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Underlying Reading-Related Skills and Abilities Among Adult Learners

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Abstract

This exploratory study identified underlying skill and ability differences among subgroups of adolescent and young adult struggling readers (N = 290) overall and in relation to a fluency-based instructional grouping method. We used principal axis factoring of participants' scores on 18 measures of reading-related skills and abilities identified in the research literature to identify a smaller set of generally uncorrelated constructs. The four underlying factors of the 18 measures explained 62.7% of the variance. We labeled these factors Encode/Decode (44.5%), Vocabulary (9.5%), Processing Speed (5.2%), and Working Memory (3.5%). Regression analysis demonstrated Working Memory, Encode/Decode, and Vocabulary collectively predicted 45.9% functional reading as measured by the *Comprehensive Adult Student Assessment System*. Alternatively, when measured by the *Test of Adult Basic Education*, Vocabulary and Encode/Decode predicted 47.1% of variance in reading. Differences in predictive utility of the factors by fluency group suggest approaches to tailoring instruction for each group. Future research might examine the optimal mix of instructional approaches that support the identified factors.

Keywords

adults, literacy, reading

The National Assessment of Adult Literacy (NAAL) indicates 43% of American adults lack the necessary literacy skills for most living wage jobs, which often require postsecondary education (Kutner et al., 2007; National Center on Education and the Economy, 2007). Closing this literacy gap, particularly among adolescent and young adults who struggle with reading, is a challenge for educators as well as policy makers concerned with the economic, civic, and cultural future of the nation. Yet little is known about the underlying reasons for adolescent and young adults' reading difficulties and, therefore, how to instructionally address these difficulties (National Research Council [NRC], 2012).

Oral Reading Fluency Assessment for Targeting Instruction

Previous research suggests that measuring oral reading fluency (ORF) may be an appropriate method for making instructional placements and choosing targeted interventions to address areas of greatest difficulty among adults with low literacy (Mellard, Anthony, & Woods, 2011; Mellard, Woods, & Fall, 2011). Such an approach is based on the evidence that fluent reading is the product of well-developed and integrated knowledge, reading skills, and rapid coordination of multiple cognitive processes, that is, "the oral translation of text with speed and accuracy" (Fuchs, Fuchs, Hosp, & Jenkins, 2001, p. 239). Reading research with children has a long history of finding a significant correlation between ORF and reading comprehension (e.g., Calfee & Piontkowski, 1981; Herman, 1985; Pinnell et al., 1995; Stanovich, 1986; Wolf & Katzir-Cohen, 2001). For this reason, Fuchs et al. (2001) refer to oral reading rate and accuracy as an elegant way to assess students' overall reading ability.

The Partnership for Reading's most recent report on adult literacy indicated that for typical readers "fluency . . . is essential to reading success" (Kruidenier, MacArthur, & Wrigley, 2010, p. 65; Snow, Burns, & Griffin, 1998). The partnership has consistently singled out fluency as one of the five instructional foci for adults with low literacy (Kruidenier, 2002; Kruidenier et al., 2010). Instructional programming for many adult literacy learners, however, is based on such functional reading assessments as the *Comprehensive Adult Student Assessment System* (CASAS, 2004) or the *Test of Adult Basic Education* (TABE; CTB/

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McGraw-Hill, 1996). Studies have suggested that these functional reading assessments can frequently result in a mismatch between students' needs and instructional placement (Mellard, Anthony, et al., 2011; Mellard, Woods, et al., 2011; Mellard, Woods, & Md Desa, 2012).

Mellard and colleagues' statistical examinations of ORF among at-risk career and technical education students and among adult basic and secondary education (ABE/ASE) learners also found that a two-dimensional measure of ORF (i.e., total word and word error rates) can be a useful tool for quickly gauging basic literacy skills and forming instructional groups with distinct profiles of numerous underlying reading component skills and cognitive abilities.

Therefore, the purpose of this study is to identify a smaller set of generally uncorrelated variables from a larger set of mostly correlated variables to determine how well these factors predict functional reading levels for different groups distinguished by their reading fluency. The NRC (2012) recommended that such instructional intervention research and design might benefit from understanding the group differences in contribution to functional reading performance for any identified factors.

Underlying Reading Component Skills

Several other recent studies of adults with low literacy reported varying models of underlying components that contribute to reading ability. Like Mellard's findings described above, Greenberg et al. (2010) implicated ORF as playing a role in low literacy. They found that fluency along with oral vocabulary and decoding efficiency explained most of the variance in TABE, a commonly used standardized reading assessment of adults with low literacy for informing placement decisions.

Adult literacy research also provides a theoretical base for selecting potentially important underlying reading component skills. Recently four studies attempted to fit adult literacy learner data to measurement models of underlying reading component skills that contribute to reading ability. Data from a sample of native and nonnative English-speaking ABE learners sufficiently fit a five-factor model of reading component skills (i.e., decoding, word recognition, spelling, fluency, and comprehension; MacArthur, Konold, Glutting, & Alamprese, 2010). This finding provided support for the reliability and construct validity of measures of reading component skills for use with ABE populations.

Data from another sample of ABE participants with up to seventh grade reading levels had only a marginally acceptable fit with a four-factor model with the following components: word recognition, language comprehension, vocabulary, and fluency/speed (Sabatini, Sawaki, Shore, & Scarborough, 2010). Nevertheless, the authors of the study concluded that the oft-cited simple view of reading two-factor model (word recognition and language comprehension; Gough & Tunmer, 1986; Hoover & Gough, 1990) does not need to be expanded for adults to include fluency or vocabulary as distinct factors.

