Abstract Title Page
Not included in page count.

Title: Latent Profiles of Reading and Language and Their Association with Standardized Reading Outcomes in Kindergarten Through 10th Grade

Authors and Affiliations:

Barbara R. Foorman, Ph.D.
Yaacov Petscher, Ph.D.
Christopher Stanley, Ph.D.
Florida Center for Reading Research
Florida State University

Abstract Body

Limit 4 pages single-spaced.

Background / Context:

The idea of targeting reading instruction to profiles of students' strengths and weaknesses in component skills is central to teaching. However, these profiles are often based on unreliable descriptions of students' oral reading errors (e.g., Argyle, 1989), text reading levels (Holliman, Hurry, & Bodman, in press), or learning profiles (e.g., Tomlinson, 1999). Reading researchers have used regression-based techniques to quantify the profiles of good and poor readers (Catts, Fey, Zhang, & Tomblin, 1999; Catts, Adlof, & Weismer, 2006) and profiles within poor readers (e.g., Badian, Duffy, Als, & McAnulty, 1991; Buly & Valencia, 2002; Morris et al., 1998; Shankweiler et al., 1995; Stanovich & Siegel, 1994; Vellutino et al., 1996). However, these regression-based approaches typically use arbitrary achievement cut points, such as below the 30^{th} or 40^{th} percentile on a norm-referenced reading achievement test or an IQ-achievement discrepancy of 1.5 SDs, to define reader groups and, therefore, suffer from problems of reliability and generalizability. More recent approaches have taken a latent class approach (LCA) to modeling the observed measures to obtain reliable classes or profiles of reader characteristics. To date, the research employing LCA has focused on low-performing readers—those with language impairment (e.g., Catts, Compton, Tomblin, & Bridges, 2012; Justice et al., in press), those in low-performing schools (e.g., Logan & Petscher, 2010), or struggling readers (Brasseur-Hock , Hock, Kieffer, Biancarosa, & Deshler, 2011).

Purpose / Objective / Research Question / Focus of Study:

The current investigation utilized latent profile analysis (LPA) to examine reading and language skills in a large, representative sample of Florida students in kindergarten through 10^{th} grades. Additionally, it examined the relations among the latent profiles and a norm-referenced reading test in kindergarten through 2^{nd} grade and a latent variable of reading comprehension in 3^{rd} through 10^{th} grades.

Setting:

K-12 public schools in Florida.

Population / Participants / Subjects:

There were 7,752 participating students in kindergarten through 10^{th} grades, 2,295 in kindergarten through 2^{nd} grade and 5,457 in 3^{rd} through 10^{th} grades. Percentages of participants by grade, gender, race/ethnicity, and English learner and Free-and-Reduced-Lunch status are provided in Table 1 (please insert Table 1 here).

Intervention / Program / Practice:

A component skills battery developed by the Florida Center for Reading Research (FCRR), called the FCRR Reading Assessment (FRA; Authors, 2014) was administered mid-year and a standardized reading test–SESAT in kindergarten and SAT-10 in grades 1-10 (Harcourt Assessment, 2004)—was administered at the end of the year during the 2012/13 school year. Additionally, scores on the state reading test—the FCAT (Florida Department of Education, 2013)—were obtained for students in 3^{rd} through 10^{th} grades. The FRA consists of a component for grades K-2 and a component for grades 3-10. In grades K-2, a flat, fixed-item, computer-administered version of the FRA was administered, with 30 items per task and a stop rule of four

incorrect responses in a row. Evidence of validity and reliability is presented in the FRA Technical Manuals (Authors, 2014).

In the K-2 FRA, print-related tasks were Phonological Awareness, Letter-Sounds, Word Reading and Spelling; oral language tasks were Sentence Comprehension (a receptive syntax measure), Vocabulary Pairs (selecting the two words out of three that go together), and Following Directions (which taps listening, syntax, and attention). In grades 3-10, a flat, fixed-item version of the Reading Comprehension task was administered but the other three FRA tasks were adaptive. The Word Recognition Task required the student to select from a list of three printed words the word that was pronounced by the computer. The Vocabulary Knowledge Task required the student to select one of three morphologically-related words that best completed a sentence. In the Syntactic Knowledge task the computer read aloud a sentence on the screen that had a missing verb, pronoun, or connective. The student selected from a dropdown menu of three words in the same form class the word that best completed the sentence.

Research Design:

A common-item non-equivalent groups design was used to collect data on the K-2 tasks and the baseline Reading Comprehension Task with 20% common items across forms. A planned missing data design was implemented such that all students were administered baseline Reading Comprehension and differentially assigned to be administered the computer-adaptive version of Vocabulary Knowledge, Word Recognition, and Syntactic Knowledge Tasks. The resulting ability score from an item response theory analysis was used for all four tasks. Raw scores from the FRA tasks in kindergarten through second grade were converted to *z*-scores for the purpose of analysis. The z-scores reflect the Florida norms. A latent factor score for reading comprehension was created from developmental scale scores from the RCT, SAT-10, and FCAT.

Data Analysis:

A two-step process of latent profile analysis (LPA) and general linear modeling was conducted at each grade level. Like a confirmatory factor analysis, the LPA uses maximum likelihood estimation to estimate a latent factor that is assumed to cause the observed measures (i.e., the K-10 FRA tasks). When the manifest variables are categorical, the approach is referred to as latent class analysis, but with continuous variables, the model is referred to as LPA.

Following the LPA, multiple regression analyses by grade level tested the extent to which profiles were statistically and meaningfully separated on the standardized measure of word reading in kindergarten and reading comprehension in all other grades. Given that there are no guidelines for acceptable posterior fit probabilities, in the present design a threshold of .70 was set so that relative confidence could be assured in testing for profile differences in the standardized outcome. Within-grade multiple regressions were subject to a linear step-up correction to guard against the false-discovery rate (Benjamini & Hochberg, 1995).

