Age, Period, and Cohort Trends in Americans' Vocabulary Knowledge*

Liying Luo
Department of Sociology
Minnesota Population Center
University of Minnesota

John Robert Warren
Department of Sociology
Minnesota Population Center
University of Minnesota

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ABSTRACT

For a quarter of a century researchers have been debating the extent to which Americans' vocabulary knowledge varies as a function of how old they are (age), the year in which they were observed (period), and the year in which they were born (cohort). This debate has important implications for educational policy and practice, and speaks to America's competitiveness in the global economy. Unfortunately, prior assessments of age, period, and cohort trends in vocabulary knowledge have either assumed *a priori* that one of the three (usually period) does not matter or else have relied on problematic statistical methods. We revisit this debate using a new methodological approach. We find that vocabulary knowledge increases through about age 70 (age); it declined in the 1980s but increased later (period); and, on average, vocabulary scores rose across the 1890 through early baby boom cohorts and then were lower across most more recent cohorts. We explore explanations for these trends, and draw preliminary conclusions about the roles of temporal trends in the quality of school and the frequency with which certain words appear in print.

Age, Period, and Cohort Trends in Americans' Vocabulary Knowledge

Have Americans' vocabulary knowledge declined over time? For a quarter of a century researchers have been debating the extent to which Americans' vocabulary knowledge—as measured using a 10-item test (WORDSUM) routinely administered as part of the General Social Survey (GSS)—varies as a function of how old they are (age), the year in which they are observed (period), and the year in which they were born (cohort). This line of scholarship emerged in the context of widespread alarm about apparently large declines over time in Americans' performance on a variety of tests of academic ability in reading, mathematics, and science (Adams 2010; Franciosi 2004; Kaestle and Damon-Moore 1993). These apparent declines have important implications for America's competitiveness in the increasingly global economy and have sparked renewed efforts to reform America's seemingly failing schools. In this broader context, academic debates about temporal trends in WORDSUM scores in the GSS have immediate economic and public policy implications.

To draw valid economic or public policy lessons from the WORDSUM debates, however, we first require a good understanding of the forces that drive temporal trends in how well Americans perform on that test of vocabulary knowledge. Can these trends be attributed to changes over time in the quality of schools or the selectivity of post-secondary institutions? Do Americans now read too little, perhaps because they spend too much time in front of television, computer, or smartphone screens? Have classroom textbooks changed over time with respect to their use of higher-order vocabulary words? Have some of the words on the GSS's WORDSUM test—which have not changed since first fielded in 1974—simply become obsolete? Can these temporal trends be attributed to changing patterns of immigration or to other demographic trends? How America chooses to respond to trends in its citizens' vocabulary knowledge depends in part on what is driving those trends.

However, in order to reach sound conclusions about the degree to which these or other forces drive temporal trends in Americans' vocabulary knowledge we must begin with an accurate *description* of those temporal trends. To what extent do WORDSUM scores (in particular) and vocabulary knowledge (more generally) vary as a function of age, period, and cohort? This question immediately invokes the age-period-cohort identification problem that has vexed demographers and statisticians for decades (Mason and Winsborough 1973; O'Brien 2011). Since cohort is completely determined by age and period such that cohort = period – age, it is difficult—and many would say impossible—to identify the independent effects of all three on vocabulary knowledge. How, then, can we describe the ways in which WORDSUM scores have changed across birth cohorts in an analysis that accounts for age *and* period? Or, how can we describe age-related trends in WORDSUM among people who differ with respect to the year in which they were observed (period) *and* the year they were born (cohort)?

In this article we argue that prior efforts to describe—and thus to explain—temporal trends in WORDSUM scores on the GSS have been inadequate. Specifically, they have responded to the age-period-cohort identification problem by either assuming that one of the three (usually period) is irrelevant or by employing sophisticated statistical methods that require strong and untestable assumptions. They have also sometimes implicitly conceived of "cohort" in a way that differs from classical sociological and demographic conceptualizations. We offer a new method for modeling age, period, and cohort trends in WORDSUM scores, a method that is more closely tied to theoretical ideas about what cohorts represent. After providing an improved description of temporal trends in vocabulary knowledge, we model (or, *will model* by the time of

PAA) the ways in which changes in (a) educational attainment; (b) population-level demographic characteristics; (c) newspaper readership; and (d) the frequency with which WORDSUM words are used in the English language have affected those trends.

BACKGROUND

In this section we briefly review the literature on temporal trends in WORDSUM scores in the GSS. After describing the major empirical claims in this literature, we critique it on both methodological and theoretical grounds.