A third study of adult literacy with a sample of native and nonnative English-speaking third- to fifth-grade-level adult readers encountered difficulties fitting an achievement model, a core deficit model, and an integrated model previously validated with children (Nanda, Greenberg, & Morris, 2010). This difficulty could be attributable to design artifacts (e.g., nonnormal sample, use of instruments normed for children rather than adults, invariability of measures, and low correlations between variables). However, the lack of fit may be due to real differences between native English speakers and English language learners, including differences in the origins of their reading problems (e.g., lack of opportunities to learn, learning disabilities; Nanda et al., 2010).

Last, Mellard, Fall, and Woods (2010) hypothesized and tested a path model of reading comprehension, estimating the magnitude of significant connections between such reading components as phonemic decoding, word reading, fluency, vocabulary, language comprehension, auditory working memory, rapid automatic naming, and reading comprehension. Mellard's data were from a more diverse sample of ABE/ASE learners compared to the other adult literacy models. Furthermore, his sample spanned the breadth of adult education program enrollee skill levels—virtually nonliterate to secondary level. Although this model identified 11 significant paths among the hypothesized cause–effect relationships, the nonsignificant paths seemed to indicate that ABE/ASE learners had not developed or acquired the ability and strategies required to integrate their word reading skills with vocabulary knowledge and other language comprehension skills for the purpose of reading comprehension (Mellard et al., 2010). Collectively, these adult literacy models guided our selection of the reading components and cognitive abilities included in the present analysis.

Literacy Skills Among At-Risk Young Adults

A relatively unexamined segment of adults with low literacy are those who are economically and educationally disadvantaged young adults. At-risk young adults are important for intervention developers to better understand because improvements to their literacy have the potential for long-lasting economic, social, and personal impact (e.g., McCracken & Murray, 2009; NRC, 2012). Job Corps, the nation's largest career and technical education program serving disadvantaged young adults, is a catchment site for just such individuals.

Job Corps students are twice as likely to have low literacy as their age peers, and only 40% of students, including those with high school diplomas, have sufficient reading skills to qualify for a GED preparation course (Burghardt et al., 2001; Glazerman, Schochet, & Burghardt, 2000). Although Job Corps primarily provides occupational skills instruction, basic literacy skills are necessary preconditions that often must be instructionally addressed with incoming students (Brandsma & Nijhof, 1999; Pearson et al., 2010).

In our previous analysis of Job Corps student literacy (Mellard et al., 2012), we assigned each student to one of four fluency groups. The fluency groups were formed based on median splits by total words read per minute (150.8) and word error rates (7.5). For comparison—while recognizing differences in the reading tasks and texts—at the completion of eighth grade, a reader with 151 words correct per minute (wcpm) ranks at the 50th percentile, and a reader with 177 wcpm ranks at the 75th percentile (Hasbrouck & Tindal, 2006). The NAAL Fluency Addition, which described ORF among the U.S. adult population across a wide range of proficiencies (Baer, Kutner, & Sabatini, 2009), offers another point of comparison. Of U.S. adults, 29% have basic prose reading competency and average 143 wcpm (SE = 0.9), and 44% are classified as intermediate readers who average 166 wcpm (SE = 0.7). Thus, the adult sample in the present study, on average, may be expected to have at least basic-level literacy skills.

Adults with basic-level literacy would likely be able to perform simple, everyday literacy tasks. These tasks include such activities as finding in a pamphlet for prospective jurors an explanation of how people were selected for the jury pool (White & Dillow, 2005). They would perhaps be able to perform moderately challenging literacy tasks such as consulting reference materials to determine which foods contain a particular vitamin, but unlikely to perform complex tasks of integrating information across documents. In some cases they might be able to participate in challenging literacy tasks, such as comparing viewpoints in two editorials or interpreting a table about blood pressure, age, and physical activity.

The four groups in our study consisted of slow and accurate (SA) readers, slow and inaccurate (SI) readers, fast and accurate (FA) readers, and fast and inaccurate (FI) readers. On individual measures of reading component skills, the SA readers' greatest strengths were phonetic skills and nonreading tasks and their greatest weaknesses were rate-related activities (e.g., word reading efficiency and rapid naming tasks). SI readers had strong abilities in listening comprehension, information, and picture vocabulary, and their least demonstrated ability was with word-level skills. FA readers' greatest strengths were word-level skills and phonemic awareness, whereas their greatest weaknesses were listening comprehension, information, and picture vocabulary. FI readers were strongest in sight word reading, rapid naming, and reading comprehension, yet scored near or below the sample mean in information, vocabulary, and elision tests. Results from this study correspond with our study of adult literacy learners, which concluded that adults who read at comparable correct word rates vary significantly in total words read and word error rates; therefore, fluency-based assessments could be an efficient and effective way to determine adult learners' literacy instruction needs (Mellard, Anthony, et al., 2011).

A question that remains is this: What constructs best predict the four reading fluency groups among at-risk young adults participating in Job Corps education and technical training? Predictive constructs may then be extended to decisions about the best instructional emphases for each group. Therefore, the purpose of this study is to explore what the predictive constructs may be and how they relate to the four fluency groups.

Method

Study Design

This exploratory study used principal axis factoring (PAF) to identify a smaller set of generally uncorrelated variables from a larger set of mostly correlated variables. Furthermore, these factors were used in multiple regression analyses to determine how well they predict functional reading levels in four instructional groups formed on the basis of a two-dimensional measure of ORF. We chose factors over individual measures for these analyses because factors represent underlying constructs and offer some control for measurement error, even in an exploratory study, whereas individual measures reflect individual task performance and lower reliability.

