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Decoding and Spelling Accommodations for Postsecondary Students with Dyslexia—It's More Than Processing Speed

Noel Gregg[1], Cheri Hoy, Donna Ann Flaherty, Peggy Norris, Christopher Coleman, Mark Davis, & Michael Jordan

University of Georgia

The vast majority of students with learning disabilities at the postsecondary level demonstrate reading decoding, reading fluency, and writing deficits. Identification of valid and reliable psychometric measures for documenting decoding and spelling disabilities at the postsecondary level is critical for determining appropriate accommodations. The purpose of this study was threefold: (a) to examine the relationship between specific Woodcock-Johnson III Cognitive and Achievement clusters (WJ III; Woodcock, McGrew, & Mather, 2001) across populations with and without dyslexia at the postsecondary level; (b) to identify the strongest WJ III cognitive predictors for decoding, spelling, and reading fluency across college students with and without dyslexia; and (c) to discuss the implications of the findings for assessment and accommodation practices for secondary and postsecondary students. A total of 101 college students with documented dyslexia and 100 college students without disabilities participated in the study. Both word knowledge and processing speed were found to significantly influence performance in very different ways.

Key Words: Decoding, Spelling, Postsecondary Education, Accommodations

Understanding the cognitive and linguistic processes impacting the performance of young adults with reading and written expression disorders is critical from both a pedagogical and an advocacy perspective. The atmosphere today around higher education and disabilities is extremely litigious (Gregg & Scott, 2000; Pitoniak & Royer, 2001). Since the passage of the Rehabilitation Act (Section 504, 1973) and the Americans with Disabilities Act (ADA; 1990), measurement specialists, psychometricians, educators, and consumers have debated issues of reliability and validity related to accurate measures for supporting accommodation requests.

The vast majority of students with learning disabilities are those with reading disabilities or dyslexia (Bruck, 1992; Gregg, Coleman et al., 2002; Shaywitz et al., 1998). Research has shown that such students do not outgrow dyslexia; it is a persistent and chronic problem (Bruck, 1992; Gregg, Coleman et al., 2002; Shaywitz et al., 1998; Shaywitz & Fletcher, 1999). Converging scientific evidence documents that students with dyslexia become increasingly more accurate in reading as they progress in school, but continue to demonstrate problems with reading and writing fluency (McGrew, Woodcock, & Ford, 2002). In a longitudinal study, Shaywitz et al. (2002)

1. Please address correspondence to Noel Gregg, Ph.D., UGA, RCLD, 339 Milledge Hall, University of Georgia, Athens, GA 30602. Email: ngregg@uga.edu

demonstrated a functional disruption in individuals with dyslexia in the neural systems responsible for fast, automatic reading. Therefore, there is strong epidemiologic evidence of the persistence of reading disabilities, as well as behavioral and biological validation of the lack of reading and writing fluency (Shaywitz et al., 2002). In fact, recent research has documented that reading fluency is the single best discriminator between college students with and without dyslexia (McGrew et al., 2002).

The Woodcock-Johnson III (Cognitive and Achievement Clusters) is one of the batteries most frequently used to support requested accommodations for students at the postsecondary level. The addition of many new clusters (i.e., Cognitive Efficiency, Cognitive Fluency, Achievement Fluency, Working Memory, Sound Awareness) provides valid and reliable measures of some of the most significant cognitive and linguistic processes documented as influencing reading and writing performance.

The purpose of this study was threefold: (a) to examine the relationship between specific WJ III cognitive abilities across samples with and without dyslexia; (b) to identify the strongest WJ III cognitive and linguistic predictors for decoding, spelling, and reading fluency across samples with and without dyslexia; and (c) to discuss the implications of the findings for assessment and accommodation practices for secondary and postsecondary students.

Method

Participants

Students demonstrating dyslexia. A total of 101 college students, all of whom spoke English as their primary language, were identified as demonstrating dyslexia at The University of Georgia Regents' Center for Learning Disorders (UGA-RCLD). The mean age of the group was 22.21, with a standard deviation of 4.26. Among participants in this group, 80% had a documented history of learning disorders prior to coming to the UGA-RCLD. Each was identified as demonstrating dyslexia based on the results of an evaluation process completed at the UGA-RCLD and in accordance with the Georgia Regents' criteria (Gregg, Heggoy, Stapleton, Jackson, & Morris, 1994). The psychometric measures used as dependent and independent variables were not part of the battery used for diagnostic purposes.

Evaluations included measures of overall ability, cognitive processing, oral language, achievement, and social-emotional functioning. Assessment instruments were selected on the basis of their psychometric properties and usefulness with the adult population. Members of an interdisciplinary team of experienced master's- or doctoral-level diagnosticians and psychologists individually administered tests used in the evaluation process. Clinical judgment was used to interpret test results as well as analyze error patterns, writing samples, and data obtained from informal assessment measures. Quantitative data included results from both standardized tests and informal measures with local norms. Qualitative data included information gathered from case histories, clinical interviews, and previous records that confirmed the chronicity of learning problems. Clinical judgment, as well as quantitative and qualitative data, was incorporated in a careful study of the performance of each individual participant. No diagnosis was made on the basis of a single test score or discrepancy between two measures; rather, they were based on patterns of problems and errors (Gregg & Scott, 2000). See Table 1 for descriptive information on the populations.

