Reading and Writing (2020) 33:2155–2171
https://doi.org/10.1007/s11145-020-10038-0

Identifying profiles of struggling adult readers: relative strengths and weaknesses in lower-level and higher-level competencies

Amani Talwar[1] · **Daphne Greenberg**[1] · **Hongli Li**[2]

Published online: 19 March 2020

Abstract
A major challenge in research with struggling adult readers is their heterogeneity in reading-related competencies and demographic characteristics. The purpose of this investigation was to identify unique profiles of skill sets among struggling adult readers and explore informative demographic differences between profiles. Using latent class analysis with a sample of 542 struggling adult readers, we uncovered four empirically distinct classes of readers based on their performance on ten assessments of lower-level and higher-level competencies. On all measured competencies, globally impaired readers ($n = 123$) demonstrated the largest deficits and globally better readers ($n = 86$) outperformed all other classes. Two intermediate profiles, weak decoders ($n = 144$) and weak language comprehenders ($n = 189$), exhibited complementary patterns of strengths and weaknesses on lower-level and higher-level competencies. One-way ANOVA and chi-square tests of difference indicated that the classes differed significantly in terms of reading comprehension performance, age, and language background but not high school completion. Implications for instruction and future research are discussed.

Keywords Adult literacy · Latent class analysis · Reading comprehension · Struggling adult readers

Introduction

The reading comprehension process involves both lower-level and higher-level competencies (McNamara & Magliano, 2009; Perfetti & Stafura, 2014). Basic skills help the reader translate print to language (Gough & Tunmer, 1986; Nagy, Berninger, &

✉ Amani Talwar
atalwar1@gsu.edu

[1] Department of Learning Sciences, Georgia State University, Atlanta, GA, USA

[2] Department of Educational Policy Studies, Georgia State University, Atlanta, GA, USA

Abbott, 2006). More complex abilities facilitate the creation of a meaningful mental model (Graessar, Singer, & Trabasso, 1994; Kintsch, 1988). Research with adolescents indicates distinct profiles of variation in these competencies (e.g., Brasseur-Hock, Hock, Kieffer, Biancarosa, & Deshler, 2011; Clemens, Simmons, Simmons, Wang, & Kwok, 2017). However, similar work is lacking with adults who have difficulty understanding text, which includes about one in five adults in the United States [National Center for Education Statistics (NCES), 2019]. This population of struggling adult readers is heterogeneous in terms of reading-related competenices as well as demographic characteristics (Lesgold & Welch-Ross, 2012; Strucker & Davidson, 2003). The goals of this investigation were to identify meaningful patterns of skill sets in this population and examine how they are related to reading comprehension. The findings can help shape adult literacy instruction that is responsive to heterogeneity.

The reading systems framework

For a comprehensive account of reading comprehension, we turn to the Reading Systems Framework (RSF; Perfetti & Stafura, 2014). The RSF posits that word-level processes, language abilities, and general knowledge are all involved in the construction of a meaningful mental model. Word recognition draws upon phonological, orthographic, and morphological knowledge. Oral language skills support the parsing of sentences and the formation of meaning units. Inference generation and prior knowledge facilitate integration processes that further strengthen the mental model, which results in deep comprehension.

Prior work with struggling adult readers supports the view that these skills and knowledge sources are related to comprehension. Metalinguistic awareness and word reading have been shown to contribute to reading comprehension performance (Braze et al., 2016; Fracasso, Bangs, & Binder, 2016; Talwar, Tighe, & Greenberg, 2018; Tighe & Schatschneider, 2016). The effects of language comprehension, background knowledge, and inference on reading comprehension have also been reported (Braze et al., 2016; Mellard, Fall, & Woods, 2010; Sabatini, Sawaki, Shore, & Scarborough, 2010; Talwar et al., 2018; Tighe, Johnson, & McNamara, 2017). Although more research is needed, the literature suggests that these competencies are important sources of variation within the struggling adult reader population.

Identifying reading profiles with latent class analysis

Researchers have utilized latent class analysis (LCA) to identify meaningful profiles of readers with children and adolescents in K-12 settings (Cogo-Moreira et al., 2013; Gilbert et al., 2013; Tsujimoto et al., 2019). LCA is a probabilistic method that estimates class membership as a latent or underlying trait based on observed performance on multiple variables. Individuals in the same latent class are considered similar to one another and significantly different from individuals in other classes on one or more observed variables. In the context of reading research, LCA can be used as a diagnostic procedure to assess varying instructional needs that can be

addressed with interventions (Logan & Pentimonti, 2016). This approach has enabled the classification of struggling readers in secondary grades into subgroups with specific deficits in component reading and language skills (Brasseur-Hock et al., 2011; Catts, Compton, Tomblin, & Bridges, 2012; Clemens et al., 2017; Lesaux & Kieffer, 2010). For example, adolescents with below-average comprehension may be deficient in vocabulary knowledge, reading fluency, or both (Clemens et al., 2017). Similarly, some struggling adolescent readers may have impairments across various competencies, whereas others may have difficulty in only one area, such as language comprehension (Brasseur-Hock et al., 2011). This heterogeneity in profiles of poor adolescent readers makes a strong case for differential interventions. Unfortunately, similar research with struggling adult readers is limited.

