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Oral Language and Reading Success: A Structural Equation Modeling Approach

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Oral language skills and habits may serve as important resources for success or failure in school-related tasks such as learning to read. This article tests this hypothesis utilizing a unique data set, the original Woodcock–Johnson Psycho-Educational Battery–Revised norming sample. This article assesses the importance of oral language by focusing on auditory processing, a variable strongly affected by the oral language of the family and peer group within which the youth is raised. It estimates a structural equation model in which this variable, along with other measures of basic cognitive skills, serve as mediators between race and mother's schooling background and basic and advanced reading skill. The model fits very well, and the youth's basic skill at auditory processing is both a major determinant of basic reading success, and by far the most important of the mediating variables. In particular, for children ages 5 to 10, this measure accounts for much of the race effect, and for more than one half of the mother's education effect on reading. Research on the determinants of social inequality should pay greater attention to the central importance of family and peer group oral language in determining cognitive performance outcomes, particularly for elementary school aged children.

A variety of family and neighborhood resources have been posited as contributing to the unequal schooling achievement of children from varying race and parental education backgrounds. Researchers have emphasized the importance of parental interaction with the school and with teachers (Lareau, 2000), parental embeddedness in networks of social relations (Coleman, 1988; Lin 2001; Portes,

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1998), parental high culture participation (e.g., museum, theater, and symphony orchestra; DiMaggio, 1982), and parental reading behavior (De Graaf, De Graaf, & Kraaykamp, 2000). However, there are other potentially important components that are transmitted from parents to their children. These are the spoken language skills and habits that parents use in everyday conversation with their children, which the children copy and absorb as they develop during the preschool age period, and on into the schooling years. The child's resulting oral language—patterns of vocabulary, grammar, receptive linguistic understanding, and expressive language use—is the principal resource that the child relies on when she or he undertakes the first great task of formal schooling—learning to read.

Now and again, researchers have flagged this parent-to-child linguistic transmission as a potentially important mechanism for the intergenerational persistence of social class status. Therefore, Bernstein (1975) focused on linguistic code differences in word usage and meaning as practiced by working- and middle-class parents, and the way that these differences advantage the middle-class students when schooling begins. Similarly, Heath (1983) examined language use in two rural working-class communities, one White and the other African American, and compared these to the speech patterns of middle-class townspeople, including teachers. Heath focused on everyday parental linguistic skills and practices as the parents interacted with their children. She observed the resulting cognitive skills acquired by the children and the meaning of conversation. She observed that, by contrast with the working class, middle-class parents more often question their children; engage them in extensive discussion; utilize a more abstract vocabulary; and, in general, teach the vocabulary, grammar, and thought processes necessary to succeed in school. She concluded that the African American working-class children were not socialized to cope with the language patterns traditionally used in school, and as a result, experienced early school failure. The White working-class children fared somewhat better in the early grades, but as these children moved to higher grades, they too were unprepared for the linguistic and thought patterns necessary for school success.

Other researchers have also focused on the stratification consequences of the relatively poor fit between the language socialization provided by less well-educated White and African American parents and the White middle-class linguistic demands of teachers and school curricular materials. Hart and Risley (1995) observed and recorded data on thousands of oral language interactions of less well-educated African American parents and their children and better educated White parents and their children. They found that the higher the socioeconomic level of the parents, the more parents spoke to their children. This, according to Hart and Risley, translated into better performance on IQ tests at age 3 and continued to be a strong predictor of IQ for a subset followed to the third grade. Meanwhile, Ogbu (1999) discussed the "bi-dialectical" situation of lower income African American children—they learn a slang dialect in the home and neighborhood, but must learn proper English as a second dialect once they begin school outside their family and community. According to Ogbu, "Students themselves report that their slang English interferes with their ability to speak or write proper English" (p. 178).[1]

However, how large is the effect of oral language on school achievement? We do not know because few data sets have contained direct measures of the key variable—student skill at schooling-oriented "standard" English speech. The purpose of this article is to report the results of analyzing one unusual data set that does contain such a measure. These are the data collected to provide national norms for the Woodcock–Johnson Psycho-Educational Battery–Revised (WJ–R) tests of cognitive performance (Woodcock & Johnson, 1989, 1990).[2] This widely used test battery includes measures of *auditory processing,* which directly tap the child's ability to extract meaning from standard English speech. It also includes measures of two other basic cognitive abilities—*long-term retrieval* and *processing speed*—that, although potentially important in learning to read, are less likely to be influenced by the oral language that the child takes from her or his family and community.

Confirmatory factor analysis and structural equation modeling are techniques often used to study the validity of scores from various scales and normed tests (e.g., Stevens, 1995, and Tomás & Oliver, 1999). Indeed, the psychometric properties of the WJ–R underlying factors have been studied and the results published (McGrew et al., 1991). What is not usually done is to build a structural model using variables outside the basic factors of the scale or test. The WJ–R original norming sample contains several variables that were collected contemporaneously with the original benchmarking of the test. These data include measures of the mother's educational level and race, as well as measures of the child's basic and advanced reading performance. Consequently, we are able to estimate a structural equation model in which the child's family background affects her or his basic cognitive skills, and these in turn determine reading performance. If auditory processing skill is found to be higher for the children of better educated and White mothers, and if auditory processing also determines reading skill, this suggests that oral language plays a mediating role in the effect of family background on school reading achievement. In this case, we are able to estimate what share of these family background effects can be attributed to this causal mechanism.[3]

[1]In this article, we do not focus on the underlying issues related to phonological structure. There are clearly important determinants that are much studied in speech science. For example, the way reading problems may be, in part, a function of initial speech encoding difficulties has been of concern for some time (e.g., see Elbro, 1996, and Fowler, 1991). We take this structure as given in our model.