Summary of the Empirical Evidence

The WORDSUM vocabulary test on the GSS consists of 10 multiple-choice questions that have been asked in most survey years since 1974. For each question, respondents are presented with a "target word" (e.g., encomium) and then asked which of five words or short phrases come closest in meaning to the target word (e.g., repetition, friend, panegyric, abrasion, or expulsion). Neither the target words nor the five options have changed over time. The words on the actual GSS instrument are not made public, but they were originally selected from items on the Thorndike–Gallup test of verbal intelligence (Thorndike 1942; Thorndike and Gallup 1944). Each item is scored as correct or incorrect, such that the total WORDSUM score ranges from 0 to 10. Following Bowles, Grimm and McArdle (2005) and others, we code non-response to individual questions to be equivalent to incorrect answers.

Alwin (1991) initiated the debate about trends in WORDSUM scores in his analysis of 1974 through 1990 GSS data. Motivated by a desire to test Zajonc's (1976; 1986) hypothesis that post-World War II changes in "family configurations" had led to declining test scores in the United States, Alwin (1991) identified education-adjusted declines across cohorts in

WORDSUM scores that began much earlier in the 20th century. He found little support for Zajonc's hypothesis that changes in family structure, family size, or birth spacing led to these declines. Alwin (1991) also found little evidence of age-related trends in WORDSUM scores, and—in order to circumvent the age-period-cohort identification problem—he assumed that period effects were ignorable.

In follow-up analyses of the same years of GSS WORDSUM scores, Glenn (1994) argued that inter-cohort declines in education-adjusted scores could not be attributed to changes in the frequency of word use or to changes in the age composition of the population. He speculated instead that these trends likely had more to do with changes in Americans' reading activities across cohorts. Like Alwin (1991), Glenn (1994) identified cohort trends in WORDSUM scores by assuming that there were no period effects on those scores.

In a 1999 exchange in the *American Sociological Review*, Wilson and Gove (1999a; 1999b) analyzed 1974 through 1996 GSS data to argue that what Alwin (1991) and Glenn (1994) identified as *cohort* trends in WORDSUM scores were actually artifacts of *age*-related patterns of change in those scores. Drawing on research in cognitive development and cognitive psychology, they argued that vocabulary knowledge increases through late mid-life and then declines thereafter as cognitive aging sets in. In the 1999 debate, Wilson and Gove (1999a; 1999b) disagreed with Alwin and McCammon (1999) and Glenn (1999) about whether WORDSUM scores in the GSS vary primarily as a function of age and period or as a function of cohort. Whereas Wilson and Gove (1999a; 1999b) saw primarily *age*-related trends that could mainly be explained by processes of cognitive development, Alwin and McCammon (1999) and Glenn (1999) analyzed the same data and saw primarily *cohort*-related trends that might best be attributed to changes in things like educational processes and Americans' reading habits.

Because of the analytic methods employed by Alwin (1991), Glenn (1994), the contributors to the 1999 exchange, and others who subsequently analyzed WORDSUM scores (e.g., Alwin and McCammon 2001; Bowles, Grimm and McArdle 2005), it was impossible for those researchers to simultaneously consider age, period, and cohort trends in vocabulary knowledge as measured by WORDSUM. Instead, researchers typically made assumptions—or empirical arguments based on assumptions—about one of the three. As described above, debates about the validity of those assumptions drove disagreement about the nature of temporal trends in WORDSUM scores; these disagreements, in turn, led to disagreements about the factors that drove those trends. As noted by Yang and Land (2006: 79), "until age, period, and cohort effects are simultaneously estimated, the question of whether the trends are due to age, period, or cohort components remains incompletely resolved."

For this reason, more recent analyses of WORDSUM scores by Yang, Land, and colleagues (Frenk, Yang and Land 2013; Yang and Land 2006; Yang and Land 2008) have been viewed as major steps forward. Using new analytic techniques that purport to simultaneously identify age, period, and cohort components of trends in vocabulary knowledge, Yang and Land (2006; 2008) concluded that WORDSUM scores vary in a curvilinear way with age, have declined across cohorts, and are not significantly different across periods. However, for reasons described below, it is not clear that Yang and Land's analytic method produces descriptions of temporal trends in WORDSUM scores that are any more credible than those that preceded them.

Methodological Critique of Prior Analyses of WORDSUM

Models that estimate the independent effects of age, period, and cohort on some outcome suffer from an identification problem: Infinitely many estimates fit the data *identically well* and without external information—some basis for adjudicating which of the many equally wellfitting estimates are best—none of them can be deemed the preferred solution (Mason et al. 1973; Fienberg and Mason 1985). Various methods have been proposed to address this problem; generally, we characterize them as "two-factor approaches" (e.g., those used by Alwin, Glenn, and the contributors to the 1999 exchange) and "three-factor models" (e.g., Yang and Land 2006). We describe the limitations of each type of method below.