Sample

The study sample was drawn from career and technical education students at a Job Corps center in the Midwest. More than 1,000 students with economic or educational difficulties attend this center each year to study carpentry, cement masonry, culinary arts, health occupations, home building, painting, welding, business office and finance, and transportation and communications. This Job Corps center already participated in a design study that was sponsored by the U.S. Department of Education Institute for Educational Science (Mellard, 2007). Job Corps admits low-income students who are U.S. citizens or permanent residents, between the ages of 16 and 24, and need education, vocational training, or counseling and assistance to complete high school/GED or to secure and maintain employment. Approximately 75% of students do not have a high school diploma when they enter Job Corps (U.S. Department of Labor [DOL], 2005). In addition, Job Corps requires written consent from a parent or guardian if the student is a minor and a child care plan when necessary. Students cannot have behavioral problems that would prevent them from adequate participation and success in Job Corps programs, cannot have required face-to-face or institutional supervision or court-imposed fines during their enrollment, and cannot use illegal drugs (DOL, 2005). Typically, Job Corps students are 19 years old on average, have a reading level of the seventh grade, come from disadvantaged families, and have never held full-time jobs (DOL, 2005).

The study sample was composed of 290 interested Job Corps students for whom we had complete data on the assessed variables. Participants received a $50 incentive to complete the assessment battery. All participants signed a consent form, and parental/guardian permission was obtained for individuals younger than 18 years of age.

The demographic composition of the sample was 32% female; 39% African American, 43% White, and 10% multiracial, with only a few Hispanic and Native American participants. The average participant was 19.75 years old. This demographic composition was representative of the participating Job Corps program's enrollment. Underlying reading skills and abilities of the sample are described in Table 1.

Measures

Dependent measures. To assess reading comprehension we used two measures: CASAS Reading Test Level C–Advanced Basic Skills subtest (CASAS, 2004) and TABE reading placement scores (CTB/McGraw-Hill, 1996). The U.S. Department of Education National Reporting System (NRS) accepts either of these tests as roughly equivalent criterion measures of educational functional levels (U.S. Department of Education, 2001). Adult education programs use NRS levels for instructional placement and monitoring learning gains. Among our sample, the correlation between CASAS and TABE scores for the sample was moderately strong ($r = .65$).

The CASAS assesses functional life skill needs of adults and youth (CASAS, 2004). The reading assessment, in particular, measures employment-related abilities using documents, signs, charts, forms, procedures, reading passages, and other realistic presentations (e.g., a pay stub, driving directions map, script for customer service representatives). Examinees must scan, locate detail, interpret, analyze, and/or evaluate these presentations and then answer multiple-choice questions. Criterion-related validity for this assessment system includes a clear monotonic relationship with the GED, and for the ACT Work Keys assessment Pearson correlation coefficients are .71 for reading and .70 for math.

Likewise, the TABE is designed to assess skills in important adult contexts such as life skills, work, and education. Examinees demonstrate their mastery of language skills (e.g., grammar, punctuation, and sentence structure) using authentic stimuli. The reading assessment, in particular, measures ability to recall and recognize information; make inferences; and evaluate documents and forms that are familiar in adult life, published fiction and nonfiction passages, and reference and consumer materials. The items assess ability to recognize signs and words and the ability to understand word, context, phrase, sentence, and passage meanings. Reliabilities for the TABE reading placement scores are .91 to .92, depending on the form and level of assessment (CTB/McGraw-Hill, 2004).

Classification measure. To measure ORF we used total words per minute (twpm) and word errors per minute (wepm) with two sixth-grade expository passages and the error scoring criteria from the Qualitative Reading Index (QRI; Leslie & Caldwell, 2001). Typically, the QRI is administered until the reader reaches a maximum level of comprehension; however, for this study, we measured all students at a fixed level of difficulty. The sample's expected median reading level was seventh grade (based on national Job Corps descriptive statistics; DOL, 2005). Therefore, we chose passages that were slightly below that and corresponded to sixth grade in reading difficulty. In addition, sixth grade passages resemble adult reading tasks, such as reading the newspaper. The first passage depicted Margaret Mead's work in anthropology and had a lexile score of 660L, whereas the second passage discussed trash-handling methods and had a lexile score of 710L. Given our choice to administer the assessment at a fixed level, no external information is available to describe the technical adequacy of this instrument.

Independent measures. We elected to use measures of six major constructs found in the large body of K–12 reading research and in recent research of adults with low literacy or dyslexia. We selected 18 measures, three each for (a) phonological processing, (b) word reading, (c) spelling, (d) vocabulary, (e) processing speed, and (f) cognitive ability.

To represent the students' phonological processing skills and abilities, which are widely understood to be important contributors to reading ability, we used three subtests from the *Woodcock–Johnson III* (WJ3) *Test of Achievement* and *Test of Cognitive Abilities* (Woodcock McGrew, & Mather, 2001a, 2001b): Sound Blending ($r = .91$), Incomplete Words ($r = .90$), and Word Attack ($r = .83$).

To describe the students' word reading skills and abilities, we selected subtest measures from three standardized tests: WJ3 Letter-Word Identification ($r = .79$–$.96$), *Wide Range Achievement Test–4* (WRAT; Wilkinson, 2006) Word Reading ($r = .73$–$.88$), and *Test of Word Reading Efficiency* (TOWRE; Torgesen, Wagner, & Rashotte, 1999) Sight Word Efficiency ($r = .82$–$.94$).

Because of the strong evidence on the relationship between word decoding (i.e., reading) and encoding (i.e., spelling; Vellutino, Tunmer, Jaccard, & Chen, 2007), we also opted to include in our analyses three standardized

Table 1. Descriptive Statistics for Raw and Standard Scores.