[2]A new version of this test, Woodcock–Johnson III Battery (Woodcock, McGrew, & Mather, 2001), has just been released and is likely to replace the Woodcock–Johnson Psychoeducational Battery–Revised (Woodcock & Johnson, 1989, 1990) over the next few years.

[3]It should be noted that McGrew, Werder, and Woodcock (1991) started down the road we are on by estimating a latent variable model that includes all their factors but without exogenous variables and without combining what we call basic and advanced reading in the same model. Our article picks up their call for "additional causal modeling research designed to investigate and account for the development of academic skills. … These studies would be especially enlightening if … combined with other important variables" (p. 195).

METHOD

Study Design and Measurement of Variables

We estimate a structural equation model in which the basic skills of long-term retrieval, processing speed, and auditory processing serve as intermediate variables for the effects of social class, proxied by mother's education, and race or ethnicity on reading achievement.[4] The model is shown in Figure 1.

Following the work of Woodcock and his collaborators (McGrew et al., 1991), the three basic skills, as well as the basic reading and advanced reading achievement variables, are modeled as latent variables, each with two indicators. Estimation is via the LISREL computer program (Version 8.3).

The complete norming sample was selected to be nationally representative and included 6,359 individuals tested between 1986 and 1988. The individuals were randomly chosen using a stratified sampling design that sampled communities, schools, and individuals. The sample was matched on a number of census characteristics including census region, community size, sex, and racial demographics of the population. The age range in this sample went from 24 months to 95 years, but we focus on the children in the sample that vary from 5 to 17 years old, leaving us with 1,169 participants; descriptive statistics on our sample are described in the following. The data design is discussed in detail by McGrew et al. (1991, chapter 4).[5]

Following the reading research literature (Ehri, 1996; Juel, 1996), we expect the parameters of the reading development process to differ by age group (i.e., we expect age to operate as a moderator). In particular, the effect of auditory processing on reading skill is likely to be larger and more important for younger children who are just developing their basic reading skills than for older children who should be building their advanced reading skills. Other basic skills are also likely to be more important for younger children than for older ones, as is the effect of basic reading on advanced reading.

Reading researchers have come to believe that success or failure in reading is largely determined by the student's experiences in Grades Kindergarten through Grade 4. As a consequence, reading research on the determinants of processes of reading achievement have been focused on this age range. The one exception is that it is increasingly believed that the preschool years are also crucial. Therefore, the standard references in the field (e.g., Adams, 1990; Barr, Kamil, Mosenthal, & Pearson, 1991; Snow, Burns, & Griffin, 1998) are concerned almost exclusively

[4]It would be desirable to control for a more complete set of socioeconomic status variables including occupation and income of both parents, but these data were not collected. Doing so would likely reduce the effects found for mother's education.

[5]These data have rarely been released to researchers. When released to us we received a subset of the variables that did not include geographical or school identifiers. Had this information been included, then we could have also tried a multilevel-type model.

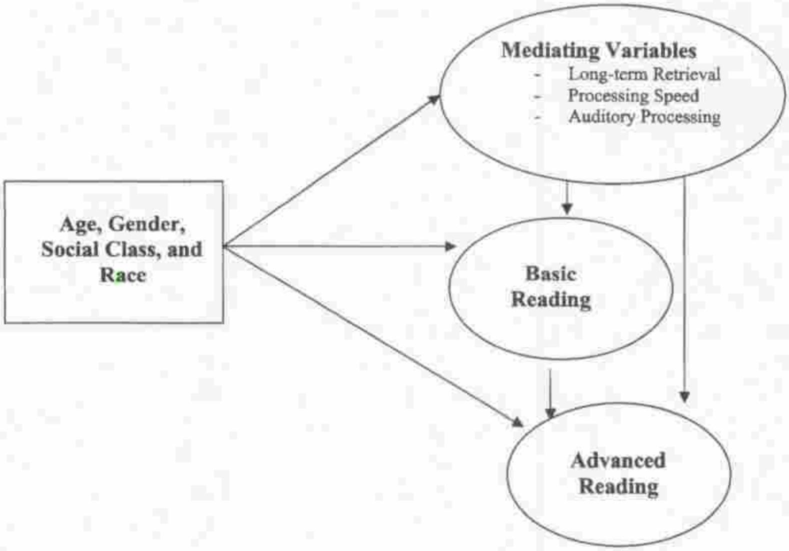

FIGURE 1 Conceptual model.

with the preschool through Grade 4 ages. Indeed, even this age range has been further decomposed by some researchers into even finer age categories (Morrison, 1991). Accordingly, we have divided our sample into two sets of respondents: those falling into the most commonly researched developmental stage (N = 647, ages 5–10) and the less commonly researched group of older readers (N = 522, ages 11–17). We formally test if the reading development process differs between these two groups or are similar enough for the samples to be pooled.

Social class is measured by the only indicator available on this data set, mother's education (highest grade attained). We also have measures of the child's gender, race (we have restricted attention to non-Hispanic Whites and African Americans as this represents over 95% of the original sample), and age (in months on the date the tests were taken).