Table 1
Descriptive Information Across Students With and Without Dyslexia

	Normally Achieving (n = 100)		LD (n = 101)	
	M	*SD*	*M*	*SD*
Age	22.00	4.27	22.60	5.29
WAIS-III Full[1]	118.13	13.16	109.60	10.27
KAIT*	113.61	8.92	__	__
WRAT-III Reading[2]	113.35	5.64	101.62	9.27
WRAT-III Spelling	111.58	6.33	97.15	15.45
WJ III Picture Vocabulary[3]	102.09	11.19	99.25	11.22
WJ III Story Recall	107.80	12.97	100.93	12.77
WJ III Oral Comprehension	103.62	11.33	96.73	11.19

[1] Wechsler Adult Intelligence Scale-III (Wechsler, 1997).
[2] Wide Range Achievement Test (Reading, Spelling) (Wilkinson, 1993).
[3] Woodcock-Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2001).

Note. The normally achieving population was split in the administration of intelligence measures: 50 received the WAIS-III and 50 received the Kaufman Adult Intelligence Scale for Adolescence and Adults (Kaufman & Kaufman, 1997).

Normally achieving students. The sample of 101 students with no documented disabilities was recruited as volunteers from classes at The University of Georgia. Participants spoke English as a first language, had no known neurological impairments, had received no special education services with the exception of gifted education, and were either currently enrolled or had been enrolled within the past year in undergraduate or graduate college classes. The group mean age was 22 with a standard deviation of 4.27. See Table 1 for additional descriptive data.

Measures

Woodcock-Johnson Battery-Third Edition (Woodcock et al., 2001). The WJ III Cognitive Battery (COG) was standardized on individuals between the ages of 2 and 90+ (normative sample composed of 8,818 participants) and was co-normed with the WJ III Achievement Battery (ACH). The WJ III COG consists of a Standard (Tests 1-10) and an Extended (Tests 11-20) battery, with a total of 20 tests. The WJ III Standard Battery and select clusters and subtests were used for the purposes of this study. Reliability for all WJ III clusters is reported to be .90 or higher, and all individual tests have a reliability of .80 or higher (McGrew & Woodcock, 2001). Besides the WJ III Standard Battery, four additional clusters and three subtests were chosen as possible predictors of decoding and spelling performance. These clusters and subtests included the following.

WJ III Cognitive Efficiency Cluster-Extended. This cluster measures short-term memory and processing speed, as well as the influence of these abilities on the efficiency of cognitive performance (Gregg, Coleman, & Knight, 2003). The cluster is comprised of four subtests (i.e., Visual Matching, Numbers Reversed, Memory for Words, Decision Speed). The Cognitive Efficiency Cluster-Extended combines not only fluency, but efficiency across verbal and nonverbal modalities. Therefore, more associative memory, word knowledge, fluid reasoning, and speed abilities are measured. Recent research with the college population has identified the WJ III Cognitive Efficiency Cluster-Extended as contributing significantly to the performance of students with documented learning disabilities across cognitive and academic performance (Gregg & Coleman, 2001).

WJ III Cognitive Fluency Cluster. The importance of fluency to reading and writing performance has been supported by research on children (National Reading Panel, 2000). The WJ III Cognitive Fluency Cluster measures several of the language processes that have been identified as important predictors of reading and spelling fluency. The cluster is comprised of three subtests (i.e., Decision Speed, Retrieval Fluency, Rapid Picture Naming). Such processes like word recall, rapid picture naming and semantic organization, as measured by this cluster, might lead one to assume that the cluster would have significant predictive strength for decoding and spelling performance.

WJ III Working Memory Cluster. This cluster is comprised of two subtests (i.e., Numbers Reversed, Auditory Working Memory) that contribute to measuring the ability to hold information in immediate awareness while performing operations on it, a vital process for decoding and spelling. Research has supported the WJ III Working Memory Cluster as a factorially purer norm-based measure of the construct of working memory than other available measures (McGrew et al., 2002). The literature has supported the importance of phonological and orthographic working memory to the ability to decode and spell (Berninger, 1996; Torgesen, 1996).

WJ III Phonemic Awareness Cluster. The persistence of phonological and orthographic processing deficits among the college population demonstrating dyslexia has been well documented (Bruck, 1992; Hatcher, Snowling, & Griffiths, 2002; Holmes & Castle, 2001). The relationship between phonological and orthographic processing and reading and spelling performance has been the focus of extensive literature (Ehri, 1998; Frith, 1985). Phonemic Awareness on the WJ III consists of the Sound Blending and Incomplete Words subtests. Gregg et al. (2003) have noted that the different standard deviations of the Incomplete Words and Sound Blending subtests can result in a significant impact on scores for the college populations. These researchers cautioned that for some college students with reading and spelling difficulties, their scores were unexpectedly high on Incomplete Words, thus increasing their Phonemic Awareness Cluster scores.

WJ III Reading Fluency Subtest. The Reading Fluency subtest rather than the WJ III Academic Fluency Cluster was chosen because this subtest has a significantly larger standard deviation than either the Writing or the Math Fluency subtests that also comprise the WJ III Academic Fluency Cluster. Therefore, it appeared to be a better predictor of decoding and spelling. The Reading Fluency subtest was analyzed both as a predictor and a criterion since it is difficult to define it as simply a cognitive or an achievement measure.

WJ III Academic Subtests. To measure the reading of single words, the WJ III Word Attack (pseudowords) and Letter/Word Identification (real words) were given to all participants. To measure spelling, the WJ III Spelling of Sounds (pseudowords) and Spelling (real words) subtests were also administered.