The "two-factor approach" solves the identification problem by assuming that the effect of one of the three temporal dimensions is zero. For example, Alwin (1991) and Glenn (1994) assumed that vocabulary knowledge does not vary across periods. However, this assumption cannot be formally tested, may be incorrect, and thus leads to an incomplete understanding of temporal changes in vocabulary knowledge; part of the substantive conclusions are assumed *a priori* instead of being formally confirmed in the data. As described above, a consequence of this approach is that researchers disagree as much about their untestable *a priori* assumptions as they do about how to interpret the data.

Two newly developed "three factor" statistical techniques—the Intrinsic Estimator (IE) Model and the Cross-Classified Fixed/Random Effects Model (CCFEM/CCREM)—have recently been introduced as methods for estimating the independent effects of age, period, and cohort (Frenk, Yang and Land 2013; Yang and Land 2006; Yang and Land 2008; Yang et al. 2008). Although their creators have claimed that IE and CCFEM/CCREM require few assumptions or constraints in order to generate valid estimates of the independent effects of age, period, and cohort, critics have more recently established that this is not the case. For example, O'Brien (2011) and Luo (Forthcoming) showed that IE imposes a constraint that is extremely difficult to verify and usually unlikely to be justifiable. Likewise, Luo and Hodges (2013a) identified the multiple constraints implicit in CCFEM/CCREM and cautioned researchers about potentially large biases in CCFEM/CCREM estimates. Consequently, we have reasons to be deeply skeptical of prior research that has used these methods to draw conclusions about age, period, and cohort trends in vocabulary knowledge (see, e.g., Frenk, Yang and Land 2013; Yang and Land 2006; Yang and Land 2008).

Theoretical Critique of Prior Analyses of WORDSUM

Debates about the nature of temporal trends in vocabulary knowledge—much like most debates about the independent effects of age, period, and cohort on many outcomes—have largely been methodological in emphasis. Putting aside the various technical and statistical critiques outlined above, we argue that a core problem with research on temporal trends in vocabulary knowledge has been a lack of careful theoretical work defining exactly what age, period, and cohort effects actually represent in this context. Most importantly, all of the research described above implicitly or explicitly assumes that it makes sense to think that there are separate and independent main effects—the independent overall effects of one predictor averaging across all levels of other predictors—of age, period, and cohort on vocabulary knowledge. However, this assumption is not consistent with central conceptualizations of what *cohorts* actually represent.

In his seminal work, Ryder (1965: 844) posited that cohort effects occur when "transformations of the social world modify people of different ages in different ways." He elaborated three basic notions on which cohort analyses rest:

> "persons of age a in time t are those who were age a-1 in time t-1; transformations of the social world modify people of different ages in different ways; the effects of these

transformations are persistent. In this way a cohort meaning is implanted in the age-time specification." (Ryder 1965: 861)

According to this conceptualization, a cohort effect is defined as the *interaction* between age and period effects. A social or historical transformation that has equivalent consequences for people of all ages can thus produce no cohort effect; likewise, an age-related process that works the same way across time periods also cannot have a cohort effect. Conceptually, this is different from thinking about cohort as having independent effects net of period and age effects. Whereas prior work in this area (at least implicitly) seeks to isolate the independent effect of cohort among people who are equivalent with respect to age and period, we think about cohort as the degree to which age and period effects are moderated by one another.

What does this alternate conceptualization of cohorts mean for describing and explaining temporal trends in vocabulary knowledge as measured by WORDSUM? Instead of assuming that period effects do not exist or that there are independent effects of cohort net of age and period effects, we should begin by explicitly describing the degree to which age effects vary across time period or, equivalently, the extent to which period effects vary across age groups. Then, if the effects of period are the same across age groups or, equivalently, if the effects of age are the same across periods, we must identify explanations for trends in vocabulary knowledge that do not rely on cohort processes; that is, we must identify explanations that are consistent with this empirical pattern. On the other hand, if there *are* such moderating effects, then we must seek explanations that are consistent with *this* empirical pattern. It seems very likely, for example, that temporal changes in reading habits have occurred differently across age groups; older people's reading habits are probably less amenable to change, and younger people have been quicker to adopt new technology. Thus changes in reading habits might explain temporal trends in WORDSUM—but only if the effects of period vary by age or vice versa.