Basic cognitive skills are operationalized through the constructs of auditory processing, long-term retrieval, and processing speed, based on the descriptions of McGrew et al. (1991). Auditory processing is defined as the ability to fluently comprehend patterns among auditory stimuli. Long-term retrieval involves the storing of information and the fluency of retrieving it later through association. Processing speed is the ability to work quickly, particularly when measured under pressure to maintain focused attention. Reading achievement is measured with two constructs—basic and advanced reading. Basic reading skill includes both sight vocabulary and the ability to apply phonic and structural analysis skills to basic reading tasks. Advanced reading tests more advanced reading skills including reading comprehension and a more advanced vocabulary. A more detailed description of these constructs is given in Appendix A along with the indicators used in the formal model. Our focus is on auditory processing. It is expected that children socialized with an oral language other than standard middle-class speech will have greater difficulty with the listening and response tasks underlying this factor, and this should show up in the estimated relation between auditory processing and the reading variables.

Structural Equation Model Construction

Descriptive statistics for the data in our project are shown in Table 1. As discussed, we divided the data into two age groups, those aged 5 to 10 and those aged 11 to 17. We group the data into those treated as exogenous and observed and those that are indicators of latent variables.

The empirical methods most often used to estimate structural equation models assume the data, at least those not perfectly measured, are multivariate normal. Multivariate normality requires that each individual variable also be univariate normal. We tested our latent variable indicators for both univariate normality as well as, collectively, multivariate normality and found little support for univariate normality for most variables, and no support for multivariate normality.[6]

The estimation techniques employed in the following allow for the nonnormality of our data. We use maximum likelihood estimation, which provides unbiased and consistent estimates but is inefficient. More important, however, is that the standard maximum likelihood approach, unless corrected, leads to an incorrect estimate of the chi-square statistic, as well as related goodness-of-fit statistics, and also to incorrect standard errors (Kaplan, 2000). We adjust these by using the asymptotic covariance matrix in our analysis to form the Satorra–Bentler (Satorra & Bentler, 1988) SCALED chi-square statistic, which is also the basis for other related fit indexes reported later. The standard errors are also corrected for nonnormality and reported later as robust standard errors (Jöreskog, Sörbom, du Toit, & du Toit, 1999; West, Finch, & Curran, 1995).

Model Specification

The model implied by Figure 1 has several features that must be dealt with prior to estimation of the full model. In the language of structural equation modeling we have both a measurement model and a structural model. We begin by specifying both models. First, we assess the measurement model and then consider the identi-

[6]For our younger aged sample, we found only crsoutw had a distribution that could not be rejected as normal in terms of both skewness and kurtosis at the .05 level of significance. For the older sample, crsoutw, vismatw, blndw, rdgvocw, and psgcmpw all met these criteria (indicator variables are defined in Appendix A). A multivariate test of normality performed separately for each group of indicators in each age group showed p values below .001, leading us to reject the multivariate normality assumption.

TABLE 1
Descriptive Statistics

	Children Under Age 11[a]		Children Age 11 Through 17[b]	
Variables	*M*	*SD*	*M*	*SD*
Age	97.165	19.300	172.102	24.464
Female	0.498	0.500	0.519	0.500
Black	0.083	0.277	0.107	0.310
Mother's education	13.318	2.325	13.027	2.115
Long-term retrieval				
Memory for names	4953.553	103.772	5050.400	121.523
Visual–auditory learning	4930.567	108.179	5039.027	104.049
Processing speed				
Visual matching	4771.847	213.177	5195.586	157.380
Cross out	4863.518	133.912	5133.310	102.783
Auditory processing				
Incomplete words	4937.594	118.732	5048.510	77.062
Sound blending	4898.509	189.074	5078.487	132.575
Basic reading				
Letter–word identification	4596.138	422.115	5228.866	193.243
Word attack	4763.283	285.267	5061.102	128.613
Advanced reading				
Reading vocabulary	4725.128	288.373	5159.349	143.397
Passage comprehension	4633.793	393.059	5151.908	141.295

Note. Latent variables are in italics with their two indicators following. As provided by Richard Woodcock, all indicators have been multiplied by 10 compared to their published form in McGrew, Werder, and Woodcock (1991). Indicator definitions are given in Appendix A, whereas the other variables are defined in the body of the article.

[a]$n = 647$. [b]$n = 522$.

fication of the system of equations. This is followed by a determination of whether the data should be separated by age group or pooled. Last, we estimate the final model.

Our model uses, in part, the framework developed by McGrew et al. (1991) to measure our underlying latent variables. Each latent variable has two indicators, and all latent variables are, technically, endogenous in our model because each is affected by our age, gender, social class, and race variables. However, to separate out the mediating latent variables from the outcome variables of interest we use the standard representation (Bollen, 1989) of a structural equation model to accommodate our specification. In particular, let η_1 represent the vector of mediating latent variables (long-term retrieval, processing speed, and auditory processing) and η_2 represent the vector of final outcome latent variables (basic reading and advanced reading); y_1 the vector of indicators affecting the mediation latent variables and y_2 the vector of indicators affecting the final outcome latent variables. Then, the measurement model for our latent variables is as follows:

$$y_1 = \Lambda_{Y_1}\eta_1 + \varepsilon_1 \quad (1)$$

$$y_2 = \Lambda_{Y_2}\eta_2 + \varepsilon_2 \quad (2)$$

where ε_i is a vector of measurement errors and Λ_{Y_i} is a parameter matrix that includes the "loadings" of each latent variable η_1 on its corresponding indicators. y_1 and ε_1 are 6×1 vectors and errors, y_2 and ε_2 are 4×1 vectors and errors, η_1 is a 3×1 vector of latent variables, and η_2 is a 2×1 vector of latent variables, Λ_{Y_1} is a 6×3 matrix of loadings, and Λ_{Y_2} is a 4×2 matrix of loadings. The unobservable nature of the latent variables requires that, for identification, each be given a specific metric. We do this by fixing one of the two indicator loadings for each latent variable to the value of 1.0. The measurement error covariance matrix is diagonal (i.e., the errors are assumed uncorrelated).