Wide Range Achievement Test-3 (WRAT-3; Wilkinson, 1993). To obtain additional descriptive information, all participants were administered the WRAT-3 Reading and Spelling subtests. These measures of reading and spelling real words have a strong correlation with the WJ III Letter/Word Identification and Spelling subtests (McGrew & Woodcock, 2001). See Table 1 for academic descriptors.

Intelligence measures. To ensure that the populations were similar in general ability, all students with a diagnosis of dyslexia were also administered the Wechsler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997). Fifty of the normally achieving students were also administered the WAIS-III, the remainder were administered the Kaufman Adolescent and Adult Intelligence Scale (Kaufman & Kaufman, 1997). See Table 1 for cognitive ability descriptors.

WJ III Picture Vocabulary, Oral Comprehension, Story Recall Subtests. Each of these subtests was chosen as a measure of the oral language abilities for each group to obtain further descriptive information only. Vocabulary or word-level knowledge is strongly correlated with academic success (Perfetti, Marron, & Foltz, 1996). In addition, vocabulary competence appears to explain a large degree of the variance in the comprehension of different types of text (Bell & Perfett, 1994; Cunningham, Stanovich, & Wilson, 1990). The assessment of sentence and text-level oral language competence is much more difficult to measure psychometrically. The Oral Comprehension subtest on the WJ III provides a means to identify more sentence-level comprehension, whereas the Story Recall subtest, a recall task, provides a reliable way to measure oral comprehension at a text level. See Table 1 for descriptive information on language ability measures across groups.

Results

The goal of the correlation analyses performed in this study was to determine the relationship between the cognitive variables used across groups (i.e., students with and without dyslexia) prior to using them as predictors. The values of these correlations may be found in the combined correlation matrix in Table 2 between the WJ III Cognitive Clusters, Clinical Clusters (i.e., Working Memory, Phonemic Awareness, Cognitive Fluency), Performance Cluster (i.e., Cognitive Efficiency-Extended), and subtest (i.e., Reading Fluency) for students both with and without dyslexia. Since a significant number of bivariate correlations were conducted per group, the Bonferroni correction technique was applied to the $p = .01$ significance level in an effort to reduce the risk of type I errors. Therefore, in order to be considered statistically significant, the correlation between WJ III Cognitive Clusters required a p value of less than .01.

As noted on Table 2, very high correlations were found between the WJ III Cognitive Efficiency and Processing Speed (i.e., Numbers Reversed, Decision Speed). Similarly, very high correlations were noted between Cognitive Efficiency and Short-Term Memory (i.e., Numbers Reversed, Memory of Words), and Cognitive Efficiency-Extended (i.e., Visual Matching, Numbers Reversed, Decision Speed, Memory for Words) clusters for each sample. Many of the same subtests comprise these clusters. Therefore, to eliminate the number of predictors, we chose to use the WJ III Cognitive Efficiency-Extended cluster rather than the Processing Speed and/or Short-Term Memory clusters. Since three outliers were identified in the first correlation analysis, the data were run both with and without the outliers. However, no significant differences were identified without the outliers present, so they were kept for the final correlation findings.

The means, standard deviations, and level of significance across the WJ III cognitive, language, and achievement measures chosen for this study are represented for each group in Table 3. As noted, significant differences were found at the .01 level on all measures except the WJ III Oral Expression Cluster and the WJ III Picture Vocabulary subtest.

One of the main purposes of this study was to identify the strongest WJ III cognitive predictors of decoding and spelling in order to determine whether the same relationship was evident for both groups (students with and without dyslexia). The dependent variables were chosen from the WJ III as representing pseudoword decoding and spelling (i.e., Word Attack and Spelling of Sounds) and real word

Table 2

Correlations for Normally Achieving (NA) Students and Students with Dyslexia (DYS) on the WJ III Cognitive Clusters and WJ III Reading Fluency

		1	2	3	4	5	6	7	8	9	10	11
1	NA											
	DYS											
2	NA	.352**										
	DYS	.362**										
3	NA	.246*	.311**									
	DYS	.258*	.284**									
4	NA	.227*	.338**	.280**								
	DYS	.281**	.411**	.177								
5	NA	.752**	.160	.009	.117							
	DYS	.685**	.272**	.135	.210*							
6	NA	.842**	.394**	.364**	.251*	.280**						
	DYS	.790**	.280**	.237*	.203*	.098						
7	NA	.253*	.371**	.847**	.182	.004	.382**					
	DYS	.269**	.257*	.856**	.143	.040	.334**					
8	NA	.708**	.400**	.367	.274**	.233*	.844**	.333**				
	DYS	.723**	.375**	.289**	.367**	.148	.858**	.354**				
9	NA	.544**	.325**	.099	.055	.595**	.307**	.161	.287**			
	DYS	.482**	.396**	.181	.114	.692**	.077	.031	.144			
10	NA	.282**	.413**	.303**	.394**	.193	.268**	.326**	.292**	.280**		
	DYS	.198	.360**	.076	.601**	.274**	.043	.085	.153	.298**		
11	NA	.362**	.188	-.016	.057	.373**	.214*	.020	.203*	.376**	.119	
	DYS	.471**	.096	.157	.407**	.282**	.175	.290**	.515**	.144	-.034	

Note. 1 = WJ-3 Cognitive Efficiency, 2 = WJ-3 Long-Term Retrieval, 3 = WJ-3 Auditory Processing, 4 = WJ-3 Fluid Reasoning, 5 = WJ-3 Processing Speed, 6 = WJ-3 Short-Term Memory, 7 = WJ-3 Phonemic Awareness, 8 = WJ-3 Working Memory, 9 = WJ-3 Cognitive Fluency, 10 = WJ-3 Verbal Comprehension, 11 = WJ-3 Reading Fluency.

