Reingold, E. M., & Schneider, B. A. (2011). Effects of aging and noise on real-time spoken word recognition: Evidence from eye movements. *Journal of Speech, Language, and Hearing Research, 54,* 243–262. http://dx.doi.org/10.1044/1092-4388(2010/09-0233)

Ben-David, B. M., Eidels, A., & Donkin, C. (2014). Effects of aging and distractors on detection of redundant visual targets and capacity: Do older adults integrate visual targets differently than younger adults? *PLoS ONE, 9,* e113551. http://dx.doi.org/10.1371/journal.pone.0113551

Ben-David, B. M., & Schneider, B. A. (2010). A sensory origin for color–word Stroop effects in aging: Simulating age-related changes in color-vision mimics age-related changes in Stroop. *Aging, Neuropsychology and Cognition, 17,* 730–746. http://dx.doi.org/10.1080/13825585.2010.510553

Ben-David, B. M., Tse, V. Y., & Schneider, B. A. (2012). Does it take older adults longer than younger adults to perceptually segregate a speech target from a background masker? *Hearing Research, 290,* 55–63. http://dx.doi.org/10.1016/j.heares.2012.04.022

Botwinick, J. (1967). *Cognitive processes in maturity and old age*. New York: Springer. http://dx.doi.org/10.1007/978-3-662-39890-6

Bowles, R. P., Grimm, K. J., & McArdle, J. J. (2005). A structural factor analysis of vocabulary knowledge and relations to age. *Journals of Gerontology: Series B*. Psychological Sciences and Social Sciences, *60,* 234–241. http://dx.doi.org/10.1093/geronb/60.5.P234

Brainerd, C. J., & Reyna, V. F. (1992). Explaining "memory free" reasoning. *Psychological Science, 3,* 332–339. http://dx.doi.org/10.1111/j.1467-9280.1992.tb00042.x

Burke, D. M., MacKay, D. G., & James, L. E. (2000). Theoretical approaches to language and aging. In T. Perfect & E. Maylor (Eds.), *Models of cognitive aging* (pp. 204–237). New York: Oxford University Press.

Cavanaugh, J. C., & Whitbourne, S. K. (1999). *Research methods*. New York: Oxford University Press.

Craik, F. I., & Salthouse, T. A. (2011). *The handbook of aging and cognition*. Hove, UK: Psychology Press.

Dickinson, M. D., & Hiscock, M. (2010). Age-related IQ decline is reduced markedly after adjustment for the Flynn effect. *Journal of Clinical and Experimental Neuropsychology, 32,* 865–870. http://dx.doi.org/10.1080/13803391003596413

Flynn, J. R. (1994). IQ gains over time. In R. J. Sternberg (Ed.), *Encyclopedia of human intelligence* (pp. 617–623). New York: Macmillan.

Gerstorf, D., Ram, N., Hoppmann, C., Willis, S. L., & Schaie, K. W. (2011). Cohort differences in cognitive aging and terminal decline in the Seattle Longitudinal Study. *Developmental Psychology, 47,* 1026–1041. http://dx.doi.org/10.1037/a0023426

Glenn, N. D. (1994). Television watching, newspaper reading, and cohort differences in verbal ability. *Sociology of Education, 67,* 216–230. http://dx.doi.org/10.2307/2112792

Gold, D. P., Andres, D., Etezadi, J., Arbuckle, T., Schwartzman, A., & Chaikelson, J. (1995). Structural equation model of intellectual change and continuity and predictors of intelligence in older men. *Psychology and Aging, 10,* 294–303. http://dx.doi.org/10.1037/0882-7974.10.2.294

Icht, M., & Ben-David, B. M. (2014). Oral-diadochokinesis rates across languages: English and Hebrew norms. *Journal of Communication Disorders, 48,* 27–37. http://dx.doi.org/10.1016/j.jcomdis.2014.02.002

Jensen, A. R. (1998). *The g factor: The science of mental ability* (pp. 270–305). Westport, CT: Praeger.

Kaufman, A. S., Reynolds, C. R., & McLean, J. E. (1989). Age and WAIS–R intelligence in a national sample of adults in the 20- to 74-year age range: A cross-sectional analysis with educational level controlled. *Intelligence, 13,* 235–253. http://dx.doi.org/10.1016/0160-2896(89)90020-2

Kemper, S., Kynette, D., Rash, S., O'Brien, K., & Sprott, R. (1989). Life-span changes to adults' language: Effects of memory and genre. *Applied Psycholinguistics, 10,* 49–66. http://dx.doi.org/10.1017/S0142716400008419

MacKay, D. G., & Burke, D. M. (1990). Cognition and aging: A theory of new learning and the use of old connections. In F. G. A. Stone & R. West (Eds.), *Advances in psychology: Vol. 71. Aging and cognition: Knowledge, organization, and utilization* (pp. 213–263). Atlanta, GA: Elsevier. http://dx.doi.org/10.1016/S0166-4115(08)60159-4

McGinnis, D., & Zelinski, E. M. (2003). Understanding unfamiliar words in young, young-old, and old-old adults: Inferential processing and the abstraction-deficit hypothesis. *Psychology and Aging, 18,* 497–509. http://dx.doi.org/10.1037/0882-7974.18.3.497

Raven, J. C. (1965). *Guide to using the Mill Hill vocabulary test with progressive matrices*. London, UK: HK Lewis.