The latent variable part of our model explains the mediating latent variables and both reading variables. The mediating latent variables are determined by the observed age, gender, social class, and race variables (X). The latent variables' long-term retrieval, processing speed, and auditory processing, along with the observed age, gender, social class, and race variables, explain the endogenous latent variable basic reading, and advanced reading is explained by all of these variables as well as basic reading. In equation form

$$\eta_1 = \Gamma_1 X + \zeta_1 \quad (3)$$

$$\textit{Basic Reading} = \beta_1\eta_1 + \Gamma_2 X + \zeta_2 \quad (4)$$

$$\textit{Advanced Reading} = \beta_2(\textit{Basic Reading}) + \beta_3\eta_1 + \Gamma_3 X + \zeta_3 \quad (5)$$

where ζi are vectors of equation errors and β and Γ are parameter matrices for the latent and observed variables, respectively. Note that this is a relatively standard recursive structural model. These relations are shown in Figure 2.

In addition, because the mediating cognitive skills variables are likely related to each other, we allow their errors to be correlated, that is, ζ_1 has a covariance matrix, ψ_1,

$$\Psi_1 = \begin{bmatrix} \psi_{11} & & \\ \psi_{21} & \psi_{22} & \\ \psi_{31} & \psi_{32} & \psi_{33} \end{bmatrix}$$

ψ_2 and ψ_3 have scalar variances (i.e., are assumed uncorrelated), as the basic and advanced reading latent variables are explained by the mediating variables and observed variables. Our rationale for this is that long-term retrieval, processing speed, and auditory processing are members of the same block, in a block-recur-

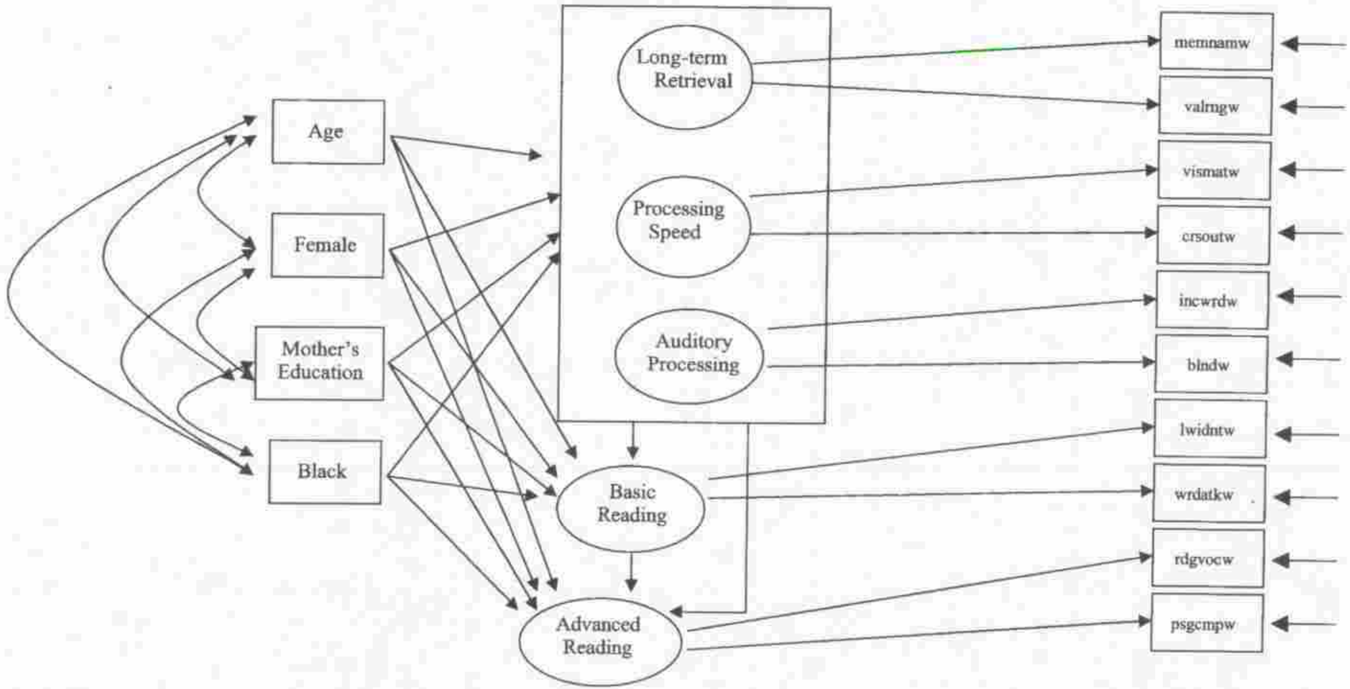

FIGURE 2 Structural equation model. Omitted are the error terms for the latent variables and the correlation of the error terms between the three mediating latent variables. Indicator variables are defined in Appendix A.

sive model. Accordingly, they are not modeled as "causing" one another, and their error terms are allowed to be correlated.