*Significant at the .05 level (2-tailed). **Significant at the .01 level (2-tailed).

Table 3
Means, Standard Deviations, and Significance Testing for the Woodcock-Johnson III (WJ III) Cognitive Clusters, Cognitive and Achievement Battery Subtests for Normally Achieving Students (NA) and Students with Dyslexia

	NA (*n* = 100)		LD (*n* = 101)	
	M	*SD*	*M*	*SD*
WJ III Verbal Comprehension*	107.75	10.56	99.53	9.97
WJ III Long-Term Retrieval*	114.50	12.84	109.37	12.70
WJ III Visual-Spatial Thinking*	108.42	9.31	101.92	12.03
WJ III Auditory Processing*	114.44	11.35	102.64	11.38
WJ III Fluid Reasoning*	109.31	9.17	102.78	10.58
WJ III Working Memory*	106.94	12.26	95.79	13.67
WJ III Cognitive Fluency	100.17	11.10	94.20	12.51
WJ III Cognitive Efficiency*	107.33	10.60	94.53	11.48
WJ III Phonemic Awareness*	112.52	10.27	102.37	10.17
WJ III Verbal Comprehension*	106.49	10.42	99.19	9.99
WJ III Visual-Auditory Learning*	102.80	9.27	91.80	11.22
WJ III Spatial Relations*	105.21	12.22	101.37	11.83
WJ III Sound Blending*	107.50	13.11	94.92	13.33
WJ III Concept Formation*	105.15	8.91	98.72	11.04
WJ III Visual Matching*	102.81	9.27	91.80	11.22
WJ III Numbers Reversed*	104.39	13.59	95.77	14.75
WJ III Letter-Word*	93.68	10.10	81.63	13.00
WJ III Word Attack*	104.54	7.90	91.83	14.50
WJ III Spelling*	108.11	10.30	91.62	13.30
WJ III Spelling of Sounds*	103.64	10.00	93.00	11.40
WJ III Reading Fluency*	106.64	9.10	92.14	10.15

* $p < .01$.

decoding and spelling (i.e., Letter-Word Identification and Spelling). To identify the predictors multiple-regression analysis provided a more favorable analysis of the WJ III Clusters and subtests. Results revealed strong, consistent predictors.

All possible regression analyses were completed using the entire sample. The best model from this set of variables for predicting decoding and spelling is represented on Tables 4 and 5. These independent variables were analyzed, and the subtests with the highest frequency of significance within the clusters were identified as the best model. Regression analyses were subsequently performed on this set of variables. Based on the results, the following WJ III Cognitive Clusters comprised the best-fit model for predicting decoding and spelling for the college population: Cognitive Efficiency-Extended; Long-Term Retrieval; Auditory Processing; Fluid Reasoning; Phonemic Awareness; Working Memory; Cognitive Fluency; and Verbal Comprehension.

Table 4
WJ III Decoding Predictors by Cognitive Clusters and WJ III Reading Fluency for Normally Achieving Students (NA) and Students with Dyslexia (DYS)

Dependent	Predictors	B		β		Sig.		R^2	
		NA	DYS	NA	DYS	NA	DYS	NA	DYS
Letter Word								.187	.431
	Cognitive Efficiency	.279	.189	.308	.153	.053*	.286		
	Long term Retrieval	-.106	.004	-.144	.004	.218	.972		
	Auditory Processing	.215	-.209	.258	-.191	.168	.262		
	Fluid Reasoning	-.040	.032	-.038	.028	.729	.807		
	Phonemic Awareness	-.017	.443	-.019	.359	.920	.041*		
	Working Memory	-.097	.093	-.128	.104	.375	.444		
	Cognitive Fluency	-.062	-.151	-.066	-.151	.586	.232		
	Verbal Comprehension	.249	.192	.273	.153	.017**	.164		
	Reading Fluency	-.011	.445	-.014	.430	.893	.000**		
Word Attack								.201	.430
	Cognitive Efficiency	.055	.516	.068	.408	.663	.005**		
	Long Term Retrieval	-.076	-.022	-.117	-.022	.310	.830		
	Auditory Processing	.034	-.051	.046	-.045	.803	.791		
	Fluid Reasoning	.053	.273	.057	.231	.603	.047*		
	Phonemic Awareness	.091	.415	.114	.328	.537	.061		
	Working Memory	.011	-.045	.017	-.048	.906	.720		
	Cognitive Fluency	-.198	-.191	-.240	-.186	.049*	.141		
	Verbal Comprehension	.287	-.185	.356	-.144	.002**	.191		
	Reading Fluency	.095	.277	.135	.261	.197	.015*		
Reading Fluency								.190	.418
	Cognitive Efficiency	.303	.230	.268	.193	.084	.177		
	Long term Retrieval	.066	-.204	.072	-.214	.531	.037*		
	Auditory Processing	-.107	-.193	-.103	-.182	.578	.284		
	Fluid Reasoning	.005	-.220	.004	-.198	.973	.086		
	Phonemic Awareness	-.011	.331	-.010	.278	.959	.108		
	Working Memory	-.039	.147	-.041	.169	.774	.213		
	Cognitive Fluency	.270	.478	.232	.494	.053	.000**		
	Verbal Comprehension	-.008	.144	-.007	.119	.951	.279		

*Significant at the .05 level (2-tailed). **Significant at the .01 level (2-tailed).