As argued by Hobcraft et al. (1982), another theoretical limitation of classic age-period-cohort (APC) analyses is that they assume that cohort effects are constant across the life course. That is, they not only assume that there is an independent effect of cohort net of age and period, but they also assume that this effect of cohort does not change for individuals from birth to death. However, under the conceptualization of cohort described above, it is possible to relax this assumption. For example, being a teenager when smartphones were invented may matter for vocabulary knowledge in young adulthood, but it is not necessary to assume that those effects persist into later life for that birth cohort. This reconceptualization of cohort allows us to test various theoretical ideas, such as the "cumulative advantage" hypothesis (e.g., Dannefer 1987; DiPrete and Eirich 2006). In its general form, the "cumulative advantage" hypothesis concerns the degree to which advantages or disadvantages persist or change with age. If this hypothesis is correct, we should see particular patterns of interactions between age and period such that members of specific birth cohorts are persistently or increasingly distinctive with respect to vocabulary knowledge as they age.

Unfortunately, beyond the serious technical limitations described above, current APC models like IE and CCREM/CCFEM are not useful for understanding cohort effects because they conceive of cohorts in a way that departs from the concept as described by Ryder (1965) and because they assume that cohort effects are constant across the life course. Therefore, in our analysis of temporal trends in vocabulary knowledge as measured by WORDSUM, we employ a new APC model that explicitly considers cohort effects as age by period interactions.

Contributions

Because of the methodological and conceptual problems outlined above, previous research provides a potentially inaccurate description of temporal trends in Americans' vocabulary knowledge. Without valid descriptions of these trends, it is difficult to formulate satisfactory explanations of them. We contribute to the literature in three ways. First, we describe temporal trends in vocabulary knowledge using a new methodological approach that is more closely tied to theoretical ideas about cohort effects. This method requires none of the problematic statistical assumptions that characterize previous research, and is consistent with the notion that cohort is best conceived as an interaction between age effects and period effects. Second, we describe temporal trends in such a way that does not assume that any effects of cohort are persistent across the life course. This allows us, for example, to test hypotheses about processes of cumulative advantage. Third, after offering what we believe to be more technically and conceptually sound descriptions of temporal trends in vocabulary knowledge, we consider several specific explanations for those trends: changes in educational attainment, changes in the demographic composition in the American population, changes in reading habits, and trends over time in the frequency with which WORDSUM words are used in print.

RESEARCH DESIGN

The GSS is a large, full-probability survey of non-institutionalized adults (age 18 or more) in the United States (Smith et al. 2013). It has been administered annually (1972-1993, except in 1979 and 1981) or biennially (1994 onward) since 1972 by NORC at the University of Chicago. The GSS collects measures of a core set of social, economic, demographic, and attitudinal attributes of respondents; in most years it has also included topical supplements. Until

1993, the GSS included about 1,500 respondents each year; from 1994 through 2004 it included almost 3,000 respondents; and in most years since 2006 it has included about 2,000 respondents.

Since 1974, the 10 WORDSUM items, described in more detail above, have been included in most GSS surveys—20 different years in total. Age and year of interview are ascertained in every survey. We begin by selecting respondents who participated in the 1974 through 2012 GSS surveys in years in which WORDSUM is administered. We excluded respondents with missing data on WORDSUM, age, gender, race/ethnicity, or educational attainment. Our final analysis sample includes 26,800 people. For our analyses, we constructed 15 age groups (18-19, 20-24, 25-29, … 80-84, and 85-89), nine periods (1974, 1975-1979, 1980-1984, …, 2005-2009, and 2010-2012), and thus 23 birth cohorts (1885, 1890, …, 1990, 1993)[1]. Table 1 shows descriptive statistics for WORDSUM, for each of the temporal dimensions, and for covariates used in our analysis.

[Table 1 About Here]

Methods

[1] In a table of five-year age groups and five-year periods, birth cohorts are defined by diagonals and extend over a nine-year interval. For example, the observations in the years 1975 through 1979 for people in the 30 to 34 age group correspond to the birth cohort of 1941 to 1949. Conventionally, each cohort is identified by its mid or central birth year (see, e.g., Frenk, Yang and Land 2013; Mason and Winsborough 1973; O'Brien 2011; Yang and Land 2008). We follow this practice and so, for example, the 1945 cohort refers to the group of people born between 1941 and 1949. It is worth noting that birth cohorts overlap with adjacent cohorts when so defined. This overlap is usually ignored in statistical modeling (Kupper et al. 1985).

As described above, we analyze WORDSUM scores using a newly developed APC model that considers cohort to be a specific form of the interaction between age effects and period effects. The general form of this model can be written as

$$g(E(Y_{ij})) = \mu + \alpha_i + \beta_j + \alpha\beta_k, \qquad (1)$$

for age groups $i = 1,2,\ldots,a$, periods $j = 1,2,\ldots,p$, and cohorts $k = j - i + a = 1,2,\ldots,(a + p - 1)$, where $\sum_{i=1}^{a}\alpha_i = \sum_{j=1}^{p}\beta_j = \sum_{k=1}^{a+p-1}\gamma_k = 0$. $E(Y_{ij})$ denotes the expected value of the outcome of interest Y for the ith age group in the jth period of time; g is the "link function;" α_i denotes the mean difference from the global mean μ associated with the ith age category; β_j denotes the mean difference from μ associated with the jth period; γ_k denotes the mean difference from μ due to the membership in the kth cohort. The usual ANOVA constraint applies such that the sum of the coefficients for each effect is set to zero.