Findings / Results:

Results are presented separately for the lower elementary grades (kindergarten through 2nd) and upper elementary grades (3rd to 5th) because of the different nature of the assessments. Results from only one of the secondary grades—8th—will be presented due to the similarity of results across the middle and high school grades. Results from the rest of the secondary grades are provided in supplemental materials (which can be provided by the authors upon request).

Descriptive statistics and correlations among raw scores for the FRA measures and SESAT Word Reading and SAT-10 Reading Comprehension developmental scale scores are provided for kindergarten through 2nd grade in Table 2 and for 3rd through 10th grades in Table 3 (please insert Tables 2 and 3 here). Fit indices from model testing are presented in Table 4 for grades K-2, 3-5, and 8 (please insert Table 4 about here). Results from Table 4 demonstrate that across grades a consistent, significant reduction in the log likelihood was observed when testing the difference between *n* and *n*-1 profiles. Along with this reduction were general reductions in the AIC and BIC values. In many instances, a class with a statistically significant reduction in the log likelihood was not selected for final class retention. This decision was due to LPA being an exploratory profile analysis. As such, certain profiles may have yielded better model fit, yet the class itself was either relatively homogeneous to other classes or had a low within-profile *n*.

Results of the LPA for kindergarten through 2nd grade are presented in Figures 1 and 2. *z*-scores of FRA measures are presented on the Y-axis. General linear model comparisons are provided in Table 5 for grades K-2 and in Table 6 for grades 3-5 and 8, with the Critical *p*-value from the linear step-up correction noted in a separate column (please insert Figures 1 and 2 and Tables 5 and 6 here).

Latent profile analysis (LPA) identified five to six classes in the elementary grades and only three in the secondary grades. In all grades the latent profiles were significantly related to the norm-referenced reading outcome scores, accounting for a low of 24% of the variance in 3rd grade to a high of 61% of the variance in 9th grade, with the mode being 42%. The range of average absolute values of the standardized difference in reading outcome across all latent classes in a grade using Hedges g was 1.10 in kindergarten to 2.53 in 5th grade. The fact that latent profiles accounted for a substantial differences in reading comprehension in a large, diverse sample of students spanning 11 grades is a significant contribution to a field dominated by latent class analyses of clinical samples (e.g., Catts et al., 2012; Justice et al., in press) or low-performing students (Logan & Petscher, 2010; Brasseur-Hock et al. 2011).

The profiles in the secondary grades fell into a pattern of low, medium, and high. The profiles of the low performers in 8th grade showed that students were lower on Vocabulary and Syntactic Knowledge tasks relative to the Word Recognition task, suggesting the need for intervention on the academic language skills of vocabulary and text discourse (Uccelli, Galloway, Barr, Meneses, & Dobbs, 2015).

The five to six reading and language profiles found in the elementary grades reflected heterogeneity of skills that should be taken into account when differentiating instruction. The latent classes of students in kindergarten through 2nd grade with strong alphabetic skills generally had higher reading outcomes. Oral language strengths did not appear to compensate for weak alphabetic skills in these early grades. However, reading intervention should not simply focus on alphabetic skills, because oral language skills account for a large proportion of variance in comprehension even in the primary grades (e.g., Authors, 2015a; Catts et al., 1999; Kendeou, van den Broek, White, & Lynch, 2009; Muter, Hulme, Snowling, & Stevenson, 2004).

In the current investigation, the importance of language skills to reading comprehension became even more obvious by the upper elementary grades. In 3rd and 5th grades, very low Vocabulary Knowledge scores were associated with performance on latent reading comprehension that was more than 1 SD below the mean. This latent class of students was similar to the "word callers" that Buly and Valencia (2002) found in their cluster analysis of 4th grade students who had failed the state reading test. However, in the 4th grade sample in this study, the close to average performance on the other language task—Syntactic Knowledge—

helped to offset the effect of low Vocabulary Knowledge on reading comprehension. Knowledge of sentence use (i.e., syntax) and knowledge of the structure and meaning of words (i.e., vocabulary) are highly related and strongly predict reading comprehension in 4th through 10th grades (Authors, 2015b). It is not surprising, then, that tasks that measure the understanding of discourse connectors in text, such as the FRA Syntactic Knowledge task, and the understanding of word meanings and structure, such as the FRA Vocabulary Knowledge task, should inform relations to reading comprehension more than Word Recognition did. This does not mean that intervention for struggling readers should ignore weaknesses in word identification. It simply means that interventions also need to build knowledge of the structure and meanings of words and of the linguistic devices for making text cohesive (e.g., Kieffer & Lesaux, 2012; Lawrence, Crosson, Paré-Blagoev, & Snow, 2015; Lesaux, Kieffer, Faller, & Kelley, 2010).

Conclusions:

Description of conclusions, recommendations, and limitations based on findings.

The LPA conducted with a diverse K-10 sample of 7,752 students revealed five to six profiles in the elementary grades and three in the secondary grades that were strongly related to standardized reading outcomes, with average absolute between-profile effect sizes ranging from 1.10 to 2.53. The profiles in the secondary grades followed a high, medium, and low pattern. Profiles in the elementary grades revealed more heterogeneity, suggestive of strategies for differentiating instruction by addressing students' academic language needs in addition to their word identification skills.