Results of the multiple-regression analyses indicated differing relationships between the clusters for the groups with and without dyslexia (see Tables 4 and 5). In particular, there was a significant difference in the R^2 across groups for the best fit model, labeled the Reading/Spelling model. The WJ III variables chosen for this study accounted for almost double the amount of variance for the population with dyslexia. For the population with dyslexia ($R^2 = .431$), the WJ III variables that best predicted the reading of real words was the WJ III Reading Fluency subtest ($p = .01$) while for the normally achieving students ($R^2 = .187$), it was the WJ III Cognitive Efficiency Verbal Comprehension ($p = .01$). For the reading of pseudowords, the best predictor for the population with dyslexia ($R^2 = .430$) was the WJ III Cognitive Efficiency-Extended ($p = .01$) while for the normally achieving students ($R^2 = .201$), it was the WJ III Verbal Comprehension ($p = .01$). When the WJ III Reading Fluency

Table 5
WJ III Spelling Predictors by Clusters and WJ III Reading Fluency for Normally Achieving Students (NA) and Students with Dyslexia

Dependent	Predictors	B		β		Sig.		R^2	
		NA	DYS	NA	DYS	NA	DYS	NA	DYS
Spelling								.254	.435
	Cognitive Efficiency	.195	.104	.175	.076	.247	.594		
	Long term Retrieval	-.099	.166	-.110	.146	.326	.165		
	Auditory Processing	.277	-.317	.272	-.260	.130	.135		
	Fluid Reasoning	-.118	.024	-.091	.019	.389	.868		
	Phonemic Awareness	-.065	.385	-.059	.285	.741	.110		
	Working Memory	-.005	.176	-.005	.174	.969	.193		
	Cognitive Fluency	-.233	.044	-.204	.040	.083	.751		
	Verbal Comprehension	.430	.117	.385	.084	.001**	.451		
	Reading Fluency	.184	.448	.188	.394	.064	.000**		
Spelling Sound								.243	.503
	Cognitive Efficiency	.141	.250	.170	.251	.266	.063		
	Long term Retrieval	-.026	.110	-.039	.138	.732	.156		
	Auditory Processing	-.022	-.119	-.029	-.134	.874	.400		
	Fluid Reasoning	-.051	.143	-.052	.153	.625	.157		
	Phonemic Awareness	.200	.519	.241	.520	.181	.002**		
	Working Memory	.016	.001	.023	.001	.871	.991		
	Cognitive Fluency	-.034	-.139	-.040	-.172	.733	.146		
	Verbal Comprehension	.260	-.137	.310	-.135	.005**	.190		
	Reading Fluency	.055	.238	.075	.284	.459	.005**		

* Significant at the .05 level (2-tailed). **Significant at the .01 level (2-tailed).

subtest was used a dependent variable, no predictors on the WJ III were significant for the population without dyslexia (R^2 = .190); however, for students with dyslexia (R^2 = .418), the WJ III Cognitive Fluency (p = .01) was significantly predictive.

In the area of spelling of real words, the WJ III Reading Fluency subtest (p = .01) was the best predictor for the population with dyslexia (R^2 =.435), whereas the Verbal Comprehension Cluster (p = .01) was best for the normally achieving students (R^2 = .254). For the spelling of pseudowords, the WJ III Phonemic Awareness Cluster (p = .01) and the Reading Fluency subtest (p = .01) were the best predictors for the population with dyslexia (R^2 = .503), and for the normally achieving students (R^2 = .243), it was the Verbal Comprehension Cluster (p = .01).

To determine the effectiveness of the WJ III Cognitive Battery-Standard as predicting decoding and spelling performance across college students with and without learning disabilities, a different set of multiple regressions was run using only the seven subtests comprising the WJ III General Intellectual Achievement (GIA) score (see Tables 6 and 7). Compared to the WJ III Reading/Spelling model chosen for analysis, it is evident that WJ III GIA model R^2's were not as predictive for either group, indicating a significant amount of the variance was unaccounted for across populations. The WJ III GIA model prediction of real-word decoding indicated that the best cognitive predictors for the population with dyslexia (R^2 = .290) was Numbers Reversed (p = .01) while for the normally achieving students (R^2 = .226), it was Verbal Comprehension (p = .01) and Visual Matching (p = .01). For the reading of pseudowords (R^2 = .327), the WJ III Visual Matching (p = .01), and Numbers Reversed (p = .01) best predicted for the population with dyslexia, and for the normally achieving students (R^2 = .151), it was the Verbal Comprehension subtest (p = .01). With the WJ II GIA model the best predictors for reading fluency were Numbers Reversed (p = .01), Visual Matching (p = . 01), and Spatial Relations (p = .01) for the population with learning disabilities (R^2 = .334), and for the normally achieving students (R^2 = .147), it was the Visual Matching subtest (p = .01).