Skill profiles of struggling adult readers

It is pertinent to our investigation to review prior attempts to explore skill profiles of struggling adult readers. In one early effort, Strucker and Davidson (2003) identified ten clusters of adults with low literacy skills. The largest group was comprised of intermediate-level readers whose decoding skills were stronger than their vocabulary knowledge. The other major groups consisted of relatively more proficient readers who had specific deficits in background knowledge and reading fluency, respectively. The distribution of native and nonnative speakers of English varied across groups, with one very low-skilled group identified as needing instruction in *English to Speakers of Other Languages* (*ESOL*).

A more recently used approach is to divide samples of struggling adult readers into four groups based on cutoff criteria on two dimensions. This approach is akin to plotting each participant's scores from two tests as a point on an X–Y coordinate plane and identifying each quadrant of the plane as a separate group. Mellard, Woods, and Desa (2012) used this method to classify different profiles informed by reading speed and accuracy (e.g., fast and inaccurate readers). Likewise, Binder and Lee (2012) were able to identify distinct groups based on decoding and comprehension performance (e.g., poor decoders/skilled comprehenders). Although this approach is informative, reliance on cutoff criteria may be susceptible to arbitrary decisions regarding what constitutes low or high performance.

Another approach is to use cluster analysis to explore different patterns of performance across multiple reading and language measures. For example, Mellard, Fall, and Mark (2009) identified seven clusters of struggling adult readers, two of which exhibited similar comprehension proficiency but different fluency skills. MacArthur, Konold, Glutting, and Alamprese (2012) found eight clusters in their sample, which were unbalanced in terms of native and nonnative speakers of English. Specifically, nonnative speakers were more likely to belong to groups that demonstrated relatively higher decoding skills and less likely to belong to groups that demonstrated relatively higher reading comprehension skills. Although these findings show the utility of cluster analysis for understanding reader profiles, cluster analysis requires normally distributed data, which are not ubiquitous in atypical populations. In contrast, LCA does not involve such strong assumptions (Schreiber & Pekarik, 2014).

Thus, we turn to LCA as an alternative option for studying readers with literacy deficits (e.g., Brasseur-Hock et al., 2011; Clemens et al., 2017).

Demographic differences among struggling adult readers

In addition to heterogeneity in skill sets, struggling adult readers also vary in terms of demographic characteristics. In the United States, adults with low literacy skills comprise a diverse population, such as in terms of language background, age, and educational attainment (Lesgold & Welch-Ross, 2012). It is possible that such characteristics covary with different reading profiles and should be explored further.

Among struggling adult readers, there appear to be some differences related to language background. Nanda, Greenberg, and Morris (2010) found that component reading skills are organized and interrelated in different ways for native and non-native English speakers. Additionally, Herman, Cote, Reilly, and Binder (2013) reported that the relations between reading comprehension and lower-level skills varied between native English and native Spanish speakers. In contrast, MacArthur, Konold, Glutting, and Alamprese (2010) observed that the same model of reading-related competencies provided acceptable fit to data collected from native and non-native English speakers.

Age is an important correlate of adult literacy levels. Across many major countries, including the United States and Canada, adults who are 16–24 years old have significantly higher literacy proficiency than adults who are 55–65 years old (OECD 2013). These discrepancies in literacy performance may be exacerbated by the age-related decline of core cognitive functions including processing speed and working memory (Deary et al., 2009).

Not surprisingly, adults' literacy proficiency is also related to their level of education (OECD 2013). This picture is complicated by the finding with struggling adult readers that having a high school diploma is not necessarily associated with performance on literacy assessments (Miller, Greenberg, Hendrick, & Nanda, 2017). More work is needed to explore whether high school completion matters in terms of literacy skill patterns among struggling adult readers.

The current study

The purpose of the current study was to extend the work of identifying subgroups within the struggling adult reader population with a robust methodology and a comprehensive assessment battery. We utilized LCA to identify patterns of performance on measures that assess lower-level and higher-level skills. Our secondary aims were to examine the importance of reading profiles to an important distal outcome like reading comprehension performance (Binder & Lee, 2012; Mellard et al., 2012) and determine whether certain demographic groups are differentially represented across profiles (MacArthur et al., 2012).

Three research questions guided our investigation:

1. Can we identify distinct classes of struggling adult readers based on reading-related competencies?
2. Are there differences between classes in reading comprehension performance?
3. Does class membership covary with demographic characteristics like age, language background, and high school completion?

Method

Participants

Participants included 542 struggling adult readers from a larger project (Institute of Education Sciences, U.S. Department of Education, Grant R305C120001). All participants were enrolled in adult literacy programs, specifically in classes that targeted reading levels between the 3.0 and 7.9 grade levels. Ages ranged from 16 to 71 years, with a mean of 36.80 years ($SD = 14.20$). Further demographic information is reported in Table 1. The majority groups were women (62%), individuals of African descent (61%), and native English speakers (72%). Additionally, 20% reported that they had a high school diploma.

Table 1 Sample demographics

Characteristic	*n*	%
Country		
United States	280	51.7
Canada	262	48.3
Gender		
Female	334	61.6
Male	189	34.9
English background		
Native speaker of English	392	72.3
Non-native speaker of English	140	25.8
Not reported	10	1.8
High school completion		
Had high school diploma	109	20.1
Did not have high school diploma	416	76.8
Not reported	17	3.1
Race		
African Descent	328	60.5
White	139	25.6
Asian	33	6.1
Native/Indigenous	12	2.2
Pacific Islander	2	0.4
Not reported	28	5.2

Materials

As part of the larger battery, 10 assessments were administered to participants one-on-one by trained research assistants.