It is crucial that differentiation be based on learning profiles derived from valid and reliable measures. Unreliable descriptions of students' strengths and weaknesses can lead to inappropriate instruction even when based on authentic tasks such as oral reading (Denton, Ciancio, & Fletcher, 2006). Even with reliable measures, metrics may not be on the scale, making measurement of growth invalid (Francis et al., 2008). Additionally, profiles may be invalid if they omit measures critical to defining the underlying construct, such as omitting language measures from the creation of reading profiles. Finally, unless learning profiles are linked to recognized outcomes, as was done in this investigation and in Brasseur-Hock et al. (2011) and in Buly and Valencia (2002), the goals for differentiated instruction may be less clear.

Limitations of this study are its cross-sectional rather than longitudinal design and the fact that the profiles and their relations to reading outcomes were limited to the measures used. An important next step for the field is to test the results of the heterogeneous profiles from this exploratory latent profile analysis with confirmatory latent class analysis. Although the samples at each grade were not sufficiently large to conduct confirmatory latent class analyses, this investigation nonetheless serves as an important first step in verifying the existence of various groupings of students (e.g., the poor comprehenders of Catts et al., 2012) and validating the instructional utility of diagnostic profiles.

Appendices

Not included in page count.

Appendix A. References

Argyle, S. (1989). Miscue analysis for classroom use. *Reading Horizons*, *29*(2), 93-102.

Badian, N., Duffy, F., Als, H., & McAnulty, G. (1991). Linguistic profiles of dyslexic and good readers. *Annals of Dyslexia*, *41*, 221-245.

Benjamini, Y., & Hochberg, Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. *Journal of the Royal Statistical Society Series B Methodological*, *57*(1), 289-300.

Brasseur-Hock, I., Hock, M., Kieffer, M., Biancarosa, G., & Deshler, D. (2011). Adolescent struggling readers in urban schools: Results of a latent class analysis. *Learning and Individual Differences*, *21*, 438-452. http://dx.doi.org/10.1016/jlindif.2011.01.008

Buly, M., & Valencia, S. (2002). Below the bar: Profiles of students who fail state reading assessments. *Education Evaluation & Policy Analysis*, *24*(3), 219-239. http://dx.doi.org/10.3102/01623737024003219

Catts, H., Adlof, S., & Weismer, S. (2006). Language deficits in poor comprehenders: A case for the simple view of reading. *Journal of Speech, Language, and Hearing Research*, *49*, 278-293. http://dx.doi.org/10.1044/1092-4388(2006/023)

Catts, H., Compton, D., Tomblin, J. B., Bridges, M. (2012). Prevalence and nature of late-emerging poor readers. *Journal of Educational Psychology*, *104*(1), 166-181. http://dx.doi.org/10.1037/a0025323

Catts, H., Fey, M., Zhang, X., & Tomblin, J.B. (1999). Language basis of reading and reading disabilities: Evidence from a longitudinal investigation. *Scientific Studies of Reading*, *3*(4), 331-361. http://dx.doi.org/10.1207/s1532799xssr0304.2

Denton, C., Ciancio, D., Fletcher, J. (2006). Validity, reliability, and utility of the Observation Survey of Early Literacy Achievement. *Reading Research Quarterly*, *41*(1), 8-34. http://dx.doi.org/10.1598/RRQ.41.1.1

Florida Department of Education. (2013). *Florida Statewide Assessments Yearbook*. (Author).

Foorman, B., Petscher, Y., & Schatschneider, C. (2014). Florida Center for Reading Research (FCRR) Reading Assessment (FRA): Technical Manuals. Retrieved from http://www.fcrr.org/_/documents/FRA_K-2_Tech_Manual_v1.pdf
Retrieved from http://www.fcrr.org/_/documents/FRA_3-12_Tech_Manual_v1.pdf

Foorman, B., & Herrera, S., Petscher, Y., Mitchell, A., & Truckenmiller, A. (2015a). The Structure of Oral Language and Reading and Their Relation to Comprehension in grades kindergarten through grade 2. *Reading and Writing*, *28*(5), 655-681. Doi: 10.1007/s11145-015-9544-5

Foorman, B., Koon, S., Petscher, Y., Mitchell, A., & Truckenmiller, A. (2015b). Examining General and Specific Factors in the Dimensionality of Oral Language and Reading in 4th-10th Grades. *Journal of Educational Psychology*, *107*(3), 884-899. Doi: 10.1037/edu0000026

Francis, D., Fletcher, J., Stuebing, K., Lyon, G.R., Shaywitz, B., & Shaywitz, S. (2005). Psychometric approaches to the identification of LD and achievement scores are not sufficient. *Journal of Learning Disabilities*, *38*, 98-108. http://dx.doi.org/10.1177/00222194050380020101

Francis, D., Santi, K., Barr, C., Fletcher, J., Varisco, A., & Foorman, B. (2008). Form effects on the estimation of students' oral reading fluency using DIBELS. *Journal of School Psychology, 46*, 315-342. http://dx.doi.org/ 10.1016/j.jsp.2007.06.003

Harcourt Assessment (2004). *Stanford Technical data report*. San Antonio, TX: Author.