In the area of spelling real words, the best predictors on the WJ III GIA model for the population with dyslexia (R^2 = .303) was Visual Matching (p =.01) and Numbers Reversed (p =.01) while for the normally achieving students (R^2 = .227), it was the Verbal Comprehension subtest (p = .01). For the spelling of pseudowords, Sound Blending (p = .01), Visual Matching (p = .01), and Numbers Reversed (p = .01) best

Table 6

WJ III Decoding Predictors by WJ III Cognitive Battery-Standard Subtests for Normally Achieving Students (NA) and Students with Dyslexia (DYS)

Dependent	Predictors	B		β		Sig.		R^2	
		NA	DYS	NA	DYS	NA	DYS	NA	DYS
Letter Word								.226	.290
	Verbal Comprehension	.280	.291	.307	.231	.006**	.034*		
	Visual Auditory	-.107	-.031	-.153	-.035	.147	.731		
	Spatial Relations	-.131	-.177	-.164	-.177	.112	.099		
	Sound Blending	.217	.224	.260	.206	.011*	.031*		
	Concept Formation	.059	.026	.059	.024	.562	.847		
	Visual Matching	.235	.204	.249	.180	.009**	.057		
	Numbers Reversed	-.002	.265	-.004	.341	.970	.001**		
Word Attack								.151	.327
	Verbal Comprehension	.249	-.084	.309	-.065	.008**	.535		
	Visual Auditory	-.067	.026	-.109	.029	.323	.773		
	Spatial Relations	.060	-.080	.085	-.079	.432	.449		
	Sound Blending	.072	.250	.098	.224	.358	.017*		
	Concept Formation	.028	.150	.031	.135	.769	.262		
	Visual Matching	-.002	.351	-.002	.302	.981	.001**		
	Numbers Reversed	.041	.231	.073	.289	.482	.004**		
Reading Fluency								.147	.334
	Verbal Comprehension	.086	.300	.076	.246	.513	.020*		
	Visual Auditory	.119	-.033	.138	-.038	.214	.695		
	Spatial Relations	-.002	-.307	-.002	-.317	.982	.003**		
	Sound Blending	-.115	.012	-.111	.011	.298	.903		
	Concept Formation	-.054	-.156	-.043	-.148	.687	.215		
	Visual Matching	.359	.450	.304	.408	.002**	.000**		
	Numbers Reversed	.064	.272	.080	.359	.439	.000**		

*Significant at the .05 level (2-tailed). **Significant at the 0.01 level (2-tailed).

Table 7
WJ III Spelling Predictors by WJ III Cognitive Battery-Standard Subtests for Normally Achieving Students (NA) and Students with Dyslexia (DYS)

Dependent	Predictors	B		β		Sig.		R^2	
		NA	DYS	NA	DYS	NA	DYS	NA	DYS
Spelling								.227	.303
	Verbal Comprehension	.427	.287	.382	.207	.001**	.064		
	Visual Auditory	-.130	.122	-.152	.121	.149	.233		
	Spatial Relations	.015	-.128	.015	-.116	.881	.277		
	Sound Blending	.192	.047	.188	.039	.065	.681		
	Concept Formation	-.119	-.027	-.096	-.022	.342	.856		
	Visual Matching	.177	.374	.153	.299	.102	.002**		
	Numbers Reversed	.078	.278	.100	.319	.313	.002**		
Spelling Sounds								.221	.396
	Verbal Comprehension	.252	-.030	.300	-.030	.007**	.766		
	Visual Auditory	.001	.059	.001	.082	.989	.381		
	Spatial Relations	.051	.029	.070	.036	.495	.711		
	Sound Blending	.119	.320	.156	.364	.127	.000**		
	Concept Formation	-.034	.008	-.036	.009	.721	.935		
	Visual Matching	.079	.219	.090	.238	.332	.007**		
	Numbers Reversed	.083	.159	.140	.252	.157	.007**		

Significant at the .05 level (2-tailed). **Significant at the 0.01 level (2-tailed).

predicted for the population with dyslexia ($R^2 = .396$), and for the normally achieving students ($R^2 = .221$), it was again the Verbal Comprehension subtest ($p = .01$).

In summary, the WJ III Reading/Spelling model chosen for this study was better at accounting for the variance across groups, in particular the population with dyslexia. The populations also differed in the cognitive processes that best predicted their performance. The WJ III Verbal Comprehension Cluster and Visual Matching subtest appears to be the best predictor of the normally achieving students' performance across decoding and spelling tasks. However, this group's small R^2 on all the dependent measures indicates that they appear to be pulling on other cognitive, language, and knowledge than measured on the WJ III. Yet, the performance of almost 50% of the students with dyslexia on the decoding and spelling measures can be accounted for by the WJ III Reading/Spelling model used in this research.

Discussion

The results of this study provide strong evidence for the usefulness of the WJ III Cognitive Abilities Clusters in predicting reading decoding and spelling performance of the postsecondary population with dyslexia. In addition, the findings raised several questions related to the importance of specific cognitive and language abilities for success with reading decoding and spelling across populations with and without dyslexia.

The results of examining the cognitive and language abilities that predict performance on specific academic tasks (i.e., reading decoding and spelling) have direct implications for instruction and appropriate use of accommodations. For instance, an adult's performance on a reading or spelling measure might be more significantly related to inferential reasoning or cognitive efficiency than phonological or orthographic processing. Examining the predictive ability of many possible cognitive and language variables on a student's performance allows professionals to reexamine current theories and practices. Challenging current models of decoding and spelling at the adult level will lead to a better understanding of the developmental growth of cognitive and linguistic processes.