	Raw Score		Standard Score	
Variable	*M*	*SD*	*M*	*SD*
WJ Sound Blending	22.7	4.5	94.0	13.9
WJ Incomplete Words	25.3	4.2	99.1	14.1
WJ Word Attack	23.1	5.8	89.5	11.5
WJ Letter-Word Identification	61.9	6.9	89.0	10.6
WRAT Word Reading	51.8	7.7	87.1	11.9
TOWRE Sight Word Efficiency	80.5	12.2	84.5	10.5
PPVT	185.7	18. 6	90.1	12.9
WJ Picture Vocabulary	28.9	3.7	86.9	9.1
WJ Reading Vocabulary	37.9	7.3	85.9	9.8
WIAT Spelling	37.5	6.6	91.3	13.7
WJ Spelling	42.1	7.0	91.6	13.8
WRAT Spelling	36.8	6.8	90.5	12.8
WJ Numbers Reversed	13.2	3.5	87.1	15.1
WJ Auditory Working Memory	24.0	6.4	91.0	15.0
WAIS Letter-Number Sequencing[a]	18.3	2.8	8.6	2.0
CTOPP Rapid Letter Naming	23.4	5.2	—	—
WJ Decision Speed	35.0	4.9	94.7	15.3
WJ Rapid Picture Naming	113.1	10.6	93.6	15.4
CASAS Reading[b]	26.9	5.9	230.2	8.8
Slow Accurate	26.6	5.2	—	—
Slow Inaccurate	23.3	5.9	—	—
Fast Accurate	30.8	4.3	—	—
Fast Inaccurate	27.1	4.7	—	—
TABE Reading[c]	—	—	569.5	51.3
Slow Accurate	—	—	569.0	40.7
Slow Inaccurate	—	—	538.2	47.4
Fast Accurate	—	—	599.5	45.9
Fast Inaccurate	—	—	576.0	45.6

Note. $N = 290$. CASAS = *Comprehensive Adult Student Assessment System*; CTOPP = *Comprehensive Test of Phonological Processing*; PPVT = *Peabody Picture Vocabulary Test*; TABE = *Test of Adult Basic Education reading placement scores*; TOWRE = *Test of Word Reading Efficiency*; WAIS = *Wechsler Adult Intelligence Scale*; WIAT = *Wechsler Individual Achievement Test*; WJ = *Woodcock–Johnson III Test of Achievement* and *Test of Cognitive Abilities*; WRAT = *Wide Range Achievement Test–4*.
[a]Scaled rather than standard score reported for this measure.
[b]Scores represent the CASAS published scoring scales.
[c]Scores represent the TABE published scoring scales.

subtests of spelling achievement from the WJ3 (Woodcock et al., 2001a; $r = .83–.93$), the WRAT (Wilkinson, 2006; $r = .80–.92$), and the second edition of the *Wechsler Individual Achievement Test* (WIAT; Harcourt Assessment Company, 2002; $r > .85$).

Based on our prior findings about the importance of vocabulary to fluency, we included three measures of vocabulary (Mellard, Woods, et al., 2011). The *Peabody Picture Vocabulary Test* (4th ed.; PPVT; Dunn & Dunn, 2007) assesses receptive vocabulary ($r = .93–.97$). The WJ3 Picture Vocabulary subtest (Woodcock et al., 2001a) assesses language development and lexical knowledge by pointing out or naming pictures ($r = .70–.93$). The WJ Reading Vocabulary subtest (Woodcock et al., 2001a) measures lexical knowledge and reading comprehension by orally saying synonyms, antonyms, and analogies for written words ($r = .67–.89$).

Reading theory associates fluent reading with processing speed or automaticity. We elected to measure this automaticity construct with two WJ3 (Woodcock et al., 2001b) subtests—Decision Speed ($r = .87$) and Rapid Picture Naming ($r = .97$)—along with the *Comprehensive Test of Phonological Processing* (CTOPP; Wagner, Torgesen, & Rashotte, 1999) Rapid Letter Naming ($r = .86$) subtest.

Interest in underlying cognitive abilities, particularly those related to short-term and working memory, prompted us to include three such measures. We assessed students with the WJ3 (Woodcock et al., 2001b) Numbers Reversed ($r = .85$) and Auditory Working Memory ($r = .80$) subtests, as well as the WAIS Letter-Number Sequencing subtest (r = .87; Wechsler, 2008).

Administration Procedures

Graduate research assistants who were trained to criterion individually administered the assessments at the participating Job Corps site, with the exception of the TABE. For each student the assessment process required approximately 3.5 hours, divided between two sessions. Job Corps personnel administered the TABE as a routine program activity and made the data available to us. During individual assessments, the participants also completed a brief background and demographics questionnaire.

Data Analysis

PAF. We conducted PAF to determine the patterns of relationship among 18 individual measured variables from their raw scores. The proportion of variance in each measured variable that is shared with other measured variables in the data set is considered to estimate the communalities from the correlation matrix of those variables. Based on eigenvalues greater than 1.0 (Tabachnick & Fidell, 2007), we retained common factors for direct oblimin rotation. We eliminated variables without minimum contributions, a decision based on factor loadings less than .32.

We demonstrated that the four fluency groups significantly differed from one another on their CASAS, TABE, and factor scores through multiple pairwise comparisons using Bonferroni tests. Furthermore, we calculated and plotted scaled scores for each measure by group to visually inspect the similarities and differences among the groups' skills. These scores were scaled to a mean of 0 (zero). For CASAS and TABE, the standard deviations equal 1; for the factor scores, the standard deviations equal the squared multiple correlation between factors and the variables in the factor.