Holliman, A., Hurry, J., & Bodman, S. (in press). Children's reading profiles on exiting Reading Recovery programme: do they predict sustained progress? *Journal of Research in Reading*. http://dx.doi.org/10.1111/1467-9817.12041

Justice, L., Logan, J., Kaderavek, J., Schmitt, M.B., Tompkins, V., & Barlett, C. (in press). Empirically based profiles of the early literacy skills of children with language impairment in early childhood special education. *Journal of Learning Disabilities*. http://dx.doi.org/10.1177/0022219413510179

Kendeou, P., van den Brock, P., White, M., & Lunch, J. (2009). Predicting reading comprehension in early elementary school: The independent contributions of oral language and decoding skills. *Journal of Educational Psychology, 101,* 765-778. http://dx.doi.org/10.1037/a0015956

Kieffer, M., & Lesaux, N. (2012). Effects of academic language instruction on relational and syntactic aspects of morphological awareness for sixth graders from linguistically diverse backgrounds. *Elementary School Journal*, *112*(3), 519-545. http://dx.doi.org/10.1086/663299

Lawrence, J., Crosson, A., Paré-Blagoev, & Snow, C. (2015). Word generation randomized trial: Discussion mediates the impact of program treatment on academic word learning. *American Educational Research Journal*, *52*(4), 750-786. http://dx.doi.org/10.3102/0002831215579485

Lesaux, N., Kieffer, M., Faller, S., & Kelley, J. (2010). The effectiveness and ease of implementation of an academic vocabulary intervention for sixth graders in urban middle schools. *Reading Research Quarterly*, *45*(2), 196-228. http://dx.doi.org/10.1598/RRQ.45.2.3

Logan, J., & Petscher, Y. (2010). School profiles of at-risk student concentration: differential growth in oral reading fluency. *Journal of School Psychology*, *48*(2), 163-186. http://dx.doi.org/ 10.1016/j.jsp.2009.12.002

Morris, R., Steubing, K., Fletcher, J., Syaywitz, S., Lyon, G.R., Shankweiler, D., Katz, L., & Francis, D. (1998). Subtypes of reading disability: Variability around a phonological core. *Journal of Educational Psychology*, *90*(3), 347-373.

Muter, V., Hulme, C., Snowling, M., & Stevenson, J. (2004). Phonemes, rimes, vocabulary, and grammatical skills as foundations of early reading development: Evidence from a longitudinal study. *Developmental Psychology*, *40*(5), 665-681. http://dx.doi.org/10.1037/0012-1649.40.5.665

Shankweiler, D., Crain, S., Katz, L., Fowler, A., Liberman, A., Brady, S., Thornton, R., Lundquest, E., Dreyer, L., Fletcher, J., Steubing, K., Shaywitz, S., & Shaywitz, B. (1995). Cognitive profiles of reading disabled children: Comparison of language skills in phonology, morphology, and syntax. *Psychological Science, 48*(2), 163-186.

Stanovich, K.. & Siegel, L. (1994). Phenotypic performance profile of children with reading disabilities: Regression-based test of phonological-core variable-difference model. *Journal of Educational Psychology*, *86*(1), 24-53. http://dx.doi.org/10.1037/0022-0663.86.1.24

Tomlinson, C. (1999). Mapping a route toward differentiated instruction. *Educational Leadership*, *57*(1), 12-16.

Uccelli, P., Galloway, E., Barr, C., Meneses, A., & Dobbs, C. (2015). Beyond vocabulary: Exploring cross-disciplinary academic-language proficiency and its association with reading comprehension. *Reading Research Quarterly*, *50*(3), 337-356. http://dx.doi.org/10.1002/rrq.104

Vellutino, F., Scanlon, D., Sipay, E., Small, S., Pratt, A., Chen, R., & Denkla, M. (1996). Cognitive profiles of difficult-to-remediate and readily remediated poor readers: Early intervention as a vehicle for distinguishing between cognitive and experiential deficits as basic causes of specific reading disability. *Journal of Educational Psychology*, *88*, 601-638.

Appendix B. Tables and Figures

Not included in page count.

Table 1

Percentage of participants by grade for gender, race/ethnicity, and English learner (EL) and free-and-reduced-lunch (FRL) status.

	Gender	Race/Ethnicity					Status	
Grade	Female	Asian	Black	Hispanic	White	Other	EL	FRL
K	50.50	--	22.98	30.94	39.80	6.28	18.11	65.34
1	51.60	--	22.69	30.68	40.36	6.26	18.40	65.68
2	50.20	--	22.56	30.43	40.53	6.48	16.18	64.81
3	52.16	2.58	22.91	30.36	40.29	3.86	7.36	64.97
4	51.36	2.72	21.95	29.91	41.49	3.93	6.91	63.18
5	51.65	2.66	22.21	29.52	41.77	3.84	8.54	62.95
6	48.84	2.57	22.75	29.22	41.73	3.71	9.63	62.39
7	48.55	2.56	22.73	29.05	42.10	3.56	8.87	60.53
8	50.04	2.44	22.32	29.00	42.86	3.37	8.72	58.63
9	50.63	2.50	22.60	28.27	43.20	3.42	5.40	54.13
10	50.61	2.64	22.73	27.95	43.46	3.21	6.21	50.72
Overall	50.31	2.58	22.55	29.10	42.18	3.59	10.39	59.69

Table 2

Descriptive statistics and correlations for measures for kindergarten, grade 1, and grade 2

Measure	1	2	3	4	5	6
			Kindergarten			
1. SESAT	1.00	.38	.46	.58	.51	.28
2. VOC	--	1.00	.45	.32	.28	.41
3. FD	--	--	1.00	.42	.33	.54
4. PA	--	--	--	1.00	.48	.33
5. LS	--	--	--	--	1.00	.27
6. SC	--	--	--	--	--	1.00
n	321	422	422	422	422	422
Raw *M*	448.02	499.95	499.99	500.14	500.33	499.99
Raw *SD*	46.60	97.60	99.88	98.45	99.20	99.52
Range (L, H)	(349.00, 565.00)	(178.00, 785.00)	(218.00, 720.00)	(238.00, 727.00)	(234.00, 665.00)	(119.18, 702.45)
			Grade 1			
1. SAT-10	1.00	.58	.51	.75		
2. VOC	--	1.00	.51	.55		
3. FD	--	--	1.00	.41		
4. WR	--	--	--	1.00		
n	989	892	979	237		
Raw *M*	589.53	500.00	500.00	500.00		
Raw *SD*	49.37	100.00	100.00	100.00		
Range (L, H)	(443.00, 666.00)	(125.00, 714.00)	(79.00, 703.00)	(177.00, 676.00)		
			Grade 2			
1. SAT-10	1.00	.55	.49	.62	.58	
2. VOC	--	1.00	.39	.44	.42	
3. FD	--	--	1.00	.35	.36	
4. SPELL	--	--	--	1.00	.77	
5. WR	--	--	--	--	1.00	
n	884	846	871	852	235	
Raw *M*	618.87	500.00	500.00	500.00	500.00	
Raw *SD*	43.30	100.00	100.00	100.00	100.00	
Range (L, H)	(489.00, 726.00)	(90.00, 695.00)	(147.00, 744.00)	(189.00, 798.00)	(230.00, 666.00)	