Lower-level competencies

Two measures tapped into metalinguistic awareness. A composite was obtained from performance on the three subtests of the Comprehensive Test of Phonological Processing II (CTOPP; Wagner, Torgesen, Rashotte, & Pearson, 2013). In the CTOPP Blending Words subtest, participants listened to separated sounds and had to blend them together to form a real word. In the CTOPP Elision subtest, participants listened to a word and had to repeat it after removing specific sounds to form a different word. In the CTOPP Phonemic Isolation subtest, participants listened to a word and had to identify the sound at a specific position in the word. In the Grammatical Morphemes subtest of the Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999), participants listened to a pair of words that had a morphological relationship and then were given a third word for which they had to produce an analogously related word.

In addition, three measures involved word reading. In the Word Attack subtest of the Woodcock-Johnson III Normative Update (WJ; Woodcock, McGrew, & Mather, 2007), participants had to read pronounceable pseudowords out loud. In the WJ Letter-Word Identification subtest, participants had to read real words out loud. In the Test of Irregular Word Reading (Reynolds & Kamphaus, 2007), participants had to read out loud real words that had irregular spellings (e.g., *yacht*).

Higher-level competencies

Three measures tapped into language comprehension. In the CASL Ambiguous Sentences subtest, participants listened to a short passage containing a target sentence with more than one meaning and had to provide two meanings for the sentence. In the CASL Meaning from Context subtest, participants listened to a short passage containing an infrequently used word and had to provide the meaning of the word based on context. In the CASL Nonliteral Language subtest, participants listened to an utterance featuring figurative language, indirect requests, or sarcasm, and had to answer a question about the meaning of the utterance.

Additionally, one measure assessed background knowledge. In the WJ Academic Knowledge subtest, participants had to answer questions related to science, social studies, and humanities. Each of these knowledge domains was tapped by a separate subscale.

Finally, one measure involved inferencing. In the CASL Inference subtest, participants listened to a short passage that had missing information and had to answer a question about the missing information using world knowledge or contextual clues.

Data analysis strategy

To establish a common scale for the data, raw scores on all measures were transformed to z-scores. LCA was used to address the first research question. In Mplus 8.1 (Muthén & Muthén, 1998–2017), we began with a two-class model that tested the possibility that all participants belong to one of two groups with homogenous reading-related competencies. Next, we estimated a model with three classes, and continued to estimate models with an increasingly larger number of classes until the Lo–Mendell–Rubin likelihood ratio test (Lo, Mendell, & Rubin, 2001) was no longer statistically significant (Logan & Pentimonti, 2016). This test assesses the likelihood that the tested LCA model exhibits identical fit to the data as an LCA model where the number of groups is smaller by one.

From the estimated models, we selected the model that fit the data and exhibited interpretable patterns of group mean scores. We classified the participants according to the selected LCA model and then conducted post-hoc analyses to examine how the class membership was related to a distal outcome (reading comprehension) and covariates (demographic characteristics). Specifically, we compared classes using ANOVAs and chi-square independence tests.

Results

Research Question 1: Can we identify distinct classes of struggling adult readers based on reading-related competencies?

Model evaluation

Following the data analysis strategy outlined above, we estimated a total of five LCA models, with the number of classes ranging from two to six. The results from these models are reported in Table 2. Entropy values were greater than 0.80 across all models, which suggests good separation between groups. The significant Lo–Mendell–Rubin likelihood ratio test result for the two-class model ($p = 0.007$) indicated that a two-class solution provided a better fit to the data than a one-class solution. Similarly, the Lo–Mendell–Rubin likelihood ratio test indicated an improvement in

Table 2 Latent class model fit indices

Number of classes	−2LL	Free parameters	AIC	BIC	Entropy	Lo–Mendell–Rubin likelihood ratio test *p* value
2	−6638.438	31	13,338.875	13,472.028	0.814	0.0072
3	−6363.663	42	12,811.325	12,991.726	0.823	0.0316
4	−6153.858	53	12,413.716	12,641.365	0.843	0.0025
5	−6010.875	64	12,149.750	12,424.647	0.844	0.0343
6	−5901.622	75	11,953.244	12,275.389	0.858	0.0548

model fit when the number of classes was increased from two to three ($p = 0.032$), three to four ($p = 0.003$), and four to five ($p = 0.034$). The p value was not significant for the six-class model ($p = 0.055$); thus, model estimation was discontinued.

This process indicated the four- and five-class models as the best LCA solutions in terms of statistical fit. We graphed the group mean scores on the ten measures according to each solution. The four-class solution exhibited relatively clear patterns whereas the five-class solution involved trend overlaps between groups and did not lend itself to clear interpretation. The five-class solution was similar to the four-class solution except that it split one of the four classes into two. The entropy values of the four-class model and five-class model were very similar, which indicates that the four-class model separated the struggling adult readers as well as the five-class model. For these reasons, coupled with a preference for parsimony, we selected the four-class LCA solution as our final model.

Interpretation of classes

The mean performance of the four latent classes across the ten measures is reported in Table 3 and visually presented in Fig. 1. Individuals in Class 1 ($n = 123$; 23% of sample) were relatively weak in all competencies and were labeled *Globally Impaired Readers*. Individuals in Class 2 ($n = 86$; 16% of sample) were relatively strong in all competencies and were labeled *Globally Better Readers*. Individuals in Class 3 ($n = 144$; 26% of sample) were relatively weak in lower-level competencies and strong in higher-level competencies; this profile was labeled *Weak Decoders*. Finally, individuals in Class 4 ($n = 189$; 35% of sample) were relatively strong in lower-level competencies and weak in higher-level competencies; this group was labeled *Weak Language Comprehenders*.