The students with dyslexia in this study scored significantly lower than their normally achieving peers on measures of processing speed and efficiency, working memory, fluency, phonological processing, and nonverbal reasoning, as well as verbal reasoning (see Table 3). The greatest mean difference (12.80) between groups on the cognitive clusters examined was on the WJ III Cognitive Efficiency Cluster-Extended, which taps into working memory, short-term memory, processing speed, and cognitive efficiency. The subtests comprising this cluster (i.e., Visual Matching, Numbers Reversed, Decision Speed, Memory for Words) measure both verbal and nonverbal abilities. As Daneman and Carpenter (1980) noted, individual differences in memory capacity may reside less with storage capacity and more with the efficient use of processes to maximize limited capacity (i.e., verbal ability and working memory).

The second largest mean difference between groups was found on the WJ III Auditory Processing Cluster (11.80) and the WJ III Working Memory Cluster (11.15), reflecting the phonological, memory, and attention problems significant among the college population with dyslexia. The literature has increasingly focused on the relationship of attention, working memory, long-term memory, and executive processes to the ability to process information (Engle & Cantor, 1992; Richardson, 1996). Interestingly, the WJ III Cognitive Fluency Cluster had the smallest group difference (5.97). One of the major limitations of this cluster for the adolescent and adult population appears to be the fact that it combines verbal fluency measures (Retrieval Fluency and Rapid Picture Naming) with Decision Speed, a task that has a strong *G*s component. This suggests the need for further validity studies to determine the cluster's effectiveness, particularly as a gauge of rapid naming abilities, with adolescents and adults. This is of particular importance since rapid naming has been found to be important to the development of age-appropriate literacy skills in children.

The WJ III Reading Fluency subtest has been identified to be the single most discriminating variable across the entire WJ III Cognitive and Achievement batteries in differentiating adult populations with and without learning disabilities (McGrew et al., 2002). In the present study the WJ III Reading Fluency subtest had the largest mean difference between groups of any of the clusters and/or subtests (16.26). Over the last few years, empirically based research has documented the critical role reading fluency plays in high-speed word recognition, spelling, and comprehension processes (National Reading Panel, 2000). As mentioned earlier, extended time on tests is the most commonly requested accommodation among the college population with dyslexia (Camara, Copeland, & Rothschild, 1998; Gregg, 2002). However, findings from this study raise the possibility that more cognitive and linguistic variables are contributing to reading fluency than just phonological awareness, orthographic awareness, and processing speed/efficiency. In the test battery for a college student for whom dyslexia might be expected, these variables would lend critical information to clinical judgment and appropriateness of specific accommodations.

One of the major purposes of this study was to better understand how well the WJ III Cognitive Clusters predict reading decoding and spelling performance in a college population with and without dyslexia. The R^2 differences between the two groups across the reading and spelling tasks present an interesting finding. The contribution of the WJ III Cognitive Clusters accounted for almost twice the variance for the population with dyslexia as for their normally achieving peers (see Tables 4 and 5). It appears that the normally achieving students are using other cognitive, language, and world knowledge, not necessarily represented on the chosen WJ III Clusters, to perform reading and spelling of single words (real or nonsense). A student's innate language and cognitive abilities are significantly impacted by home and school environment. Experience with books and exposure to a literate environment has been discussed as a significant contributor to reading and spelling (Clay, 1985; Mason, 1992). In addition, exposure to teacher discourse and school curricula also predicts literacy performance (Wilkinson & Silliman, 2000). Given that 80% of the students with dyslexia in this study had been in a variety of pullout special education programs during their school years, they might not have been exposed to the same literacy experiences as their normally achieving peers. This gives rise to the question whether the dependence of the students with dyslexia on such cognitive and language processes as working memory, processing speed, or phonemic awareness is the result of deficits with crystallized knowledge and underdeveloped verbal abilities, or whether comprised cognitive and linguistic processes lead to deficits with crystallized knowledge. What may be concluded from this study is that the WJ III Reading/Spelling model used in this research was able to account for almost half of the decoding and spelling variance of students with dyslexia. Therefore, the constellation of WJ III Cognitive Clusters comprising the WJ III Reading/Spelling model is highly effective in the diagnosis of specific decoding and spelling disorders at the postsecondary level.

Research on the cognitive and linguistic abilities of the adult population with and without dyslexia has demonstrated the predictive ability of word knowledge, phonological, orthographic, morphological, and grammatical awareness for reading decoding and spelling (Bruck, 1992; Carlisle, 1995; Carlisle & Rice, 2002; Gregg et al., 2002). Based on the findings from this research on the reading decoding and spelling performance of a postsecondary population with and without learning disabilities (dyslexia), one can conclude that the two groups appear to be utilizing different cognitive and linguistic processes to perform the tasks administered. Specifically, the WJ III measures of reading or spelling of real words (Letter/Word Identification; Spelling) or nonsense words (Word Attack; Spelling of Sounds), the normally achieving students' performance on the WJ III Verbal Comprehension Cluster better predicted their performance. For the population with dyslexia on the reading of real words, the Reading Fluency subtest and the Phonemic Awareness Cluster best predicted their performance, whereas on the reading of nonsense words the Cognitive Efficiency Cluster-Extended, Fluid Reasoning Cluster, and the Reading Fluency subtest were the strongest predictors of performance. Measures examining the spelling of real and nonsense words again identified the population without learning disabilities as calling more upon their word knowledge (i.e., vocabulary and verbal reasoning). For the population with dyslexia, the ability to spell real words was best predicted by their performance on the WJ III Reading Fluency subtest, and their spelling of nonsense words was best predicted by their performance on both the WJ III Phonemic Awareness Cluster and the WJ III Reading Fluency subtest.