Note. All correlations are significant at the .01 level. SESAT= Stanford Early Scholastic Achievement Test, Form A; VOC=Vocabulary Pairs; FD=Following Directions; PA=Phonological Awareness; LS=Letter Sounds; SC=Sentence Comprehension; SAT-10=Stanford Achievement Test, 10th edition (Reading Comprehension); WR=Word Reading; SPELL=Spelling.

Table 3

Descriptive statistics and correlations for measures for grades 3-5 and grade 8

Measure	1	2	3	4	5	6
			Grade 3 (*n* = 607)			
1. VKT	1.00	.33	.31	.57	.53	.54
2. WRT	--	1.00	.29	.41	.39	.35
3. SKT	--	--	1.00	.40	.38	.38
4. RCT	--	--	--	1.00	.76	.77
5. SAT-10	--	--	--	--	1.00	.81
6. FCAT	--	--	--	--	--	1.00
Raw *M*	498.97	499.24	501.61	381.98	644.14	201.00
Raw *SD*	98.24	96.56	97.23	66.40	44.47	21.80
Range (L, H)	(212.00, 810.00)	(223.00, 956.00)	(232.00, 812.00)	(260.00, 571.00)	(522.00, 740.00)	(140.00, 260.00)
			Grade 4 (*n* = 587)			
1. VKT	1.00	.29	.36	.43	.43	.42
2. WRT	--	1.00	.35	.45	.36	.39
3. SKT	--	--	1.00	.53	.50	.54
4. RCT	--	--	--	1.00	.72	.78
5. SAT-10	--	--	--	--	1.00	.75
6. FCAT	--	--	--	--	--	1.00
Raw *M*	500.16	500.44	500.17	465.15	655.41	214.14
Raw *SD*	93.94	94.31	95.51	64.21	40.20	21.70
Range (L, H)	(86.00, 877.00)	(246.00, 813.00)	(185.00, 954.00)	(339.00, 654.00)	(522.00, 761.00)	(154.00, 269.00)
			Grade 5 (*n* = 659)			
1. VKT	1.00	.38	.46	.59	.55	.58
2. WRT	--	1.00	.35	.42	.39	.45
3. SKT	--	--	1.00	.59	.56	.62
4. RCT	--	--	--	1.00	.75	.81
5. SAT	--	--	--	--	1.00	.81
6. FCAT	--	--	--	--	--	1.00
Raw *M*	500.11	499.72	499.64	478.22	665.80	219.86
Raw *SD*	95.25	94.74	96.03	90.06	37.16	21.88
Range (L, H)	(94.00, 759.00)	(222.00, 888.00)	(192.00, 810.00)	(267.00, 680.00)	(554.00, 777.00)	(161.00, 277.00)

Table 3 Continued

Measure	1	2	3	4	5	6
			Grade 8 (*n* = 629)			
1. VKT	1.00	.33	.38	.52	.46	.56
2. WRT	--	1.00	.51	.42	.38	.44
3. SKT	--	--	1.00	.56	.51	.57
4. RCT	--	--	--	1.00	.67	.75
5. SAT	--	--	--	--	1.00	.71
6. FCAT	--	--	--	--	--	1.00
Raw *M*	499.99	500.21	500.24	558.06	685.13	231.26
Raw *SD*	100.00	79.59	85.32	138.82	32.81	21.72
Range (L, H)	(17.00, 921.00)	(198.00, 797.00)	(126.00, 830.00)	(337.00, 927.00)	(593.00, 801.00)	(175.00, 296.00)

Note. All correlations are significant at the .01 level. VKT= Vocabulary Knowledge Task; WRT=Word Recognition Task; SKT=Syntactic Knowledge Task; RCT=Reading Comprehension Task; SAT-10=Stanford Achievement Test, 10th edition (Reading Comprehension); FCAT=Florida Comprehensive Assessment Test (Reading Comprehension).