Research Question 2: Are there differences between classes in reading comprehension performance?

Table 3 includes the performance of the total sample and each of the four classes on the WJ Passage Comprehension subtest. A one-way ANOVA indicated a significant difference between classes on WJ Passage Comprehension score $F(3,512) = 103.26$ ($p < 0.001$). Tukey's post hoc comparison of group means showed that *Globally Better Readers* had higher scores than all other classes and *Globally Impaired Readers* had lower scores than all other classes ($ps < 0.001$). No significant difference was found between *Weak Decoders* and *Weak Language Comprehenders*.

Research Question 3: Does class membership covary with demographic characteristics like age, language background, and high school completion?

Age

Globally Impaired Readers represented an age range of 18 to 71 years, with a mean of 38.25 ($SD = 12.85$). For *Globally Better Readers*, ages ranged from 16 to

Table 3 Performance on measures

Measure	Total sample				Globally impaired readers				Globally better readers				Weak decoders				Weak language comprehenders			
	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE
CTOPP Phonological Awareness	47.45	16.67	13–87	–	35.64	12.12	13–71	–	66.61	12.72	31–87	–	42.73	13.60	16–83	–	50.50	14.24	17–84	–
CASL Grammatical Morphemes	18.16	8.61	3–45	–	11.74	5.70	3–34	–	28.46	7.94	12–45	–	16.75	6.30	4–40	–	18.85	7.49	4–42	–
WJ Word Attack	16.70	7.45	1–31	3.3	8.89	3.90	1–19	2.1	23.96	4.09	13–31	6.1	11.76	4.09	4–23	2.4	21.98	4.27	13–31	5.1
Test of Irregular Word Reading	37.83	5.23	20–50	7.1	32.80	5.18	20–44	4.9	42.40	2.61	32–48	10.7	35.93	4.33	22–45	6.2	40.46	2.78	33–50	8.7
WJ Letter Word Identification	54.98	8.34	33–72	5.3	46.31	5.28	34–59	3.5	63.72	4.12	54–71	9.1	50.91	6.13	33–67	4.4	59.94	4.81	47–72	7.1
CASL Ambiguous Sentences	5.66	6.02	0–28	–	1.56	2.20	0–10	–	13.90	5.85	0–28	–	7.21	5.01	0–19	–	3.46	4.25	0–16	–

Table 3 (continued)

Measure	Total sample				Globally impaired readers				Globally better readers				Weak decoders				Weak language comprehenders			
	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE	Mean score	SD	Range	Mean GE
CASL Non-literal Language	9.57	6.73	0–36	–	14.02	6.41	0–32	–	28.59	6.19	1–41	–	24.95	5.76	10–39	–	17.07	6.77	0–33	–
CASL Meaning from Context	20.30	8.33	0–41	–	5.07	3.76	0–15	–	18.56	6.43	6–36	–	12.58	4.52	3–25	–	6.10	4.17	0–17	–
WJ Academic Knowledge	46.02	6.43	22–64	4.2	41.05	4.96	29–55	2.8	52.63	4.60	41–64	6.5	48.90	4.38	40–59	5.2	44.10	5.71	22–56	3.7
CASL Inference	23.89	9.65	0–46	–	17.11	7.59	0–30	–	33.46	6.24	15–46	–	30.43	5.37	6–42	–	19.07	7.88	1–36	–
WJ Passage Comprehension	28.36	4.77	15–42	3.7	24.08	4.06	15–34	2.7	33.35	2.96	27–42	6.7	29.27	3.56	17–39	4.0	28.18	4.06	17–38	3.7

GE grade equivalent, *CTOPP* comprehensive test of phonological processing II, *CASL* comprehensive assessment of spoken language, *WJ* Woodcock–Johnson III normative update. Grade equivalents are not available for all measures

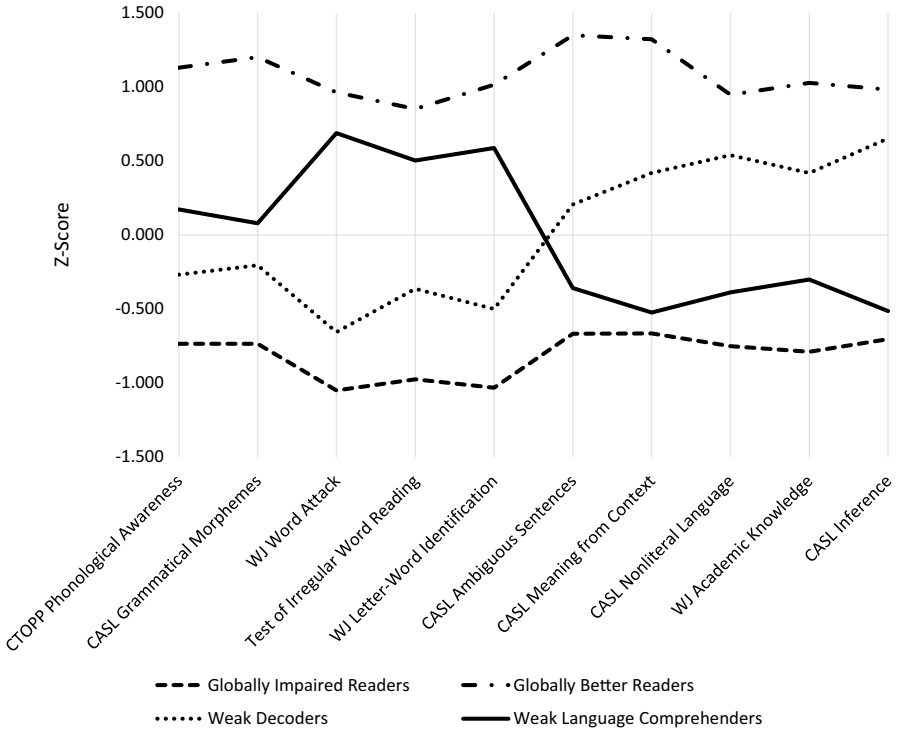

Fig. 1 Mean performance of the four latent classes on ten reading-related competencies