Schaie, K. W. (1996). *Intellectual development in adulthood: The Seattle longitudinal study*. New York: Cambridge University Press.

Schneider, B. A., Pichora-Fuller, K., & Daneman, M. (2010). Effects of senescent changes in audition and cognition on spoken language comprehension. In S. Gordon-Salant, R. D. Frisina, A. N. Popper, & R. R. Fay (Eds.), *The aging auditory system* (pp. 167–210). New York: Springer. http://dx.doi.org/10.1007/978-1-4419-0993-0_7

Singer, T., Verhaeghen, P., Ghisletta, P., Lindenberger, U., & Baltes, P. B. (2003). The fate of cognition in very old age: Six-year longitudinal findings in the Berlin Aging Study (BASE). *Psychology and Aging, 18,* 318–331. http://dx.doi.org/10.1037/0882-7974.18.2.318

Sliwinski, M., & Buschke, H. (1997). Processing speed and memory in aging and dementia. *Journals of Gerontology: Series B*. Psychological Sciences and Social Sciences, *52,* 308–318. http://dx.doi.org/10.1093/geronb/52B.6.P308

Uttl, B., & Van Alstine, C. L. (2003). Rising verbal intelligence scores: Implications for research and clinical practice. *Psychology and Aging, 18,* 616–621. http://dx.doi.org/10.1037/0882-7974.18.3.616

Verhaeghen, P. (2003). Aging and vocabulary scores: A meta-analysis. *Psychology and Aging, 18,* 332–339.

Wechsler, D. (1981). *Manual of the Wechsler Adult Intelligence Scale—Revised*. New York: Psychological Corporation.

Wechsler, D. (1997). *Wechsler Adult Intelligence Scale (WAIS–IIIuk): Wechsler Memory Scale (WMS–IIIuk)*. San Antonio, TX: Psychological Corporation.

Wilson, J. A., & Gove, W. R. (1999). The age-period-cohort conundrum and verbal ability: Empirical relationships and their interpretation: Reply to Glenn and to Alwin and McCammon. *American Sociological Review, 64,* 287–302. http://dx.doi.org/10.2307/2657533

Wister, A. V. (1989). Environmental adaptation by persons in their later life. *Research on Aging, 11,* 267–291. http://dx.doi.org/10.1177/0164027589113001

Zelinski, E. M., & Kennison, R. F. (2007). Not your parents' test scores: Cohort reduces psychometric aging effects. *Psychology and Aging, 22,* 546–557. http://dx.doi.org/10.1037/0882-7974.22.3.546

(*Appendix follows*)

Appendix

From a 32- to a 6-Parameter Model

To examine the relationship between aMH and years of education in a way that allowed us to test for interactions between the 2-year subgroups ($1 \leq i \leq 8$) and age groups (younger vs. older), we first fit separate linear functions to each combination of 2 age-groups × 8 year-of-testing subgroups according to the model

$$\begin{cases} aMH_{younger,j} = c_{y,i} + b_{y,i} * years\_of\_education \\ aMH_{older,j} = c_{o,i} + b_{o,i} * years\_of\_education \end{cases} \quad (A1)$$

An examination of the intercept values of this 32-parameter model (which accounted for 24% of the variance in aMH scores) suggested that the intercept values in each group decreased as a function of year of testing in each group. Hence, we fit a reduced model that allowed for the intercept values to change as a linear function of year of testing but at different rates for younger and older participants in each of the eight 2-year subgroups, that is,

$$\begin{cases} aMH_{younger,j} = c_y + a_y * i + b_{y,i} * years\_of\_education \\ aMH_{older,j} = c_o + a_o * i + b_{o,i} * years\_of\_education \end{cases} \quad (A2)$$

In this model the intercept for younger participants in 2-year subgroup i is given by $c_y + a_y{*}i$, whereas the intercept for older participants in 2-year subgroup i is given by $c_o + a_o{*}i$. Also note that this model allows separate slopes to be fitted to each combination of age and year of testing. We cannot reject the null hypothesis that this 20-parameter model provides as good a fit to the data, as does the 32-parameter model, $F(12, 2004) = 1.34$, $p = .186$.