Multiple regression analyses. To determine the predictive utility of the factors, we used them as independent variables in multiple regression analyses. We used a stepwise approach to multiple regression, choosing the variables with the strongest empirical associations with the criterion measures. Because of differences between the CASAS and TABE tasks, we performed one set of analyses in which the CASAS score was the dependent (criterion) variable, and a second set in which the TABE score was the dependent variable.

Each set of analyses considered the factors' predictive utility for the total sample and the four fluency groups. The sample is fairly heterogeneous and represents the full range of skills and abilities in our study population. The defined fluency groups represent truncated distributions with restricted score ranges and thus less predictive utility. However, we expected the fluency groups to be informative for understanding students' targeted instructional needs.

Results

PAF Results

PAF yielded a total explained variance of 62.7% with four factors whose eigenvalues were greater than 1.0. The proportion of variance in each independent variable estimates the communalities from the correlation matrix of the measured variables. The PAF identified four factors, which we labeled (a) Encode/Decode, (b), Vocabulary, (c) Processing Speed, and (d) Working Memory. Encode/Decode accounted for 44.5% of variance, Vocabulary accounted for 9.5%, Processing Speed accounted for 5.2%, and Working Memory accounted for 3.5%—for a total of 62.7% of the variance.

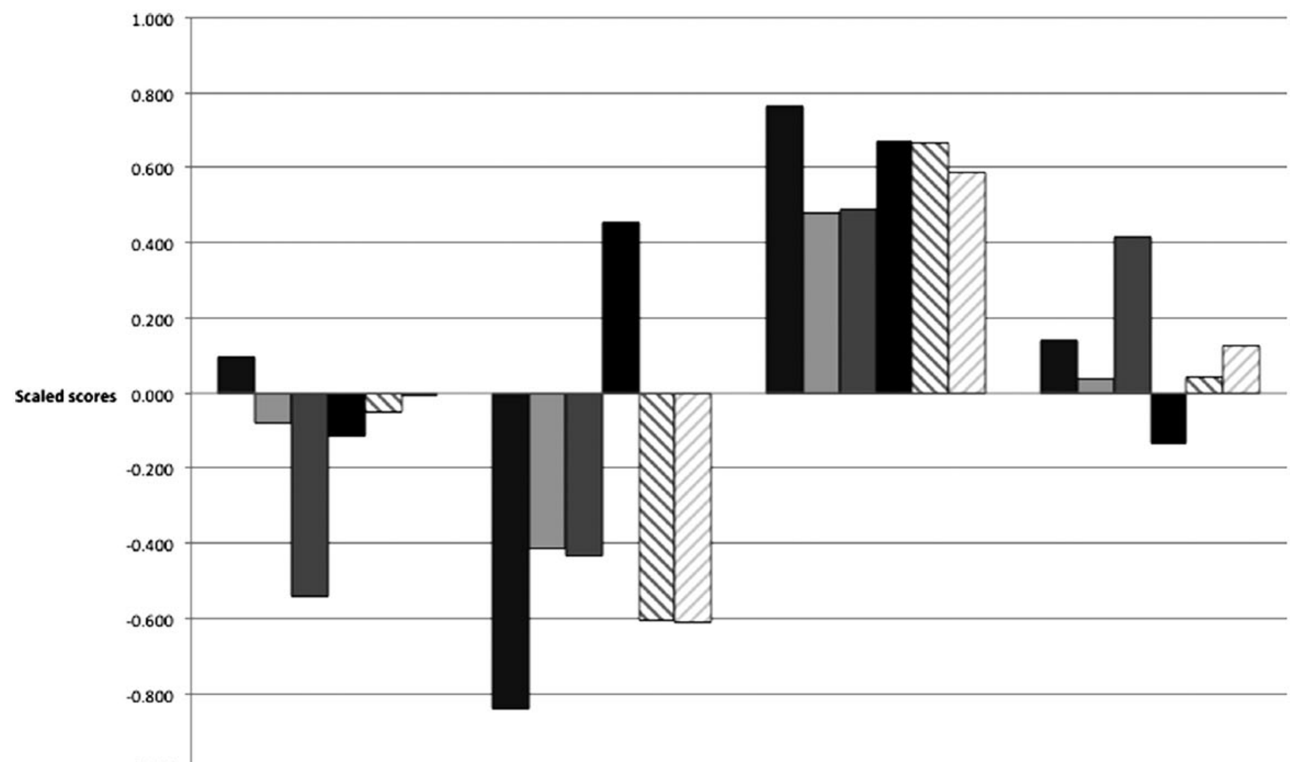
The first component, Encode/Decode (44.5% of variance), combined word spelling and recognition tasks. The factor was composed of seven measures: WRAT Spelling (λ = .90), WJ3 Spelling (λ = .85), WIAT Spelling (λ = .85), WRAT Word Reading (λ = .79), WJ3 Letter-Word Identification (λ = .78), WJ3 Word Attack (λ = .77), and TOWRE Sight Word Efficiency (λ = .52), which was a cross-loading variable with Processing Speed. In this PAF, the Encode/Decode component accounted for almost 5 times the amount of variance (44.5%) than the second component, Vocabulary.

The second component, Vocabulary (9.3% of variance), was composed of vocabulary and phonemic variables. The five measures loaded to this factor as follows: WJ3 Picture Vocabulary (λ = .85), PPVT (λ = .75), WJ3 Reading Vocabulary (λ = .59), WJ3 Incomplete Words (λ = .53), and WJ3 Sound Blending (λ = .37).