66 years, with a mean of 31.61 ($SD = 12.17$). The age range for *Weak Decoders* was 18 to 71 years, with a mean of 43.64 ($SD = 15.22$). For *Weak Language Comprehenders*, the age range was 17 to 65 years, with a mean of 33.05 ($SD = 12.92$). A one-way ANOVA indicated a significant difference between classes on age $F(3, 524) = 21.42$ ($p < 0.001$). Tukey's post hoc comparison of group means showed that on average *Weak Decoders* were older than all other classes, and *Globally Impaired Readers* were older than *Globally Better Readers* and *Weak Language Comprehenders* ($ps < 0.01$). No significant difference in age was found between *Globally Better Readers* and *Weak Language Comprehenders* ($p > 0.05$).

Native speaker status

Native speakers of English comprised 68.3% of *Globally Impaired Readers*, 86.9% of *Globally Better Readers*, 85.7% of *Weak Decoders*, and 62.2% of *Weak Language Comprehenders*. A chi-square test of independence indicated a significant relationship between class membership and native English speaker status (χ^2 (3) = 32.53, $p < 0.001$). *Globally Better Readers* and *Weak Decoders* included a significantly larger proportion of native English speakers than the other two classes. In other words, native speakers were more likely to be members of groups with strong higher-level competencies.

High school completion

Individuals with a high school diploma comprised 17.2% of *Globally Impaired Readers*, 11.9% of *Globally Better Readers*, 24.5% of *Weak Decoders*, and 24.4% of *Weak Language Comprehenders*. A chi-square test of independence indicated that there was no significant relationship between class membership and having a high school diploma (χ^2 (3) = 7.58, $p > 0.05$).

Discussion

According to the most recent estimate, about 19% of adults in the United States have inadequate reading skills (NCES, 2019). To design reading interventions for struggling adult readers, it is crucial to assess the specific needs of this population. In service of this goal, the purpose of this study was to explore distinct groups of struggling adult readers based on competencies that are important for reading. Using LCA, we identified four unique profiles in our sample. Two extreme profiles showed relative impairment or proficiency across all competencies, and two intermediate profiles demonstrated complementary patterns of strengths and weaknesses in lower-level and higher-level skills. Furthermore, we uncovered systematic variations among these profiles in terms of age and language background. Younger adults were more likely to belong to one of the two groups with stronger lower-level skills. Additionally, native English speakers were more likely to belong to one of the two groups with stronger higher-level skills.

Extreme profiles with uniform skill levels

Two profiles had ability levels at opposite ends of the spectrum: *Globally Impaired Readers* and *Globally Better Readers*. Given the large sample size, it is not surprising that some readers are relatively highly skilled and others are relatively lower skilled across all measured areas. It is likely that individuals in these groups have similar skill levels in reading-related domains that we did not assess. Such divergent groups have been identified in previous investigations with struggling adult readers. For example, Strucker and Davidson (2003) identified a cluster of beginning readers with severe deficiencies as well as a separate cluster with strong skills that may be ready to achieve high school equivalency. Likewise, Mellard et al. (2009) found two clusters that had the highest and lowest mean performance, respectively, on all measured skills.

Almost a quarter of the current sample consisted of *Globally Impaired Readers*. This flat profile of deficient skills was associated with the lowest reading comprehension performance. On average, individuals in this group were significantly older than those who were classified as *Globally Better Readers* or *Weak Language Comprehenders*. It is possible that older adults' performance on reading assessments suffers due to typical cognitive slowing (Deary et al., 2009; Hedden & Gabrieli, 2004).

Adults who match the profile of *Globally Impaired Readers* may need extensive instruction and support in adult literacy reading classes. A strategic interventional approach might be to deliver a curriculum focused on decoding, since this lower-level competency appears to be malleable for struggling adult readers (Alamprese, MacArthur, Price, & Knight, 2011; Greenberg et al., 2019).

Globally Better Readers, characterized by relatively strong performance across all domains, comprised the smallest group in the sample. Not surprisingly, this profile had the highest mean reading comprehension scores. However, individuals in this group should not be considered expert adult readers, because their reading comprehension performance was equivalent to the sixth grade level on average (see Table 3). Younger adults were more likely to be classified as *Globally Better Readers* than *Globally Impaired Readers*, perhaps because they are more likely to have recently experienced formal education and, thus, more likely to recall skills and knowledge acquired in K-12 settings. Overall, adults who fit this profile are likely to be very capable readers and may be best suited to classes that prepare them for the high school equivalency test or postsecondary education.