Next, we tested a further reduction of the number of parameters in the model in which we restricted the slope values for younger and older adults to be independent of year of testing, but allowed the slope values to differ between age groups, that is, that $b_{y,i} = b_y$ and $b_{o,i} = b_o$. A test of the null hypothesis that this 6-parameter model provides as good a fit as the 20-parameter model specified in Equation A2 could not be rejected, $F(14, 2016) = 1.68$, $p > .05$. In addition, this 6-parameter model accounts for almost as much of the variance in Mill Hill scores (23%) as does the 32-parameter model (24%).

Because this 6-parameter model (in which there is no interaction between age group and year of testing) provides almost as good a fit as the 32-parameter model (which allows for an Age Group × Year of Testing interaction), we conclude that there is very little evidence for an Age Group × Year of Testing interaction in the present data.

Received February 16, 2015
Revision received June 16, 2015
Accepted July 21, 2015 ■

UNITED STATES POSTAL SERVICE® **Statement of Ownership, Management, and Circulation (All Periodicals Publications Except Requester Publications)**

1. Publication Title	2. Publication Number	3. Filing Date
Psychology and Aging	0 0 0 - 6 8 7	October 2015
4. Issue Frequency	5. Number of Issues Published Annually	6. Annual Subscription Price
Quarterly	4	Mbr $99 Indiv $229 Inst $781

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4®)
750 First Street, NE, Washington, DC 20002-4242
Contact Person: Barbara Spruill
Telephone (Include area code): 202 336-5578

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer)
750 First Street, NE, Washington, DC 20002-4242

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)
Publisher (Name and complete mailing address)
American Psychological Association
750 First Street, NE
Washington, DC 20002-4242
Editor (Name and complete mailing address)
Ulrich Mayr, PhD
Department of Psychology, University of Oregon
Eugene, 97403
Managing Editor (Name and complete mailing address)
Susan J.A. Harris
750 First Street, NE
Washington, DC 20002-4242

10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)

Full Name	Complete Mailing Address
American Psychological Association	750 First Street, NE
	Washington, DC 20002-4242

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box → ☒ None

Full Name	Complete Mailing Address
NONE	

12. Tax Status (For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one)
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:
☒ Has Not Changed During Preceding 12 Months
☐ Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement)

PS Form 3526, July 2014 (Page 1 of 4 (see instructions page 4)) PSN: 7530-01-000-9931 PRIVACY NOTICE: See our privacy policy on www.usps.com

13. Publication Title: Psychology and Aging
14. Issue Date for Circulation Data Below: September 2015

15. Extent and Nature of Circulation		Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies (Net press run)		950	900
b. Paid Circulation (By Mail and Outside the Mail)	(1) Mailed Outside-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	367	349
	(2) Mailed In-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)		
	(3) Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS®	303	301
	(4) Paid Distribution by Other Classes of Mail Through the USPS (e.g., First-Class Mail®)		
c. Total Paid Distribution (Sum of 15b (1), (2), (3), and (4))		670	650
d. Free or Nominal Rate Distribution (By Mail and Outside the Mail)	(1) Free or Nominal Rate Outside-County Copies included on PS Form 3541		
	(2) Free or Nominal Rate In-County Copies Included on PS Form 3541		
	(3) Free or Nominal Rate Copies Mailed at Other Classes Through the USPS (e.g., First-Class Mail)		
	(4) Free or Nominal Rate Distribution Outside the Mail (Carriers or other means)	16	17
e. Total Free or Nominal Rate Distribution (Sum of 15d (1), (2), (3) and (4))		16	17
f. Total Distribution (Sum of 15c and 15e)		686	667
g. Copies not Distributed (See Instructions to Publishers #4 (page #3))		264	233
h. Total (Sum of 15f and g)		950	900
i. Percent Paid (15c divided by 15f times 100)		98%	97%

* If you are claiming electronic copies, go to line 16 on page 3. If you are not claiming electronic copies, skip to line 17 on page 3.

PS Form 3526, July 2014 (Page 2 of 4)

UNITED STATES POSTAL SERVICE® **Statement of Ownership, Management, and Circulation (All Periodicals Publications Except Requester Publications)**

16. Electronic Copy Circulation — Psychology and Aging	Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Paid Electronic Copies		
b. Total Paid Print Copies (Line 15c) + Paid Electronic Copies (Line 16a)	670	650
c. Total Print Distribution (Line 15f) + Paid Electronic Copies (Line 16a)	686	667
d. Percent Paid (Both Print & Electronic Copies) (16b divided by 16c × 100)	98%	97%

☐ I certify that 50% of all my distributed copies (electronic and print) are paid above a nominal price.

17. Publication of Statement of Ownership
☒ If the publication is a general publication, publication of this statement is required. Will be printed in the December 2015 issue of this publication. ☐ Publication not required

18. Signature and Title of Editor, Publisher, Business Manager, or Owner: Barbara Spruill, Director, Service Center Operations — Date: 9/24/2015

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

PS Form 3526, July 2014 (Page 3 of 4) PRIVACY NOTICE: See our privacy policy on www.usps.com