Table 4

Latent profile model fit for kindergarten through grade 5 and grade 8

Grade	Profiles	Parameters	LL	AIC	aBIC	-2LL
K	2	19	-3255.01	6548.01	6624.87	
	3	22	-2681.62	5407.25	5496.24	1146.77*
	4	28	-2653.41	5362.82	5476.08	56.42*
	5	34	-2629.75	5357.51	5465.04	47.32*
	6	**40**	**-2618.44**	**5316.88**	**5458.68**	**22.63***
1	2	10	-2818.26	5656.52	5705.49	
	3	14	-2785.14	5598.28	5666.84	66.24*
	4	18	-2768.46	5572.92	5661.01	33.36*
	5	**22**	**-2752.99**	**5549.98**	**5657.71**	**30.94***
	6	26	-2743.43	5546.86	5674.17	19.12*
2	2	13	-3768.29	7562.59	7624.79	
	3	18	-3697.13	7430.26	7516.38	142.33*
	4	23	-3669.02	7384.03	7494.08	56.22*
	5	28	-3655.54	7367.07	7501.04	26.96*
	6	**33**	**-3642.95**	**7355.89**	**7513.78**	**25.17***
3	2	10	-2202.90	4425.81	4438.14	
	3	14	-2173.78	4375.56	4392.83	58.24*
	4	18	-2154.42	4344.83	4367.04	38.73*
	5	**22**	**-2129.87**	**4303.74**	**4330.88**	**49.10***
	6	26	-2104.72	4261.43	4293.51	50.30*
4	2	10	-2166.75	4353.49	4365.49	
	3	14	-2140.35	4308.69	4325.50	52.80*
	4	18	-2112.79	4261.58	4283.18	55.12*
	5	22	-2097.77	4239.54	4265.95	30.04*
	6	**26**	**-2087.22**	**4226.44**	**4257.65**	**21.10***
5	2	10	-2451.39	4922.79	4935.95	
	3	14	-2405.92	4839.83	4858.25	90.96*
	4	18	-2383.61	4803.22	4826.91	44.61*
	5	**22**	**-2363.13**	**4770.25**	**4799.20**	**40.97***
	6	26	-2353.85	4759.70	4793.91	18.55*
8	2	10	-1996.36	4012.71	4025.41	
	3	**14**	**-1954.42**	**3936.83**	**3954.60**	**83.88***
	4	18	-1924.65	3885.30	3908.15	59.53*
	5	22	-1902.37	3848.73	3876.65	44.57*
	6	26	-1885.47	3822.95	3855.95	33.78*

Note. LL =log likelihood, AIC = Akaike Information Criteria, aBIC = sample adjusted Bayes Information Criteria, -2LL = log likelihood ratio test. Values in bold represent final selected class. *$p < .001$.

Table 5

General linear model contrasts among latent profile classes for Kindergarten through grade 2

Grade	Comparison	Estimate	S.E.	t-value	*p*	Critical *p*	Hedge's *g*
K	c1 vs c2	-46.35	15.14	-3.06	.002	.027	-1.56
	c1 vs c3	-53.60	8.13	-6.59	<.001	.003	-1.33
	c1 vs c4	-23.38	8.43	-2.77	.006	.030	-0.90
	c1 vs c5	-29.11	11.52	-2.53	.012*	.006	-1.05
	c1 vs c6	-100.16	9.13	-10.97	<.001	.007	-2.26
	c2 vs c3	-7.25	13.57	-0.53	.593	-	-0.18
	c2 vs c4	22.96	13.75	1.67	.096	-	0.93
	c2 vs c5	17.24	15.83	1.09	.277	-	0.68
	c2 vs c6	-53.82	14.19	-3.79	<.001	.010	-1.13
	c3 vs c4	30.21	5.12	5.90	<.001	.013	0.84
	c3 vs c5	24.49	9.37	2.61	.009	.033	0.61
	c3 vs c6	-46.56	6.19	-7.52	<.001	.017	-1.06
	c4 vs c5	-5.73	9.63	-0.59	.553	-	-0.23
	c4 vs c6	-76.78	6.59	-11.66	<.001	.020	-2.15
	c5 vs c6	-71.05	10.24	-6.94	<.001	.023	-1.59
1	c1 vs c2	-116.87	12.29	-9.51	<.001	.005	-3.40
	c1 vs c3	-44.96	14.21	-3.16	.002	.045	-1.09
	c1 vs c4	-40.91	12.48	-3.28	<.001	.010	-1.17
	c1 vs c5	-81.80	12.26	-6.67	<.001	.015	-2.18
	c2 vs c3	71.92	7.76	9.27	<.001	.020	1.64
	c2 vs c4	75.97	3.72	20.41	<.001	.025	2.02
	c2 vs c5	35.17	2.90	12.12	<.001	.030	0.87
	c3 vs c4	4.06	8.05	0.50	.614	-	0.09
	c3 vs c5	-36.74	7.70	-4.77	<.001	.035	-0.80
	c4 vs c5	-40.80	3.60	-11.33	<.001	.040	-1.01
2	c1 vs c2	-64.92	5.92	-10.98	<.001	.003	-2.17
	c1 vs c3	-33.99	5.62	-6.05	<.001	.007	-1.32
	c1 vs c4	-72.39	5.24	-13.82	<.001	.010	-2.51
	c1 vs c5	-104.59	5.24	-19.95	<.001	.013	-3.55
	c1 vs c6	-43.96	6.69	-6.57	<.001	.017	-1.72
	c2 vs c3	30.93	4.35	7.11	<.001	.020	0.99
	c2 vs c4	-7.47	3.84	-1.95	<.001	.023	-0.22
	c2 vs c5	-39.67	3.84	-10.32	<.001	.027	-1.16
	c2 vs c6	20.96	5.66	3.70	<.001	.030	0.67
	c3 vs c4	-38.40	3.40	-11.40	<.001	.033	-1.27
	c3 vs c5	-70.60	3.38	-20.91	<.001	.037	-2.29
	c3 vs c6	-9.96	5.36	-1.86	<.001	.040	-0.37

c4 vs c5	-32.21	2.60	-11.98	<.001	.043	-0.96
c4 vs c6	28.43	4.95	5.74	<.001	.047	0.94
c5 vs c6	60.64	4.96	12.24	<.001	.050	1.98

*p value was not statistically significant after applying linear step-up correction (i.e., p > Critical p). All remaining p values < .05 were statistically significant after applying linear step-up correction (i.e., p < Critical p).