Intermediate profiles with complementary strengths and weaknesses

The two intermediate profiles, *Weak Language Comprehenders* and *Weak Decoders*, showed specific deficits in reading-related competencies but performed similarly on the reading comprehension assessment. Patterns of varying strengths and weaknesses have also been observed in prior investigations with struggling adult readers; for example, Binder and Lee (2012) identified a group with strong decoding skills but poor comprehension skills, and a second group that exhibited the opposite pattern. In the current study, even though participants completed ten assessments, the main difference between these two profiles was related to their performance on word-level skills versus all other measured competencies. As suggested by the RSF, it is possible that word processing is a pressure point for comprehension among some adult readers (Perfetti & Stafura, 2014) and that deficits in this domain require compensatory reliance on language abilities, inferential skills, and background knowledge.

Weak Language Comprehenders comprised over a third of the current sample. Individuals with this profile had difficulty with the higher-level competencies assessed in this investigation, which tapped into language comprehension, inferencing, and background knowledge. This deficit was complimented by relatively strong performance on word reading and metalinguistic awareness. This group included a high proportion of nonnative English speakers, which is consistent with past findings indicating that nonnative speakers have stronger phonological and decoding skills (Nanda et al., 2010). This profile is similar to two clusters identified by MacArthur et al. (2012) in which nonnative speakers were overrepresented and word-level competencies were stronger than other skills. The oral language competence of *Weak Language Comprehenders* can be improved by using individualized technology-based tools, such as apps for English language learning that include audio stimuli and feedback (Nisbet & Austin, 2013). Additionally, the knowledge gaps of

such learners can be addressed with informative text materials, videos, and interactive games (Strucker, 2013).

The other intermediate profile consisted of *Weak Decoders* and included about a quarter of the current sample. This group struggled with assessments of lower-level skills, which involved word reading and metalinguistic awareness, but had above-average performance on the higher-level competencies. On average, this group was significantly older than all other groups. It is possible for older adults to compensate for limitations in cognitive processing by relying on acquired knowledge (Charness, 2000), which may explain the pattern of competencies observed with this profile. There may also be a cohort effect involving word reading strategies, which can be attributed to historical changes in reading instruction (Hempenstall, 1997). Overall, this group appears to be similar to the "resilient readers" identified by Binder and Lee (2012), who performed above average on reading comprehension despite poor decoding skills. Like *Globally Impaired Readers*, this profile may benefit from intensive didactic instruction in decoding (Alamprese et al., 2011; Greenberg et al., 2019).

Limitations and future research

An important limitation to note is that the measures included in this study were not intended to be administered to our population of interest. Due to a lack of measures designed specifically for struggling adult readers, we administered measures that are widely used with children and adolescents in clinical and research settings. Some of these measures, such as the WJ subtests, were normed on general adult samples. Other measures, such as the CASL subtests, were normed on individuals younger than 21 years. We recognize the possibility that measures designed for children may not function as expected for struggling adult readers (Greenberg, Pae, Morris, Calhoon, & Nanda, 2009) and recommend the use of psychometrically appropriate instruments for this population once they are available.

We also recommend that results be interpreted in the context of the specific reading comprehension measure administered in the current study. The WJ Passage Comprehension subtest is a cloze task consisting of relatively short items. Keenan, Betjemann, and Olson (2008) have demonstrated with school-age youth that a major portion of the variance in test performance is carried by word recognition and not language comprehension. Future investigations should explore other measures of reading comprehension in relation with profiles of struggling adult readers. Both researchers and practitioners may be interested in assessments that are administered in adult education programs to monitor student progress, such as the Test of Adult Basic Education (TABE; Data Recognition Corporation, 2019) and the Comprehensive Adult Student Assessment Systems (CASAS, 2019).

The profiles that emerged in the current sample were characterized by distinct patterns of strengths and weaknesses across ten competencies. One potential application of the findings is to administer a short screening battery of assessments to new students who enroll in adult literacy programs. Their performance can be used to identify their specific needs and categorize them into groups that

can receive targeted instruction (Mellard et al., 2012). Additionally, it is important to consider that struggling adult readers differ in ways other than performance on reading assessments. For instance, it is worth exploring whether subgroups can be identified based on the strategies and processes that adults use to complete reading tasks. This can be done by analyzing behavioral data, such as records of eye movements made during a reading activity (Hyönä, Lorch, & Kaakinen, 2002) and response times for answering reading comprehension questions in a virtual learning environment (Fang et al., 2018).

Acknowledgements The research reported here is supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305C120001, Georgia State University. The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.

References

Alamprese, J. A., MacArthur, C. A., Price, C., & Knight, D. (2011). Effects of a structured decoding curriculum on adult literacy learners' reading development. *Journal of Research on Educational Effectiveness, 4*(2), 154–172.

Binder, K. S., & Lee, C. (2012). Reader profiles for adults with low literacy skills: A quest to find resilient readers. *Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education, 1*(2), 78.

Brasseur-Hock, I. F., Hock, M. F., Kieffer, M. J., Biancarosa, G., & Deshler, D. D. (2011). Adolescent struggling readers in urban schools: Results of a latent class analysis. *Learning and Individual Differences, 21*(4), 438–452.

Braze, D., Katz, L., Magnuson, J. S., Mencl, W. E., Tabor, W., Van Dyke, J. A., et al. (2016). Vocabulary does not complicate the simple view of reading. *Reading and Writing: An Interdisciplinary Journal, 29*, 435–451.

Carrow-Woolfolk, E. (1999). *Comprehensive assessment of spoken language*. Bloomington, MN: Pearson Assessments.

Catts, H. W., Compton, D., Tomblin, J. B., & Bridges, M. S. (2012). Prevalence and nature of late-emerging poor readers. *Journal of educational psychology, 104*(1), 166.