RESULTS

Fitting the Model

The measurement model, with indicators described in Appendix A, was evaluated separately from the structural model. A well-specified measurement model allows us to have more confidence in the structural parameter estimates we finally arrive at by not confounding these estimates with misspecification of the underlying latent variables. Therefore, we estimate the combined measurement model, Equations 1 and 2, separately for each age group that we use in our analysis and allow all latent variables to covary. All goodness-of-fit statistics suggest an excellent fit of the measurement model for both age groups. For the younger age group, the SCALED χ^2 = 28.587 (N = 647), with 25 df (p = .282); the root mean square error of approximation (RMSEA) = 0.015, with confidence interval 0 to 0.036; the goodness-of-fit index (GFI) = 0.974; the incremental fit index (IFI) = 0.992; the comparative fit index (CFI) = 0.992; and the Tucker–Lewis (nonnormed) index (TLI) = 0.986. For the older age group, the SCALED χ^2 = 17.850 (N = 522; p = .849); RMSEA = 0.000, with confidence interval 0 to 0.020; GFI = 0.973; IFI = 0.979; CFI = 0.979; and TLI = 0.961.

The identification of the model is established using a two-step process (Bollen, 1989). First, the model is considered as if it were a confirmatory factor model in which the structural relations are ignored. In our case, this comes down to asking whether Equations 1 and 2 are jointly identified, allowing all factors to intercorrelate. The two indicators available for all latent variables is a sufficient condition here to establish identification for this step. The second step of the identification process considers all latent variables as if they were perfectly observed and then asks whether the structural part of the model is identified. The structural model is recursive, with no feedback loops; again, this is a sufficient condition for identification. The overall model, therefore, is identified given both the measurement model and the latent variable model individually being identified.

We discussed earlier why we believe that we should analyze our two age groups separately rather than pool them together. We formally test this by performing a sequence of multisample group analyses to determine whether we have statistical support for this approach. We begin by testing whether the groups statistically have the same form, that is, whether the specification, although *not* the parameters, are the same for each groups' measurement and latent variable models (Bollen, 1989). We find a very good overall fit, SCALED $\chi^2(90, N = 1{,}179) = 43.85$, $p = 1.000$. We compare this to a totally invariant model where all coefficients and variances are constrained to be equal for both the measurement and latent variable models, SCALED $\chi^2(140, N = 1{,}179) = 709.03$, $p = .000$; a more relaxed model with the latent variable and exogenous variable coefficients equal but the measurement model and variances free, SCALED $\chi^2(117, N = 1,179) = 230.59$, $p = .000$; and an even more relaxed model with just the exogenous variable coefficients constrained to be equal, SCALED $\chi^2(114, N = 1,179) = 177.86$, $p = .000$. Likelihood ratio (difference in chi-square) tests in all cases reject the constraints, supporting our separate modeling of the age groups.

Parameter Estimates

The results for the structural part of our final model for each age group are shown in Table 2. The measurement models for each age group are shown in Appendixes B1 and B2. The overall fit for the combined structural and measurement model of both age group models is generally excellent compared to commonly accepted cut-off values (Hu & Bentler, 1995). The SCALED chi-square for both models is statistically nonsignificant, indicating a fit of the model to the data, and all but one GFI is above 0.95, with the lone one still above 0.9. The RMSEA is well below the 0.05 value that is normally taken to indicate a good model fit, and this holds up using a 90% confidence interval.

The first panel of Table 2 presents the path coefficients for the structural equation model for children aged 5 to 10 years. The first number is the unstandardized coefficient, followed by the *Z* statistic. Standardized coefficients are in brackets. Note that all *Z* statistics are based on robust standard errors allowing for possible nonnormality of the data.

Age (in months) has a very powerful positive effect on the three basic cognitive skills, with the largest effect (as measured by the standardized coefficients) being for processing speed; however, long-term retrieval (memory) and auditory processing are close seconds. In this age range, during Grades Kindergarten through 4, children's basic cognitive skills grow very dramatically with age. Basic and advanced reading also grow significantly with age, but at slower rates than the basic cognitive skills. The growth rate is larger for basic than for advanced reading, which is to be expected during the early elementary grades. Gender has a significant effect only on processing speed, with girls being faster than boys.

Race shows a significant negative effect for auditory processing and long-term retrieval and is close to significant for processing speed. The largest effect is for auditory processing—African Americans are significantly weaker at this skill than are Whites. Because, as we shall see, auditory processing is the strongest determinant of basic reading skill, this strongly supports the oral language explanation of the lower basic reading performance of African American children.

African Americans also score lower than Whites on long-term retrieval and processing speed, although the latter effect is small. However, net of these basic skills, the Black effect on basic reading is significant and positive. That is, although weaker basic skills reduce the basic reading performance of African American children, these children manage to perform better on basic reading than they would be expected to on the basis of their basic skills and other characteristics. The Black structural effect on advanced reading is not significant, indicating that Black–White differences in advanced reading are fully the result of Black–White differences in the intermediate variables in the model.

Mother's education, the measure of social class, is significantly and positively related to all three basic skills. As with race, the largest effect is for auditory processing, supporting the importance of oral language in social class effects on children's reading achievement. This is further supported by the absence of statistically significant social class structural effects on either basic or advanced reading. Instead, social class differences in children's reading achievement are largely due to social class differences in the basic skills of long-term retrieval, processing speed, and auditory processing, with auditory processing playing the largest role.