The WJ III Reading Fluency subtest was chosen as a predictor rather than the WJ IIII Academic Fluency Cluster since we were looking specifically at reading decoding and spelling performance. The WJ III Reading Fluency subtest has a significantly larger weight than either the WJ III Writing Fluency or the WJ III Math Fluency subtests; therefore, we felt the WJ III Reading Fluency subtest would be the best predictor. Table 4 lists the WJ III Cognitive Clusters that best predict performance on the WJ III Reading Fluency subtest across normally achieving and students with learning disabilities at a college level. Again, consistent with the R^2 differences mentioned earlier between the groups, the normally achieving students appear to be using different resources to perform the WJ III Reading Fluency task. For the population with dyslexia, their performance on the WJ III Long-Term Retrieval and the WJ III Cognitive Fluency clusters best predicts their performance. The WJ III Long-Term Retrieval Cluster is most likely picking up the dependence of this group on low-level orthographic, morphological, and grammatical awareness. Weaknesses in orthographic, morphological, and grammatical awareness might again have more of an impact on reading fluency than phonological processing. In addition, upon investigation of the subtests that comprise WJ III Cognitive Fluency (Word Retrieval; Rapid Picture Naming; Decision Speed), the groups differed significantly only on Word Retrieval and Decision Speed, possibly tapping into a problem with categorical reasoning and organization.

The WJ III Verbal Comprehension Cluster played a significant role in differentiating the functional processing of the two groups of learners. The role of verbal knowledge, as measured on the WJ III, cannot be attributed to oral language competence alone. As Table 3 indicates, the populations did not differ significantly on their vocabulary performance (WJ III Picture Vocabulary) or oral recall of text (WJ III Story Recall) as measured on the WJ III, but did differ on the WJ III Oral Comprehension subtest, as well as the Fluid Reasoning Cluster (Concept Formation; Analysis/Synthesis). As the two groups were comparable on vocabulary, the possible differences in the predictive ability of the Verbal Comprehension Cluster might rest more with inferential reasoning.

Verbal and metalinguistic abilities both draw upon oral language but also depend heavily on inferential reasoning. Direct and indirect contributions of verbal concepts and semantic relationships contribute to performance with verbal abilities (Carlisle & Rice, 2002). Verbal ability requires individuals to engage inferential reasoning in order to make connections and/or see elements of implicit meaning. While a great deal of research has documented the critical role of inferential reasoning in the comprehension and production of text, little attention has been paid to its critical role in the development of word meanings for adolescent and adult populations with communication disorders (Carlisle & Rice, 2002; Oakhill & Yuill, 1996).

Based on this study, it appears that verbal reasoning (i.e., synonyms/antonyms; analogies) was a strategic ability the normally achieving students applied to decoding and spelling words. Significance tests run on each of the individual sections within the WJ III Verbal Comprehension subtests (i.e., Picture Vocabulary; Synonyms/Antonyms; Analogies), showed that the groups differed only on their performance with Synonyms/Antonyms and Analogies. Future research is needed to further explore this finding with adolescent and adults with learning disabilities.

When only the WJ III Standard Cognitive Battery was used to identify predictors for decoding and spelling performance, the amount of R^2 (variance) declined significantly across groups. The WJ III Cognitive and Achievement Batteries (Woodcock et al., 2001) provide examiners with a reliable and valid way to measure the cognitive and language processes that impact the reading decoding and spelling performance of college students with dyslexia. The results from this study indicate that examiners working with the secondary and postsecondary population should be encouraged to examine the cognitive fluency and efficiency (Cognitive Fluency Cluster; Cognitive Efficiency Cluster-Extended; Academic Fluency Cluster; Reading Fluency subtest), phonemic orthographic, morphologic, and grammatical awareness (Phonemic Awareness Cluster; Sound Awareness subtest; Long-Term Retrieval Cluster; Visual/Auditory subtest), and inferential reasoning (Verbal Comprehension Cluster; Verbal Comprehension subtest; Fluid Reasoning Cluster; Concept Formation subtest) of these students in order to more accurately support the need for specific accommodations for learning.

Noel Gregg, Ph.D., *is a Distinguished Research Professor in the Department of Psychology, and the Department of Communication Science Disorders and Special Education. The focus of her research has related to the literacy profiles of adults with learning disorder. Her publications have primarily addressed assessment and accommodation issues.* ***Donna Ann Flaherty, Ed.S.,*** *and* ***Peggy Norris, M.Ed.,*** *are advanced graduate students in the Department of Special Education at the University of Georgia.* ***Cheri Hoy*** *is a professor in the Department of Special Education and the Associate Dean for Faculty, Administration and Finance. The focus of her research is assessment of adults with learning disorders.* ***Peggy Norris*** *is an educational program specialist student in the Department of Special Education.* ***Michael Jordan, Ph.D****., is an Assistant Director for Assessment, Georgia Southern University, Office of Strategic Research and Analysis.* ***Christopher Coleman, M.A.,*** *is a linguist at the University of Georgia Regents' Center for Learning Disorders, Department of Psychology. He is published extensively in the area of adults with reading and written language disorders.* ***Mark Davis, Ph.D.,*** *is the Head of Evaluation at the University of Georgias Regents' Center for Learning Disorders, Department of Psychology. His main areas of research focus on assessment, dyslexia, and AD/HD in the adult population.*

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