Charness, N. (2000). Can acquired knowledge compensate for age-related declines in cognitive efficiency? In S. H. Qualls & N. Abeles (Eds.), *Psychology and the aging revolution: How we adapt to longer life* (pp. 99–117). Washington: American Psychological Association.

Clemens, N. H., Simmons, D., Simmons, L. E., Wang, H., & Kwok, O. M. (2017). The prevalence of reading fluency and vocabulary difficulties among adolescents struggling with reading comprehension. *Journal of Psychoeducational Assessment, 35*(8), 785–798.

Cogo-Moreira, H., Carvalho, C. A. F., Kida, A. D. S. B., de Avila, C. R. B., Salum, G. A., Moriyama, T. S., et al. (2013). Latent class analysis of reading, decoding, and writing performance using the Academic Performance Test: concurrent and discriminating validity. *Neuropsychiatric Disease and Treatment, 9*, 1175–1185.

Comprehensive Adult Student Assessment System. (2019). *CASAS catalog 2019*. Retrieved December 2, 2019 from https://www.casas.org/docs/default-source/newsroom/catalog.pdf.

Data Recognition Corporation. (2019). *Test of adult basic education 11 and 12*. Retrieved December 2, 2019 from https://tabetest.com/students-2/tabe-1112/.

Deary, I. J., Corley, J., Gow, A. J., Harris, S. E., Houlihan, L. M., Marioni, R. E., et al. (2009). Age-associated cognitive decline. *British Medical Bulletin, 92*(1), 135–152.

Fang, Y., Shubeck, K., Lippert, A., Cheng, Q., Shi, G., Feng, S., et al. (2018). Clustering the learning patterns of adults with low literacy skills interacting with an intelligent tutoring system. In *Proceedings from the 11th international conference on educational data mining*, Raleigh, NC.

Fracasso, L. E., Bangs, K., & Binder, K. S. (2016). The contributions of phonological and morphological awareness to literacy skills in the adult basic education population. *Journal of Learning Disabilities, 49*(2), 140–151.

Gilbert, J. K., Compton, D. L., Fuchs, D., Fuchs, L. S., Bouton, B., Barquero, L. A., et al. (2013). Efficacy of a first-grade responsiveness-to-intervention prevention model for struggling readers. *Reading Research Quarterly, 48*(2), 135–154.

Gough, P. B., & Tunmer, W. E. (1986). Decoding, reading, and reading disability. *Remedial and Special Education, 7*(1), 6–10.

Graesser, A. C., Singer, M., & Trabasso, T. (1994). Constructing inferences during narrative text comprehension. *Psychological Review, 101*(3), 371.

Greenberg, D., Ginsburg, L., & Wrigley, H. S. (2017). Research updates: Reading, numeracy, and language education. *New Directions for Adult and Continuing Education, 155*, 83–94.

Greenberg, D., Lovett, M. W., Graesser, A., Frijters, J. C., Branum-Martin, L., & Olney, A. (2019). Center for the study of adult literacy. *Panel presented at the annual principal investigators meeting of the Institute of Education Sciences in Washington, D.C*.

Greenberg, D., Pae, H. K., Morris, R. D., Calhoon, M. B., & Nanda, A. O. (2009). Measuring adult literacy students' reading skills using the Gray Oral Reading Test. *Annals of Dyslexia, 59*(2), 133–149.

Hedden, T., & Gabrieli, J. D. (2004). Insights into the ageing mind: A view from cognitive neuroscience. *Nature Reviews Neuroscience, 5*(2), 87–96.

Hempenstall, K. (1997). The whole language-phonics controversy: An historical perspective. *Educational Psychology, 17*(4), 399–418.

Herman, J., Cote, N. G., Reilly, L., & Binder, K. S. (2013). Literacy skill differences between adult native English and native Spanish speakers. *Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education, 2*(3), 142–155.

Hyönä, J., Lorch, R. F., Jr., & Kaakinen, J. K. (2002). Individual differences in reading to summarize expository text: Evidence from eye fixation patterns. *Journal of Educational Psychology, 94*(1), 44.

Keenan, J. M., Betjemann, R. S., & Olson, R. K. (2008). Reading comprehension tests vary in the skills they assess: Differential dependence on decoding and oral comprehension. *Scientific Studies of Reading, 12*(3), 281–300.

Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction-integration model. *Psychological Review, 95*(2), 163–182.

Lesaux, N. K., & Kieffer, M. J. (2010). Exploring sources of reading comprehension difficulties among language minority learners and their classmates in early adolescence. *American Educational Research Journal, 47*(3), 596–632.

Lesgold, A. M., & Welch-Ross, M. (Eds.). (2012). *Improving adult literacy instruction: Options for practice and research*. Washington, DC: National Academies Press.

Lo, Y., Mendell, N. R., & Rubin, D. B. (2001). Testing the number of components in a normal mixture. *Biometrika, 88*(3), 767–778.

Logan, J. A., & Pentimonti, J. M. (2016). Introduction to latent class analysis for reading fluency research. In K. D. Cummings & Y. Petscher (Eds.), *The fluency construct* (pp. 309–332). New York, NY: Springer.

MacArthur, C. A., Konold, T. R., Glutting, J. J., & Alamprese, J. A. (2010). Reading component skills of learners in adult basic education. *Journal of Learning Disabilities, 43*(2), 108–121.