Table 6
General linear model contrasts among latent profile classes in grades 3-5 and grade 8

Grade	Comparison	Estimate	S.E.	t-value	*p*	Critical *p*	Hedge's *g*
3	c1 vs c2	-0.61	0.27	-2.31	.021	.040	-0.53
	c1 vs c3	-0.99	0.19	-5.30	<.001	.005	-1.04
	c1 vs c4	-2.43	0.23	-10.71	<.001	.010	-2.94
	c1 vs c5	-2.05	0.25	-8.23	<.001	.015	-2.47
	c2 vs c3	-0.37	0.20	-1.86	.063	-	-0.52
	c2 vs c4	-1.81	0.24	-7.64	<.001	.020	-2.07
	c2 vs c5	-1.44	0.26	-5.55	<.001	.025	-1.67
	c3 vs c4	-1.44	0.14	-10.16	<.001	.030	-1.45
	c3 vs c5	-1.07	0.18	-6.07	<.001	.035	-1.21
	c4 vs c5	0.38	0.22	1.73	.085	-	0.25
4	c1 vs c2	-1.45	0.13	-10.77	<.001	.005	-1.40
	c1 vs c3	0.12	0.32	0.38	.703	-	0.25
	c1 vs c4	-1.91	0.17	-11.07	<.001	.010	-2.62
	c1 vs c5	-0.37	0.16	-2.28	.023	.040	-0.54
	c2 vs c3	1.57	0.31	5.12	<.001	.015	1.56
	c2 vs c4	-0.46	0.14	-3.25	.001	.035	-0.68
	c2 vs c5	1.08	0.13	8.37	<.001	.020	0.92
	c3 vs c4	-2.03	0.33	-6.25	<.001	.025	-2.83
	c3 vs c5	-0.49	0.32	-1.54	.125	-	-0.75
	c4 vs c5	1.54	0.17	9.16	<.001	.030	1.80
5	c1 vs c2	-0.72	0.30	-2.44	.015	.050	-1.17
	c1 vs c3	-1.43	0.26	-5.60	<.001	.005	-2.01
	c1 vs c4	-2.55	0.26	-9.93	<.001	.010	-3.36
	c1 vs c5	-3.54	0.28	-12.51	<.001	.015	-5.65
	c2 vs c3	-0.71	0.16	-4.40	<.001	.020	-1.05
	c2 vs c4	-1.83	0.16	-11.15	<.001	.025	-2.40
	c2 vs c5	-2.82	0.20	-13.93	<.001	.030	-4.37
	c3 vs c4	-1.12	0.07	-16.00	<.001	.035	-1.31
	c3 vs c5	-2.11	0.14	-15.38	<.001	.040	-2.64
	c4 vs c5	-0.98	0.14	-7.00	<.001	.045	-1.34
8	c1 vs c2	-1.46	0.08	-18.16	<.001	.012	-1.61
	c1 vs c3	1.10	0.18	6.07	<.001	.033	1.42
	c2 vs c3	2.56	0.19	13.42	<.001	.050	3.53

Note. All *p* values < .05 were statistically significant after applying linear step-up correction (i.e., *p* < Critical *p*).