The third component, Processing Speed (5.1% of variance), was composed of two of the three expected speed variables and a cross-loading variable associated with efficient word reading. Specifically, the CTOPP Rapid Letter Naming (λ = .70), WJ3 Rapid Picture Naming (λ = .48), and TOWRE Sight Word Efficiency (λ = .60) loaded to this factor. Not included was the Decision Speed variable, which loaded to the Working Memory factor.

The fourth component, Working Memory (3.7% variance), was composed of WAIS Letter-Numbering Sequencing (λ = .68), WJ3 Auditory Working Memory (λ = .63), WJ3 Numbers Reversed (λ = .58), and WJ Decision Speed (λ = .32).

All 18 of the individual measures were retained and represented in the four factors. That is, they all had pattern matrix loadings greater than .32. The factors had only moderate to low correlations with one another. Encode/Decode correlated with Vocabulary at r = .31, Processing Speed at



	Slow Accurate	Slow Inaccurate	Fast Accurate	Fast Inaccurate
Encode/Decode	0.096	-0.839	0.765	0.142
Vocabulary	-0.081	-0.417	0.480	0.040
Processing Speed	-0.541	-0.431	0.489	0.414
Working Memory	-0.117	0.456	0.673	-0.132
CASAS Reading	-0.050	-0.607	0.668	0.044
TABE Reading	-0.009	-0.610	0.586	0.127

Figure 1. Factors and criterion measures scaled scores by fluency group.

r = .24, and Working Memory at r = .46. Vocabulary correlated with Processing Speed at r = .19 and Working Memory at r = .53. Processing Speed correlated with Working Memory at r = .24.

Group Comparisons on Instructional Placement Scores and Factor Scores

Bonferroni comparisons of the four fluency groups demonstrated statistically significant differences from one another on the both the CASAS and TABE, except for SA and FI. These two groups performed similarly on both reading comprehension measures (p = 1.0). Likewise, on the Encode/Decode, Vocabulary, and Working Memory factors, SA and FI had similar scores (p = 1.0), whereas all other group comparisons demonstrated significant differences. For Processing Speed, two pairs of fluency groups were similar (p = 1.0), SA and SI, and FA and FI. Figure 1 presents the scaled scores for each factor, CASAS and TABE by fluency group for a visual representation of the similarities and differences among the groups.

Predicting Reading Comprehension: Multiple Regression Results

Table 2 summarizes the regression analyses conducted with the whole sample and then separately with four reading fluency groups using CASAS and TABE scores as the dependent variables.

For the total sample, factors that predicted the most variance in functional reading when measured by the CASAS reading assessment were Working Memory (β = .397), Encode/Decode (β = .237), and Vocabulary (β = .173). These factors explained 45.9% of the variance in CASAS

Table 2. Summary of Stepwise Regression Analyses for Factors Predicting CASAS and TABE Scores in Total and by Fluency Groups.

	Comprehensive Adult Student Assessment System (CASAS) Reading				Test of Adult Basic Education (TABE) Reading		
	B	β	Adj. R^2		*B*	β	Adj. R^2
Total sample (*N* = 290)							
Constant	26.85			Constant	569.47		
Step 1[a]			.405	Step 1			.384
Working Memory	4.27	.638		Vocabulary[j]	33.91	.622	
Step 2[b]			.443	Step 2[k]			.471
Working Memory	3.37	.505		Vocabulary	27.61	.506	
Encode/Decode	1.43	.240		Encode/Decode	16.70	.319	
Step 3[c]			.459				
Working Memory	2.65	.397					
Encode/Decode	1.42	.237					
Vocabulary	1.07	.173					
Slow accurate group (*n* = 50)							
Step 1[d]			.457	Step 1[l]			.258
Constant	27.05			Constant	570.82		
Working Memory	4.23	.684		Vocabulary	22.30	.523	
Slow inaccurate group (*n* = 97)							
Step 1[e]			.163	Step 1[m]			.224
Constant	24.80			Constant	549.30		
Working Memory	3.30	.415		Vocabulary	26.74	.482	
				Step 2[n]			.295
				Constant	554.92		
				Vocabulary	23.43	.422	
				Processing Speed	16.21	.286	
				Step 3[o]			.323
				Constant	557.73		
				Vocabulary	17.41	.314	
				Processing Speed	13.45	.238	
				Working Memory	14.30	.224	
Fast accurate group (*n* = 86)							
Step 1[f]			.431	Step 1[p]			
Constant	28.14			Constant	583.21		.416
Working Memory	3.90	.662		Vocabulary	33.98	.650	
Step 2[g]			.500	Step 2[q]			.445
Constant	28.21			Constant	573.10		
Working Memory	2.58	.438		Vocabulary	31.35	.600	
Encode/Decode	1.71	.352		Encode/Decode	14.86	.196	
Step 3[h]			.524	Step 3[r]			.468
Constant	27.46			Constant	580.03		
Working Memory	2.25	.382		Vocabulary	30.66	.587	
Vocabulary	1.66	.340		Encode/Decode	14.24	.188	
Encode/Decode	1.30	.184		Processing Speed	−12.50	−.169	
Fast inaccurate group (*n* = 63)							
Step 1[i]			.162	Step 1[s]			
Constant	24.47			Constant	574.83		.270
Working Memory	2.71	.419		Vocabulary	28.70	.531	

(continued)

Table 2 . (continued)

	Comprehensive Adult Student Assessment System (CASAS) Reading				Test of Adult Basic Education (TABE) Reading		
	B	β	Adj. R^2		*B*	β	Adj. R^2
				Step 2[t]			.304
				Constant	573.01		
				Vocabulary	27.0.1	.500	
				Encode/Decode	13.27	.214	