In Equation (1) cohort effects are considered a specific form of the age-by-period interaction. In statistics, interactions between two variables measure the differential effects of one variable depending on the level of the other variable (Scheffé 1959). In the context of age-period-cohort research, if temporal trends in the outcome of interest can be attributed to the variation between cohort groups, then statistically significant age-by-period interactions should be observed. When cohort membership does not affect the outcome—that is, when the effects of historical or social shifts (period) are no different across age categories—then statistically significant age-by-period interactions should not be observed.

Note that not all types age-by-period interactions correspond to the cohort effects defined by sociological and demographic theories. Rather, only the set of age-by-period interactions that lie along the diagonal cells of an age-by-period cross-classification are considered to represent effects due to cohort membership. We propose a three-step procedure to investigate variation between and within cohorts. First, we conduct a *global F* test of the age-by-period interactions in an ANOVA model that includes main age effects, main period effects, and their interactions. When the global *F* test does not reject the null hypothesis that the age effects on the outcome of interest, say, vocabulary knowledge, do not vary by time periods, then we conclude that there are no cohort effects on vocabularies. If the global *F* test suggests that at least some of the age-by-period interactions are significant, we proceed to the second step of *local F* tests: Separately for each cohort, we do an *F* test to examine *whether* cohorts matter for or are associated with the vocabulary knowledge. For cohorts whose membership "matters" for vocabulary knowledge based on the results of local *F* tests, the third step involves two sets of *t* tests about *how* cohort membership is associated with vocabularies. For variation between cohorts, we use a *t* test to investigate whether a cohort, averaged across the age groups they have travelled through, has significantly higher or lower WORDSUM scores. To examine the "cumulative advantage" hypothesis about variation within cohorts, we develop a *t* test of orthogonal polynomial contrasts that focuses on the linear trend in cohort effects represented by the age-by-period interactions. For more details about this modeling strategy, see Luo and Hodges (2013b).

RESULTS

Descriptions of Age, Period, and Cohort Trends in Vocabulary Knowledge

Table 2 reports—and Figure 1 illustrates—estimated age, period, and cohort trends in WORDSUM scores. This initial analysis simply describes temporal trends; later we endeavor to explain those trends. Models 1 and 2 describe bivariate relationships between WORDSUM and age and period, respectively. Model 3 considers the ways in which WORDSUM varies by age and period under the assumption of no cohort effects. Model 4 then describes variation in

WORDSUM as a function of age, period, and cohort simultaneously. Model fit statistics—including AIC, adjusted R-squared, and a global F test ($F = 2.670$, $df = 112$, $p < 0.001$)—suggest that the model that includes the age-by-period interactions (Model 4) fit better than the model without them (Model 3). We thus conclude that cohort trends are likely in WORDSUM scores where cohort effects are conceptualized and modeled as described above.

An inspection of the estimated age and periods effects shows that age trends in WORDSUM scores do not differ depending on periods, so a meaningful description of a general age trend and a general period trend is warranted[2]. As in prior research (Schaie 1983; Schaie 1996; Wilson and Gove 1999a; Yang and Land 2008), we find that vocabulary knowledge increases with age through midlife and then declines thereafter. The estimated period effects in the models in Table 2 suggest that vocabulary knowledge was especially low during the 1980s and was especially high in the late 1990s and early 2000s. In general, the magnitude of the period effects is smaller than those of the age effects.

[Table 2 About Here]

[Figure 1 About Here]

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[2] In the presence of significant interactions between explanatory variables, researchers should be cautious when interpreting main effects of the explanatory variables. There are two types of interactions: qualitative (the slopes in the effects of one variable have different signs depending on the level of the other variable) and quantitative interactions (the slopes in the effects of one variable have the same across the levels of other variable). It is difficult to interpret main effects in a meaningful way when qualitative interactions are present. However, one can still interpret main effects with quantitative interactions. See Aiken and West (1991) and Jaccard and Turrisi (2003) detailed discussions on this topic.