MacArthur, C. A., Konold, T. R., Glutting, J. J., & Alamprese, J. A. (2012). Subgroups of adult basic education learners with different profiles of reading skills. *Reading and Writing: An Interdisciplinary Journal, 25*, 587–609.

McNamara, D. S., & Magliano, J. (2009). Toward a comprehensive model of comprehension. In B. Ross (Ed.), *Psychology of learning and motivation* (Vol. 51, pp. 297–384). Burlington, MA: Academic Press.

Mellard, D. F., Fall, E., & Mark, C. (2009). Reading profiles for adults with low-literacy: Cluster analysis with power and speeded measures. *Reading and Writing: An Interdisciplinary Journal, 22*, 975–992.

Mellard, D., Fall, E., & Woods, K. (2010). A path analysis of reading comprehension for adults with low literacy. *Journal of Learning Disabilities, 43*(2), 154–165.

Mellard, D., Woods, K., & Desa, M. (2012). An oral reading fluency assessment for young adult career and technical education students. *Learning Disabilities Research & Practice, 27*(3), 125–135.

Miller, C. D., Greenberg, D., Hendrick, R. C., & Nanda, A. (2017). Educational attainment: Limited implications for adult literacy learners. *Journal of Research and Practice for Adult Literacy, Secondary, and Basic Education, 6*(2), 21.

Muthén, L. K., & Muthén, B. O. (1998–2017). *Mplus user's guide* (8th ed.). Los Angeles, CA: Muthén & Muthén.

Nagy, W., Berninger, V. W., & Abbott, R. D. (2006). Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle-school students. *Journal of Educational Psychology, 98*(1), 134.

Nanda, A. O., Greenberg, D., & Morris, R. (2010). Modeling child-based theoretical reading constructs with struggling adult readers. *Journal of Learning Disabilities, 43*(2), 139–153.

National Center for Education Statistics. (2019). *Highlights of the 2017 U.S. PIAAC Results Web Report (NCES 2020-777).* Washington, DC: U.S. Department of Education. Retrieved December 11, 2019 from https://nces.ed.gov/surveys/piaac/current_results.asp.

Nisbet, D., & Austin, D. (2013). Enhancing ESL vocabulary development through the use of mobile technology. *Journal of Adult Education, 42*(1), 1–7.

Organisation for Economic Co-operation and Development. (2013). *OECD skills outlook 2013: First results from the survey of adult skills.* OECD Publishing. Retrieved April 10, 2019 from https://www.oecd-ilibrary.org/education/oecd-skills-outlook-2013_9789264204256-en.

Pae, H. K., Greenberg, D., & Williams, R. S. (2012). An analysis of differential response patterns on the Peabody Picture Vocabulary Test-IIIB in struggling adult readers and third-grade children. *Reading and Writing: An Interdisciplinary Journal, 25*, 1239–1258.

Perfetti, C., & Stafura, J. (2014). Word knowledge in a theory of reading comprehension. *Scientific Studies of Reading, 18*(1), 22–37.

Reynolds, C. R., & Kamphaus, R. W. (2007). *Test of irregular word reading efficiency*. Odessa, FL: Psychological Assessment Resources Inc.

Sabatini, J. P., Sawaki, Y., Shore, J. R., & Scarborough, H. S. (2010). Relationships among reading skills of adults with low literacy. *Journal of Learning Disabilities, 43*(2), 122–138.

Schreiber, J. B., & Pekarik, A. J. (2014). Technical note: Using latent class analysis versus K-means or hierarchical clustering to understand museum visitors. *Curator: The Museum Journal, 57*(1), 45–59.

Strucker, J., & Davidson, R. (2003). *Adult reading components study (ARCS): A NCSALL research brief*. Retrieved April 3, 2019 from https://www.ncsall.net/fileadmin/resources/research/brief_strucker2.pdf.

Strucker, J. (2013). The knowledge gap and adult learners. *Perspectives on Language and Literacy, 39*(2), 25–28.

Talwar, A., Tighe, E. L., & Greenberg, D. (2018). Augmenting the Simple View of Reading for struggling adult readers: A unique role for background knowledge. *Scientific Studies of Reading, 22*(5), 351–366.

Tighe, E. L., & Schatschneider, C. (2016). A quantile regression approach to understanding the relations among morphological awareness, vocabulary, and reading comprehension in adult basic education students. *Journal of Learning Disabilities, 49*(4), 424–436.

Tighe, E. L., Johnson, A. M., & McNamara, D. S. (2017). Predicting adult literacy students' reading comprehension: Variations by assessment type. In *American Educational Research Association (AERA) conference*. San Antonio, TX.

Tighe, E. L., Little, C. W., Arrastia-Chisholm, M. C., Schatschneider, C., Diehm, E., Quinn, J. M., et al. (2019). Assessing the direct and indirect effects of metalinguistic awareness to the reading comprehension skills of struggling adult readers. *Reading and Writing: An Interdisciplinary Journal, 32*, 787–818.

Tsujimoto, K. C., Boada, R., Gottwald, S., Hill, D., Jacobson, L. A., Lovett, M., et al. (2019). Causal attribution profiles as a function of reading skills, hyperactivity, and inattention. *Scientific Studies of Reading, 23*(3), 254–272.

Wagner, R. K., Torgesen, J. K., Rashotte, C. A., & Pearson, N. A. (2013). *Comprehensive Test of phonological processing II*. Austin, TX: Pro-Ed.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2007). *Woodcock–Johnson III normative update*. Rolling Meadows, IL: Riverside Publishing.