The centrality of auditory processing for basic reading achievement is revealed by the structural coefficients for the effect of the basic skills on basic reading. Only those for processing speed and auditory processing achieve statistical significance, with the latter coefficient being almost five times the magnitude of the former. Looking down the column for structural effects on basic reading, we see that auditory processing exerts by far the largest effect on this variable, with age in second place.

The final column of the first panel of Table 2 shows the estimated structural effect coefficients for advanced reading. Only two of these are statistically significant: those for age and for basic reading, with the latter being the dominant effect.

Overall, these coefficients tell a clear and simple story. In our model, auditory processing is the most influential determinant of basic reading, and basic reading is the most influential determinant of advanced reading.

The second panel of this table shows the structural equation parameter estimates for children aged 11 to 17. Many patterns are similar to those for the younger children, but as expected, there are a number of differences.

Once again, all the effects of age are positive and statistically significant. However, as expected, basic skills and basic reading grow more slowly with age among the older children, whereas advanced reading skills grow more rapidly in this group. As with the younger group, the only significant effect of gender is that girls have greater processing speed than boys.

Once again, African Americans score below Whites on all three basic skills, but only the effects on long-term retrieval and auditory processing are significant. Most important, as with the younger group, the largest of these effects is for auditory processing. For this group of older children, there is no significant structural effect of race on basic reading. There is, however, a modest negative structural effect of being African American on advanced reading.

As with the younger group, the effect of social class (mother's education) on basic skills is positive and statistically significant for all three basic skills. However, in this

TABLE 2
Structural Effects

	Structural Effects for Children Under Age 11[a]					Structural Effects for Children Age 11 Through 17[b]				
Variables	*Long-Term Retrieval*	*Processing Speed*	*Auditory Processing*	*Basic Reading*	*Advanced Reading*	*Long-Term Retrieval*	*Processing Speed*	*Auditory Processing*	*Basic Reading*	*Advanced Reading*
Age	2.478	9.414	3.077	6.983	1.274	0.890	3.341	0.449	0.273	0.992
	15.393*	41.979*	14.401*	7.674*	2.456*	5.418*	14.979*	4.928*	1.977*	4.541*
	[0.669]	[0.874]	[0.689]	[0.328]	[0.089]	[0.271]	[0.623]	[0.304]	[0.260]	[0.192]
Female	–5.513	29.890	3.016	20.357	–3.440	3.608	53.224	4.041	–5.160	–10.738
	–1.144	3.501*	0.528	1.326	–0.473	–0.472	5.277*	1.044	–0.388	–1.523
	[–0.039]	[0.072]	[0.018]	[0.025]	[–0.006]–	[–0.022]	[0.203]	[0.056]	[–0.014]	[–0.043]
Black	–45.642	–32.819	–72.444	79.785	–6.477	–28.374	–5.654	–22.390	14.313	–22.846
	–4.949*	–1.935	–6.608*	2.720*	–0.421	–2.156*	–0.389	–3.179*	0.552	–2.097*
	[–0.177]	[–0.044]	[–0.233]	[0.054]	[–0.007]	[–0.109]	[–0.013]	[–0.192]	[0.023]	[–0.056]
Mother's education	4.143	7.553	6.601	3.613	1.834	8.309	6.258	2.947	10.056	6.688
	3.184*	3.947*	4.662*	0.982	0.937	4.423*	2.748*	2.935*	3.148*	3.931*
	[0.135]	[0.084]	[0.178]	[0.020]	[0.015]	[0.218]	[0.101]	[0.172]	[0.112]	[0.112]
Long-term retrieval				0.442	0.193				0.273	0.164
				1.353	1.387				1.977*	2.156*
				[0.077]	[0.050]				[0.115]	[0.104]

Processing speed	0.230	−0.056	0.200	0.152
	2.445*	−1.167	2.068*	3.022*
	[0.116]	[−0.042]	[0.138]	[0.158]
Auditory processing	2.525	−0.177	2.369	0.569
	6.175*	−0.744	4.956*	2.432*
	[0.529]	[−0.055]	[0.449]	[0.163]
Basic reading		0.643		0.308
		11.188*		6.915*
		[0.953]		[0.466]
Satorra–Bentler chi-square statistic	53.261 ($p = .186$) with 45 *df*		49.827 ($p = .287$) with 45 *df*	
Root mean square error of approximation	0.017; 90% confidence interval: (0.0–0.033)		0.0144; 90% confidence interval: (0.0–0.033)	
Goodness-of-fit index	0.968		0.962	
Incremental fit index	0.988		0.963	
Comparative fit index	0.988		0.962	
Tucker–Lewis [nonnormed] index	0.976		0.924	

Note. The first number is the unstandardized coefficient, followed by the *Z* statistic. Standardized coefficients are in brackets.

[a]$n = 647$. [b]$n = 522$.

*$p < .05$.

case the largest effect is for long-term retrieval, with auditory processing second, and processing speed third. Unlike the younger children, mother's education exerts significantly positive structural effects on both basic and advanced reading.

For the full set of determinants of basic reading, the pattern of magnitudes for the older children resembles that for the younger children. That is, the largest effect is due to auditory processing, further supporting the centrality of oral language in the development of basic reading skill.