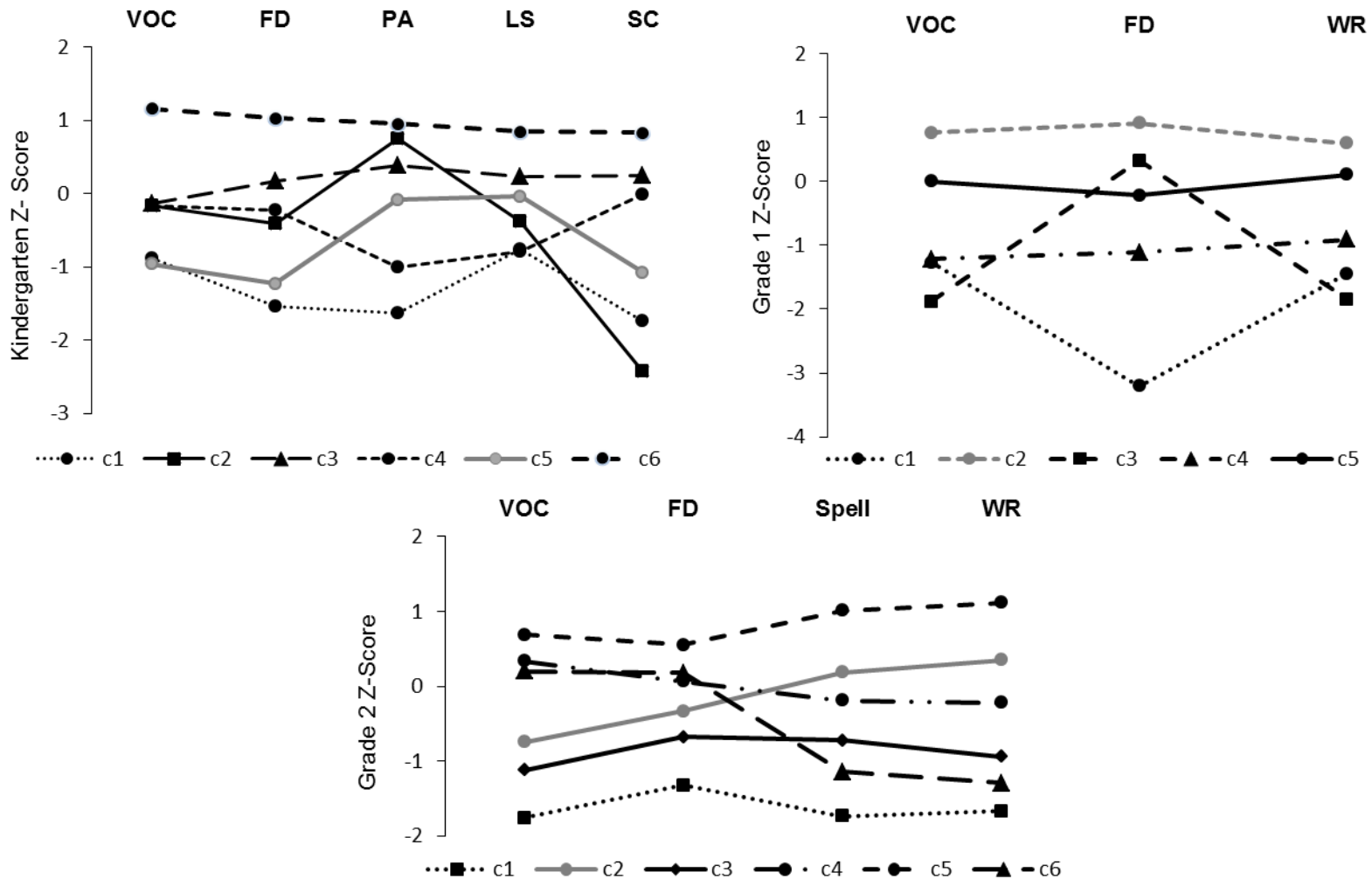

Figure 1

Clockwise from top left, profile plots reflect data for K-2 grades for FRA measures of Vocabulary Pairs (VOC), Following Directions (FD), Phonological Awareness (PA), Letter Sounds (LS), Sentence Comprehension (SC), Word Reading (WR), and Spelling (Spell). The lines represent distinct emergent profiles (i.e., c1, c2, c3, etc.).

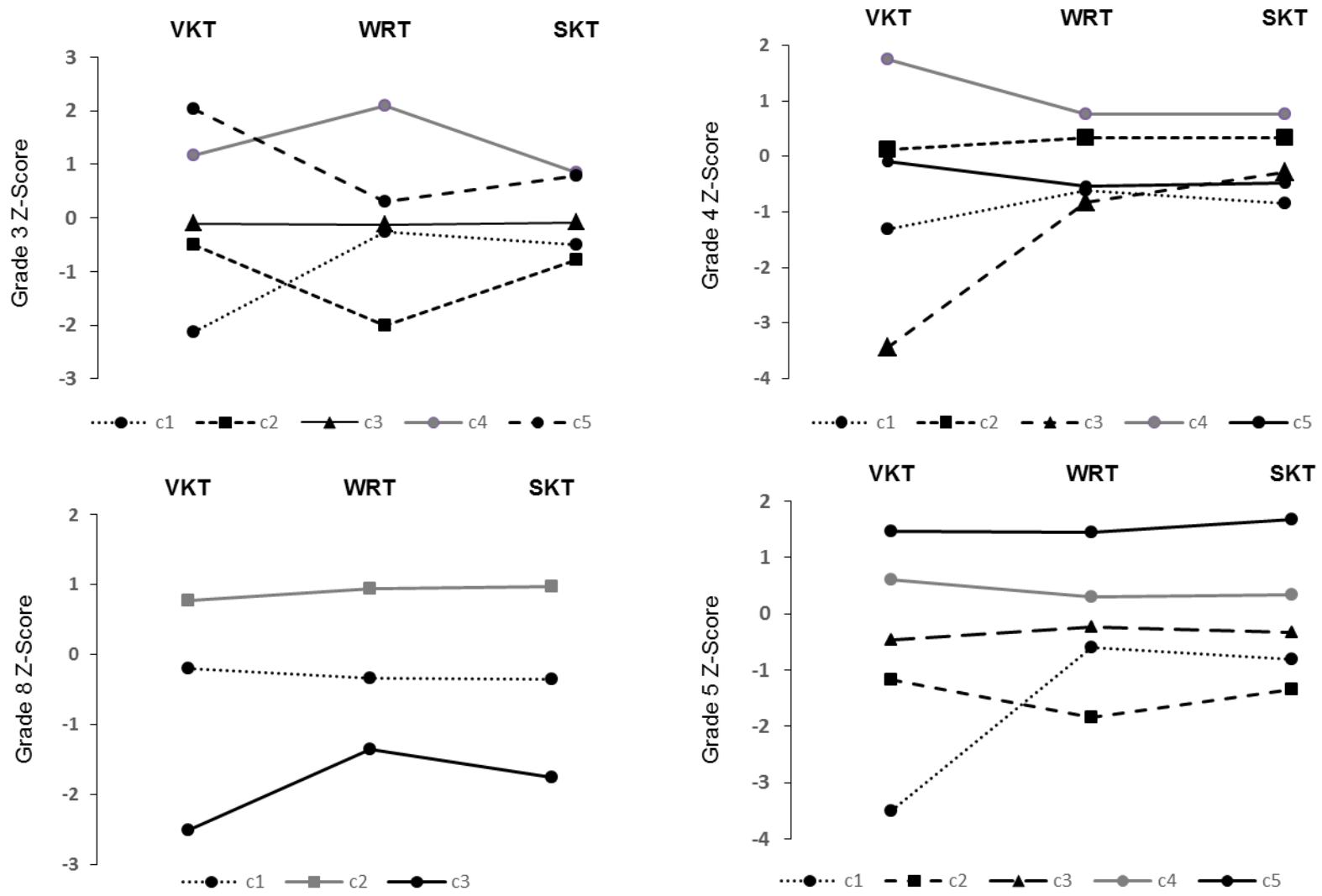

Figure 2

Clockwise from top left, profile plots reflect data for 3rd, 4th, 5th, and 8th grades for FRA measures of Vocabulary Knowledge Task (VKT), Word Recognition Task (WRT), and Syntactic Knowledge Task (SKT). The lines represent distinct emergent profiles (i.e., c1, c2, c3, etc.).