[a]Partial correlations for the three excluded variables in CASAS total sample Step 1 were Encode/Decode (ED), Vocabulary (V), and Processing Speed (PS), .258, .178, .107, respectively.
[b]Partial correlations for the two excluded variables in CASAS total sample Step 2 were V and PS, .180, .063, respectively.
[c]Partial correlation for the one excluded variable in CASAS total sample Step 3 was PS, .061.
[d]Partial correlations for the three excluded variables in CASAS Slow Accurate Step 1 were ED, V, PS, .028, –.150, –.015, respectively.
[e]Partial correlations for the three excluded variables in CASAS Slow Inaccurate Step 1 were ED, V, PS, .089, .203, .159, respectively.
fPartial correlations for the three excluded variables in CASAS Fast Accurate Step 1 were ED, V, and PS, .250, .362, –.158, respectively.
[g]Partial correlations for the two excluded variables in CASAS Fast Accurate Step 2 were ED and PS, .247, –.122, respectively.
[h]Partial correlation for the one excluded variable in CASAS Fast Accurate Step 3 was PS, –.109.
[i]Partial correlations for the three excluded variables in CASAS Fast Inaccurate Step 1 were ED, V, PS, .250, .060, –.124, respectively.
[j]Partial correlations for the three excluded variables in TABE total sample Step 1 were ED, PS, Working Memory (WM), .379, .186, .261, respectively.
[k]Partial correlations for the two excluded variables in TABE total sample Step 2 were PS and WM, .097, .108, respectively.
[l]Partial correlations for the three excluded variables in TABE Slow Accurate Step 1 were ED, PS, WM, .241, .103, .168, respectively.
[m]Partial correlations for the three excluded variables in TABE Slow Inaccurate Step 1 were ED, PS, WM, .225, .320, .284, respectively.
[n]Partial correlations for the two excluded variables in TABE Slow Inaccurate Step 2 were ED and WM, .164, .222, respectively.
[o]Partial correlation for the one excluded variable in TABE Slow Inaccurate Step 1 was ED, .091.
[p]Partial correlations for the three excluded variables in TABE Fast Accurate Step 1 were ED, PS, WM, .250, –.233, .117, respectively.
[q]Partial correlations for the two excluded variables in TABE Fast Accurate Step 2 were PS and WM, –.229, .061, respectively.
[r]Partial correlation for the one excluded variable in TABE Fast Accurate Step 3 was WM, .086.
[s]Partial correlations for the three excluded variables in TABE Fast Inaccurate Step 1 were ED, PS, WM, .250, –.059, .093, respectively.
[t]Partial correlations for the two excluded variables in TABE Fast Inaccurate Step 2 were PS and WM, –.018, .012, respectively.

scores. When functional reading was measured by the TABE reading assessment, the most predictive factors were Vocabulary (β = .506) and Encode/Decode (β = .319). These two factors explained 47.1% of variance in TABE scores. Although a similar amount of variance was explained for both the CASAS (45.9%) and TABE (47.1%), the contribution of the respective components varied, which suggests that different skills and abilities contribute to the respective reading comprehension scores.

For three of the four fluency groups the best predictor of CASAS scores was Working Memory alone. For SA readers, 45.7% of variance was explained by this single factor (β = .684). For SI and FI readers, Working Memory was the only significant factor (β = .415 and β = .419, respectively), yet explained very little of the variance (16.3% and 16.2%, respectively). Only the FA group regression had a contribution from multiple factors, which explained 43.1% of variance. As with the other fluency groups, Working Memory made the greatest contribution (β = .382), followed by Vocabulary (β = .340) and Encode/Decode (β = .184).

Predicting TABE scores by fluency group involved a variety of factors. Only 25.8% of the SA group variance was predicted by Vocabulary (β = .523), the only significant factor. Slightly more (32.3%) of the variance among the SI group TABE scores was predicted by Vocabulary (β = .314), Processing Speed (β = .238), and Working Memory (β = .224). Among the FA group, 46.8% of variance was explained by Vocabulary (β = .587), Encode/Decode (β = .188), and Processing Speed (β = –.169). Finally, the FI group variance of 30.4% was explained by two factors, Vocabulary (β = .500) and Encode/Decode (β = .214).

Discussion

Our results suggested the existence of four underlying factors that explain overall reading ability: Encode/Decode, Vocabulary, Processing Speed, and Working Memory. Encode/Decode was composed of various letter and word decoding and spelling measures, and therefore combined three of our anticipated constructs into a single factor. Because this factor is strongly influenced by the phonics and orthographic elements of efficient reading, one might expect readers' deficits in such areas could be addressed through carefully sequenced, explicit instruction with controlled practice.

The Vocabulary factor included the three expected vocabulary measures along with two word analysis measures (incomplete words and sound blending). This factor indicates a relationship between word reading abilities and knowing the meaning of words. Reader deficits in this factor may be instructionally addressed in instructional content. However, to improve reading ability in general, instruction may develop strategies for discovering word meanings (e.g., root words, context cues) in novel contexts.

The third factor, Processing Speed, was composed of two of the three expected timed measures (rapid letter and picture naming) as well as a measure of sight word reading efficiency. Not surprisingly, the sight word reading measure cross-loaded onto the Encode/Decode factor. Readers with deficits in this area may need practice in building automaticity. In child-based reading instruction, repeated readings are typically recommended.

Working Memory is a very different factor composed of auditory working memory, letter-number sequencing, number reversal, and decision speed measures. This factor includes measures that require careful attention, short-term memory, and manipulation of the information into organized response. Readers with deficits in these areas may need instruction in memory strategies and practice in mental manipulations.