The final column of this panel shows the determinants of advanced reading for the older children. As with the younger children, the strongest effect is due to basic reading skill. Here, however, all the basic skills also exert statistically significant effects. Note that, again, auditory processing has one of the larger effects. Therefore, auditory processing affects advanced reading both indirectly via its effect on basic reading, and directly as a structural effect.

Decomposition of Effects

The magnitude of the role played by oral language as a mediating variable between class and race background and reading achievement is summarized in Table 3. For ages 5 to 10, the standardized total effect of social class (mother's education) on basic reading is 0.135. This is calculated from Table 2 based on the sum of all indirect effects of social class with the direct effect of social class on basic reading, that is, $(0.135 \times 0.077) + (0.084 \times 0.116) + (0.178 \times 0.529) + .020 = 0.134$, where the difference in the third digit is due to rounding. The indirect effect of social class via its effect on auditory processing is .094. Therefore, fully 70% of the social class effect on basic reading is mediated by auditory processing.

Repeating this calculation for the race effect on basic reading yields a value of 140%. This is over 100% because the negative effect of race via auditory processing is partially opposed by a positive direct (structural) effect of race on basic reading. Nevertheless, the message is clear: The total effect of being African American on basic reading is negative, and this negative effect is primarily due to the lower auditory processing skills of this group of children.

For advanced reading among 5- to 10-year-olds, auditory processing accounts for 58% of the social class effect and 124% of the race effect. Clearly, auditory processing is a principal conduit by which class and race effects on reading are expressed.

The pattern continues, at a diminished level, for older children. For basic reading by these children, auditory processing accounts for 34% of the social class effect and 112% of the race effect. For advanced reading, it accounts for 22% of the class effect and 52% of the race effect. Reading down the columns of Table 3, we see that auditory processing plays its largest mediating role for basic reading by younger children. As one moves to advanced reading skills, and to older children, the magnitude of this role diminishes.

TABLE 3
The Percentage of Total Effects of Class and Race on Reading Achievement Due to Auditory Processing (Standardized Coefficients)

	Class Effect	*Race Effect*
Ages 5 to 10		
Basic reading		
Total effect	0.135	–0.088
Direct effect	0.020	0.054
Indirect effect via auditory processing	0.094	–0.123
Percentage due to auditory processing	70	140
Advanced reading		
Total effect	0.137	–0.085
Direct effect	0.015	–0.007
Indirect effect via auditory processing	0.080	–0.105
Percentage due to auditory processing	58	124
Ages 11 to 17		
Basic reading		
Total effect	0.228	–0.077
Direct effect	0.112	0.023
Indirect effect via auditory processing	0.077	–0.086
Percentage due to auditory processing	34	112
Advanced reading		
Total effect	0.285	–0.137
Direct effect	0.112	–0.056
Indirect effect via auditory processing	0.064	–0.071
Percentage due to auditory processing	22	52

Note. An example of the calculation of total effect is shown in the body of the article. Numbers are derived from Table 2, although slight differences in calculations will be found due to rounding. Presented results are based on keeping significant digits in calculation.

This is exactly what is reported by reading researchers. The language, speech, and hearing connections to reading are most crucial for the basic reading skills of younger children (Adams, 1990; Snow, Burns, & Griffin, 1998). Therefore, it is at younger ages that the weaker auditory-processing skills of lower social class and African American children have their greatest effect.

CONCLUSION

Using a national sample of U.S. children aged 5 to 17, we have found that the child's basic skill at auditory processing is a key mediating variable for the effect of class and race effects on reading achievement. This extends the works of Bernstein (1975) and Heath (1983) and suggests that oral language plays a central role in determining stratification outcomes. It is also consistent with a growing body of research demonstrating that children's auditory processing (including phonemic awareness) skills are central to success at reading in elementary school (Adams, 1990; Ehri, 1996; Snow et al., 1998).

The implication is that future studies of the intergenerational transmission of social class status should pay greater attention to the role of oral language in this transmission process. The potential benefits to the field of social stratification research are many. The full life course, developmental trajectories of children from different social class backgrounds could be traced. These trajectories might be examined separately, for cognitive development and for the development of social and behavioral habits. Where cognition is concerned, we can hope to expand on studies such as this one, where the transition from skill at spoken language to skill at written language is traced. Where social and behavioral development is concerned, we can hope to trace the transition from early attentiveness and school readiness to student work habits in middle and high school. We can examine how family background affects these cognitive and social and behavioral outcomes, and how these outcomes affect one another as the student ages. Such a research agenda would reveal how family and neighborhood effects in the preschool years translates into the skills and habits affecting early success or failure at school, and how these skills and habits, and associated success or failure, then evolve over the child's school career. (For related work, see Duncan & Brooks-Gunn, 1997; Guo, 1998; Jencks & Phillips, 1998.)

Our findings also support intervention efforts aimed to facilitate the transition to school for low-income and minority children by improving the linguistic and vocabulary skills explicitly taught in Head Start and other preschool programs (Whitehurst et al., 1994; Whitehurst & Lonigan, 1998). Our findings suggest that such interventions are crucially important if we are to reduce the social class and race and ethnicity reading gaps that play a large role in the transmission of poverty from parent to child.

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APPENDIX A
Construct Definitions

This section draws heavily from various portions of McGrew, Werder, and Woodcock (1991) and is intended to facilitate understanding of how the basic cognitive skills and reading factors are operationalized. The indicator labels used in Figure 2 are given in parentheses.