Table 3 reported estimated age-by-period effects that are rearranged so each column shows cohort effects represented by the age-by-period interactions that lie along the diagonal cells in the age-by-period cross-classifications. A significant *F* statistic about these multiple estimates of the age-by-period interactions pertaining to a cohort indicates, generally speaking, whether the membership of that cohort is associated with one's WORDSUM score. We find that vocabulary knowledge improved across the 1895 through 1950 birth cohorts and declined for more recent cohorts. In particular, the early baby boomers—that is, the 1945 and 1950 birth cohorts—scored significantly higher on WORDSUM than most other cohorts. In general, these findings suggest that the effects of age do vary across periods, at least in some cases; likewise, the effects of period are not always the same for people in all age groups. Consequently, explanations of these trends should focus on at least some historical factors that might have mattered differently across age groups.

In addition to a description of the average differences *across* cohorts in vocabulary knowledge, Table 3 also shows the diversity and variability across ages and periods *within* cohorts. According to the "cumulative advantage" hypothesis, cohorts with high WORDSUM scores should have persistently higher scores across the life course as they accumulate more reading skills and resources. The results in Table 3 show mixed findings about the "cumulative advantage" hypothesis. Specifically, we do not find evidence supporting the cumulative hypothesis for the 1945 birth cohort: While this cohort scored higher than "an average person," the slope for WORDSUM scores along the trajectory for that cohort is significantly and negative, suggesting that this cohort lost its relative advantage as they aged. For the 1950 birth cohort, the non-significant trajectory slope indicates that members of this cohort were able to maintain (but not to increase) their relative advantage in vocabulary knowledge. In contrast, because the late baby boomers of the 1960 cohort were left behind in WORDSUM scores, the significant negative slope means that members of that cohort did increasingly worse as they grew older.

[Table 3 About Here]

Factors Influencing Trends in Vocabulary Knowledge

After providing an improved description of temporal trends in vocabulary knowledge, we will model—by the time of PAA—the ways in which changes in (a) educational attainment; (b) population-level demographic characteristics; (c) newspaper readership; and (d) the frequency with which WORDSUM words are used in the English language have affected those trends.

In the case of educational attainment, demographic characteristics, and newspaper readership, our strategy will be to begin with Model 4 and then add—in separate analyses—measures from the GSS that represent these variables. In each case, we will ask how the age, period, and cohort patterns noted in Model 4 are changed by holding constant these factors. If we find, for example, that there are no longer age-by-period interactions after adjusting for newspaper readership, then we will conclude that the cohort patterns we noted above are due to changes over time in how often people (and perhaps especially young people) read newspapers.

In the case of the frequency of word use, our strategy is different. The hypothesis posed by previous scholars is that period and cohort declines in WORDSUM scores are a function of the words themselves, not of GSS respondents. Specifically, some words may be less commonly used today than in the past, victims of changes in culture and taste in word use. To consider this possibility, we will (a) identify which WORDSUM words have declined in use over time and then (b) re-estimate Models 1 through 4 separately for only those words that have *not* declined in the frequency with which they are used. Following others (Greenfield 2013; Roivainen

Forthcoming), we have begun by using Google's NGram Viewer to quantify the relative frequency with which words are used in books written in American English in each year from 1974 through 2010. Our preliminary results show two things: First, almost none of the words or short phrases used in WORDSUM have declined substantially in their frequency of use since the 1970s; indeed a fair number of the words have *increased* in frequency of use over time. Second, the basic findings we describe above hold when we restrict the analysis to words that have not changed in frequency of use over time. This casts doubt on the hypothesis that temporal trends in WORDSUM are being driven to any important extent by word obsolescence.

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Tables and Figures

Table 1. Descriptive Statistics for GSS WORDSUM Data, 1974-2012

Variable	Description	N	Mean	SD	Min	Max
WORDSUM	A composite GSS item that consists of 10 multiple-choice vocabulary questions	26800	6.004	2.139	0	10
AGE	Age at time of survey	26800	45.185	17.322	18	89
PERIOD	Survey year	26800	-	-	1974	2012
COHORT	Birth year	26800	-	-	1885	1994
EDUCATION	Years of schooling	26800	12.933	3.059	0	20
FEMALE	Sex: 1 = female; 0=male	26800	0.566	0.496	0	1
BLACK	Race: 1=black; 0=other	26800	0.143	0.351	0	1