Factor Contributions to CASAS and TABE

The importance of these factors is in their utility to predict reading performance strengths and identify weaknesses where instruction may be beneficial. We chose to examine the factors' usefulness with two criterion measures, the CASAS and the TABE, because prior studies suggested that these assessments require different strategies from the learners and measure different reading tasks (Cutting & Scarborough, 2006; Hock & Mellard, 2005; Keenan & Betjemann, 2006). Indeed, although the R^2 values were comparable, .459 for the CASAS and .471 for the TABE, we found very different factor contributions for each criterion. The CASAS was best predicted by a model incorporating the Working Memory, Encode/Decode, and Vocabulary factors (see Table 2). In this sample, Working Memory had the greatest weight, .397. Alternatively, TABE was best predicted by the Vocabulary and Encode/Decode factors, with regression weights of .506 and .319, respectively. Working memory, which involves holding information in short-term storage and manipulating that information, was very important to the CASAS tasks, but did not contribute to the TABE score. For the TABE, a reader's vocabulary knowledge was the most significant contributor. One might speculate that the knowledge one brings to the task, especially vocabulary knowledge, is much more important for success on the TABE, whereas on the CASAS, word recognition skills and vocabulary knowledge are less important.

The different factor models for CASAS and TABE have implications for adult literacy programs. Alignment of instruction with the criterion measure is key to helping students achieve learning gains. However, the current practice in adult education is to place students in instruction and monitor their progress using several roughly equivalent measures of educational functioning levels from the U.S. Department of Education's NRS. These two factor models demonstrate that although students' CASAS and TABE scores correlate ($r = .65$), the two assessments measure different underlying component skills. Students assessed using the CASAS must draw on Working Memory (e.g., attention to detail, short-term memory, and manipulation of the information into organized response) to demonstrate their functional literacy abilities. Alternatively, if student progress is measured by the TABE, then Vocabulary needs to be instructionally emphasized.

Fluency Group Factor Profiles

General instructional statements, however, are not sufficient in adult literacy program contexts. Such programs work with learners who have a variety of reading strengths and weaknesses. A simple fluency grouping approach in connection with the factors identified here suggest some further instructional refinements that can target specific instructional needs.

For learners that are working to improve on a CASAS reading score, as we said in general, Working Memory is important. However, continued reliance on Working Memory alone will not help adults with low literacy advance to mature reading. The FA reader group presents a picture of more mature functional reading, in which a balanced reliance on Working Memory, Vocabulary, and Encode/Decode abilities are evident. Thus, word reading, spelling, and word meanings are important instructional emphases for the SA, SI, and the FI readers. Processing Speed does not appear to be important, and thus is not an area for instructional emphasis when CASAS is the criterion measure.

For learners to improve on a TABE reading score, the predictive and instructional scenarios are more diverse. Reliance on Vocabulary knowledge is evident among all groups. However, to move from low literacy to mature reading ability, these readers need to integrate their reliance on Vocabulary with Encode/Decode and Processing Speed abilities. The FA readers demonstrated heavy reliance on Vocabulary with some contribution from Encode/Decode and an inverse relationship with Processing Speed. The FI readers lacked this Processing Speed element. We speculate that the later group may have been reading too rapidly and sacrificed accuracy as well as understanding. The SI group, on the other hand, relied on Vocabulary, Processing Speed, and Working Memory. Their inaccuracy is consistent with Encode/Decode deficits. The SA readers relied solely on Vocabulary and have apparent deficits in Encode/Decode, Processing Speed, and Working Memory. When TABE is the criterion measure, more tailored instructional approaches seems to be necessary.

Limitations and Future Research

This sample represents a specific at-risk population with a restricted age and skill ranges, and therefore generalization must be done cautiously. Likely, the general population median ORF measures are not equivalent to our sample's medians, and therefore an optimal cutoff score for the distinction between slow and fast readers, as well as for accurate and inaccurate readers, could improve classification accuracy and tailored instruction. The NAAL's nationally representative sample of the adult population reported fluency as a total correct words read per minute metric and did not separately consider word error rates as we did in this analysis. If word error rates could be identified in the NAAL data, we could replicate our analysis to find optimal cutoff scores for forming more generalizable and stable fluency groups, rather than using our sample's median rates.

Although our theoretical approach aims toward parsimony, future research might also consider examination of learners' fluidity with other tasks, such as writing or mathematics computation, which can be important in a functional literacy context. To some degree writing was represented in the present analysis in the spelling subtests, but needs to be further explored such as with tasks on syntactical structures and connected prose. Fluency rates in mathematics computation rely on similar cognitive processing components (e.g., short-term memory, working memory, speed of processing) but are not mediated through the principal language domains (e.g., phonics, semantic). Math computations often require a particular rule-based pattern, which may parallel the structure systems in prose, such as syntactic structure.

Applied research could translate these findings into techniques to test how instructional placement based on ORF and other predictors actually improves outcomes in adolescent and adult education settings.

Conclusion

This exploratory study of 290 at-risk students participating in Job Corps career and technical education programs supports our hypothesis that instructional placement groups formed on the basis of a two-dimensional ORF measure are beneficial for adolescent and young adult instructional grouping and provide insight into the groups' underlying skills and abilities. Results of PAF and regression analyses indicate that the factors Encode/Decode, Vocabulary, Processing Speed, and Working Memory explain 62.7% of the total variance in scores and predict between 45.9% of the variance in functional reading measured by CASAS and 47.1% of the variance measured by TABE. From these findings, we conclude that these factors contribute important information regarding reading performance but also are lacking sufficient saturation to explain reading comprehension or accurately classify students into instructional groupings. The results support the need for understanding readers' performance as multiple components of reading skills and cognitive abilities, especially working memory and vocabulary.

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