Auditory processing is defined as the ability to fluently comprehend patterns among auditory stimuli. On the Woodcock–Johnson Psycho-Educational Battery–Revised (Woodcock & Johnson, 1989, 1990) it is measured by two tests, *Sound Blending* (blndw) and *Incomplete Words* (incwrdw). The first of these tests the ability to integrate and then say whole words after hearing parts (syllables, phonemes, or both) of the words. An audiotape is used to present word parts in their proper order for each item. The second of these is a tape-recorded test that measures auditory closure. After hearing a recorded word that has one or more phonemes missing, in any order, the respondent names the complete word. The use of audiotape guarantees that all children receive the same auditory stimulus.

Long-term retrieval involves the storing of information and the fluency of retrieving it later through association. The length of intervening time is not the essence, but rather that intervening tasks have engaged working memory during the interim and the information must be retrieved. It is measured by *Memory for Names* (memnamw) and *Visual–Auditory Learning* (valrngw). The first of these measures the ability to learn associations between unfamiliar auditory and visual stimuli. At each step in the test the respondent is shown a picture of a space creature and told the creature's name. The respondent is then shown a page of nine space creatures and asked to point to the creature just introduced and to the previously introduced space creatures as named by the examiner. The second test measures the ability to associate new visual symbols (rebuses, i.e., drawings) with familiar words in oral language and to translate a series of symbols into verbal sentences.

Processing speed is the ability to work quickly, particularly when measured under pressure to maintain focused attention. Examples include speed of scanning, comparison, printing, or writing. Whatever the task, it must be so easy that most people would get all items correct if the test were not highly speeded up. In a broader sense, it is the ability to maintain focused and steady concentration during thinking. Speediness in intellectual tasks relates to carefulness, processing strategies, mood, and persistence, as well as to features of physiological structures (neural, hormonal). It is measured by *Visual Matching* (vismatw) and *Cross Out* (crsoutw). The first of these measures the ability to locate and circle the two identical numbers in a row of six numbers. The task proceeds in difficulty from single-digit numbers to triple-digit numbers and has a 3-min time limit. The second test measures the ability to quickly scan and compare visual information. The participant must mark the 5 drawings in a row of 20 drawings that are identical to the first drawing in the row. The participant is given a 3-min time limit to complete as many rows of items as possible.

Reading achievement is measured with two constructs—basic and advanced reading:

Basic reading skill includes both sight vocabulary and the ability to apply phonic and structural analysis skills to basic reading tasks. Sight vocabulary is measured by a test of *Letter–Word Identification* (lwidntw), which requires identifying isolated letters and words that appear on the test book. The items become more difficult (utilizing words that appear less and less frequently in written English) as the test continues. Phonic and structural analysis skills are determined by the test of *Word Attack* (wrdatkw). The respondent reads aloud letter combinations that, although linguistically logical in English, form nonsense words or words that constitute low-frequency words in the English language.

Reading comprehension skill tests more advanced reading skills, using tests of *Passage Comprehension* (psgcmpw) and *Reading Vocabulary* (rdgvocw). The first of these tests the participant's skill in reading a short passage and identifying a missing key word. The task requires the participant to state a word that would be appropriate in the context of the passage. This requires the exercise of a variety of comprehension and vocabulary skills. The *Reading Vocabulary* test measures the participant's skill in reading words and supplying appropriate meanings. In Part A: Synonyms, the participant must state a word similar in meaning to the word presented. In Part B: Antonyms, the participant must state a word that is opposite in meaning to the word presented. Only one-word responses are acceptable.

APPENDIX B1
Measurement Models: Children Under Age 11

	Memory for Names	*Visual–Auditory Learning*	*Visual Matching*	*Cross Out*	*Incomplete Words*	*Sound Blending*	*Letter–Word Identification*	*Word Attack*	*Reading Vocabulary*	*Passage Comprehension*
Long-term retrieval	1.000 [0.690]	1.344 17.239 [0.889]								
Processing speed			1.000 [0.976]	0.570 37.955 [0.886]						
Auditory processing					1.000 [0.726]	1.875 18.406 [0.854]				
Basic reading							1.000 [0.975]	0.644 50.742 [0.929]		
Advanced reading									1.000 [0.962]	1.365 56.538 [0.963]

Note. The first number is the unstandardized coefficient, followed by the Z statistic based on robust standard errors, and then the standardized coefficient in brackets. The latent variable is scaled to its first listed indicator. Indicator definitions are given in Appendix A. All coefficients are significant at $p < .05$.

APPENDIX B2
Measurement Models: Children Age 11 Through 17

	Memory for Names	*Visual–Auditory Learning*	*Visual Matching*	*Cross Out*	*Incomplete Words*	*Sound Blending*	*Letter–Word Identification*	*Word Attack*	*Reading Vocabulary*	*Passage Comprehension*
Long-term retrieval	1.000 [0.662]	1.078 11.035 [0.834]								
Processing speed			1.000 [0.833]	0.665 20.272 [0.848]						
Auditory processing					1.000 [0.470]	2.739 7.942 [0.748]				
Basic reading							1.000 [0.988]	0.468 17.468 [0.694]		
Advanced reading									1.000 [0.882]	0.908 24.276 [0.812]

Note. The first number is the unstandardized coefficient, followed by the Z statistic based on robust standard errors, and then the standardized coefficient in brackets. The latent variable is scaled to its first listed indicator. Indicator definitions are given in Appendix A. All coefficients are significant at $p < .05$.