Table 2. Estimated Age, Period, and Cohort Effects on WORDSUM in GSS, 1974-2012

		Model 1		**Model 2**		**Model 3**		**Model 4**	
Intercept		5.904	***	6.005	***	5.905	***	5.894	***
	18-19	-0.908	***			-0.903	***	-0.857	***
	20-24	-0.472	***			-0.464	***	-0.439	***
	25-29	-0.077				-0.070		-0.029	
	30-34	0.110	**			0.111	**	0.127	**
	35-39	0.287	***			0.286	***	0.272	***
	40-44	0.331	***			0.326	***	0.307	***
	45-49	0.370	***			0.362	***	0.348	***
Age	50-54	0.265	***			0.257	***	0.259	***
	55-59	0.346	***			0.345	***	0.354	***
	60-64	0.261	***			0.263	***	0.280	***
	65-69	0.264	***			0.273	***	0.258	***
	70-74	0.019				0.018		0.026	
	75-79	-0.242	***			-0.243	***	-0.316	***
	80-84	-0.051				-0.057		-0.035	
	85-89	-0.501	na			-0.505	na	-0.553	na
	1974			0.013		0.029		-0.030	
	1975-79			0.002		0.035		-0.057	
	1980-84			-0.128	***	-0.102	**	-0.148	**
	1985-89			-0.172	***	-0.160	***	-0.210	***
Period	1990-94			0.084	**	0.071	*	0.043	
	1995-99			0.072	*	0.059		0.076	
	2000-04			0.111	**	0.090	*	0.175	***
	2005-09			0.043		0.014		0.127	**
	2010-12			-0.024	na	-0.037	na	0.025	na
Cohort	See Table 3								
Adujsted R^2		0.018		0.002		0.019		0.026	
AIC		116347		116785		116321		116246	

***p < 0.001; ** p<0.01; * p<0.5.

Table 3. Inter- and Intra-Cohort Change in Vocabulary Knowledge

		Cohort						
		1885	1890	1895	1900	1905	1910	1915
Age	18-19							
	20-24							
	25-29							
	30-34							
	35-39							
	40-44							
	45-49							
	50-54							
	55-59							-0.142
	60-64						0.028	0.170
	65-69					-0.307	0.043	-0.057
	70-74				-0.280	-0.724 ***	0.026	0.175
	75-79			-0.520	0.066	-0.303	-0.034	0.556 ***
	80-84		-0.162	0.301	0.289	-0.177	-0.368	-0.409
	85-89	0.190	-0.950 **	-0.478 *	-0.109	-0.150	0.417	0.656
Testing Cohort Effects	F statistics	na	7.154 **	3.068 *	1.075	6.710 ***	1.205	2.693 *
	inter-cohort difference	0.019	-0.556 *	-0.233	-0.008	-0.332 ***	0.018	0.135
	intra-cohort slope	na	-0.557	0.030	na	0.273	na	0.349

Note 1: *** p < 0.001; ** p<0.01; * p<0.5.

Note 2: We do not test the slopes for cohorts for which the local *F* statistic is non-significant.

Table 3 (continued).

		Cohort						
		1925	1930	1935	1940	1945	1950	1955
Age	18-19							0.091
	20-24						0.050	0.192
	25-29					0.666 ***	0.224 *	-0.209 *
	30-34				0.226	0.281 *	0.460 ***	-0.012
	35-39			0.059	0.171	0.403 ***	0.308 **	0.086
	40-44		0.006	0.056	0.189	0.340 **	0.210 *	-0.023
	45-49	0.116	-0.111	-0.021	0.138	0.297 **	0.376 **	-0.399 ***
	50-54	0.084	-0.086	-0.196	-0.116	0.287 *	0.224	0.066
	55-59	-0.192	-0.214	-0.141	0.321	0.091	0.142	-0.055
	60-64	-0.382 **	-0.181	-0.249	0.057	0.343 *	0.179	
	65-69	0.260 *	-0.195	0.102	-0.066	0.248		
	70-74	-0.139	0.278	0.258	0.369			
	75-79	0.095	0.186	0.020				
	80-84	0.098	0.359					
	85-89							
Testing Cohort Effects	F statistics	1.773	1.928	1.354	1.845	7.111 ***	5.534 **	2.006 *
	inter-cohort difference	-0.037	0.005	-0.013	0.143	0.329 ***	0.241 ***	-0.029
	intra-cohort slope	na	na	na	na	-0.279 *	-0.017	-0.174

Table 3 (continued).

		Cohort															
		1960		1965		1970		1975		1980		1985		1990		1994	
	18-19	0.007		-0.053		0.030		-0.264		0.179		-0.386		0.600	*	-0.204	na
	20-24	-0.003		-0.027		-0.121		0.025		0.027		-0.059		-0.082			
	25-29	0.187		-0.058		-0.255	*	-0.099		-0.280	*	-0.177					
	30-34	-0.047		-0.176		-0.260	*	-0.283	*	-0.188							
	35-39	-0.094		-0.209		-0.391	**	-0.334									
	40-44	-0.245	*	-0.482	***	-0.050											
	45-49	-0.279	*	-0.117													
Age	50-54	-0.244															
	55-59																
	60-64																
	65-69																
	70-74																
	75-79																
	80-84																
	85-89																
	F statistics	2.050	*	2.553	*	2.820	*	2.037		1.131		0.822		4.469	*	na	
Testing Cohort Effects	inter-cohort difference	-0.090		-0.160	**	-0.175	**	-0.191		-0.066		-0.207		0.259		na	
	intra-cohort slope	-0.346	*	-0.237		-0.146		na		na		na		-0.482	*	na	

Figure 1a. Mean WORSUM Scores Based on Model 1.

	1974	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-12
18-19	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
20-24	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4
25-29	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
30-34	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
35-39	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
40-44	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
45-49	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
50-54	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
55-59	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3
60-64	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
65-69	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2
70-74	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
75-79	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7	5.7
80-84	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9	5.9
85-89	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4	5.4

Note: The number in each cell is mean WORDSUM SCORE for people in that cell. Black cells have the minimum mean score and white cells have the maximum.

Figure 1b. Mean WORSUM Scores Based on Model 2.

	1974	**1975-79**	**1980-84**	**1985-89**	**1990-94**	**1995-99**	**2000-04**	**2005-09**	**2010-12**
18-19	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
20-24	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
25-29	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
30-34	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
35-39	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
40-44	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
45-49	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
50-54	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
55-59	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
60-64	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
65-69	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
70-74	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
75-79	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
80-84	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0
85-89	6.0	6.0	5.9	5.8	6.1	6.1	6.1	6.0	6.0

Figure 1c. Mean WORSUM Scores Based on Model 3.

	1974	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-12
18-19	5.0	5.0	4.9	4.8	5.1	5.1	5.1	5.0	5.0
20-24	5.5	5.5	5.3	5.3	5.5	5.5	5.5	5.5	5.4
25-29	5.9	5.9	5.7	5.7	5.9	5.9	5.9	5.9	5.8
30-34	6.0	6.1	5.9	5.9	6.1	6.1	6.1	6.0	6.0
35-39	6.2	6.2	6.1	6.0	6.3	6.3	6.3	6.2	6.2
40-44	6.3	6.3	6.1	6.1	6.3	6.3	6.3	6.2	6.2
45-49	6.3	6.3	6.2	6.1	6.3	6.3	6.4	6.3	6.2
50-54	6.2	6.2	6.1	6.0	6.2	6.2	6.3	6.2	6.1
55-59	6.3	6.3	6.1	6.1	6.3	6.3	6.3	6.3	6.2
60-64	6.2	6.2	6.1	6.0	6.2	6.2	6.3	6.2	6.1
65-69	6.2	6.2	6.1	6.0	6.2	6.2	6.3	6.2	6.1
70-74	6.0	6.0	5.8	5.8	6.0	6.0	6.0	5.9	5.9
75-79	5.7	5.7	5.6	5.5	5.7	5.7	5.8	5.7	5.6
80-84	5.9	5.9	5.7	5.7	5.9	5.9	5.9	5.9	5.8
85-89	5.4	5.4	5.3	5.2	5.5	5.5	5.5	5.4	5.4

Figure 1d. Mean WORSUM Scores Based on Model 4.

	1974	1975-79	1980-84	1985-89	1990-94	1995-99	2000-04	2005-09	2010-12
18-19	5.1	5.0	4.8	4.9	4.8	5.3	4.8	5.8	4.9
20-24	5.5	5.6	5.3	5.2	5.4	5.6	5.7	5.5	5.4
25-29	6.5	6.0	5.5	5.8	5.9	5.7	5.9	5.7	5.7
30-34	6.2	6.2	6.3	5.8	6.0	5.9	5.9	5.9	5.9
35-39	6.2	6.3	6.4	6.3	6.3	6.1	6.1	5.9	5.9
40-44	6.2	6.2	6.2	6.3	6.5	6.3	6.1	5.8	6.2
45-49	6.3	6.1	6.1	6.2	6.6	6.7	6.0	6.1	6.1
50-54	6.1	6.2	5.9	5.7	6.1	6.5	6.6	6.3	5.9
55-59	6.1	6.4	5.9	5.8	6.2	6.6	6.5	6.5	6.2
60-64	6.2	6.3	6.1	5.6	6.0	6.0	6.4	6.6	6.4
65-69	5.8	6.1	5.9	5.9	6.5	6.0	6.4	6.2	6.4
70-74	5.6	5.1	5.8	5.9	6.0	5.9	6.4	6.3	6.3
75-79	5.0	5.6	5.1	5.3	6.2	5.6	5.8	5.9	5.6
80-84	5.7	6.1	6.0	5.5	5.5	5.5	6.1	6.1	6.2
85-89	5.5	4.3	4.7	5.0	5.2	5.8	6.2	5.6	5.6