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University Students with a Significant Historyof Reading Difficulties:What Is and Is Not Compensated?

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Abstract

This study examined the status of current reading, spelling, and phonological processing skills of 28 university students who reported a history of reading acquisition problems. The results indicated that 21 of these participants were currently able to comprehend text at a level expected for university students, although only 8 at a rate comparable to that of university students without a history of reading acquisition problems. In addition, all but two participants showed current problems in two or more of the additional areas examined, including word reading, decoding, spelling, and phonological processing. The performance of ten participants who had a recent diagnosis of reading disability was mostly indistinguishable from the performance of participants without such diagnosis, except on the phonological processing tasks.

Statistics Canada recently published two stunning statistics: 42% of Canadian adults lack the functional literacy skills required in today's information society (Desjardins, Murray, Clermont, & Werquin, 2005), and each 1% improvement in the average literacy rate would translate into 1.5% (or $18 billion) increase in annual GDP (Coulombe, Trembley, & Marchant, 2004). These statistics, albeit simplistic, effectively remind us that reading disabilities are not only a personal but also a societal tragedy. In this paper, we focus on the success stories: adults with a significant history of reading acquisition problems who are completing post-secondary education. More specifically, we examine to what extent they have compensated for their earlier problems both at the level of reading, and at the level of cognitive processes that support reading.

Several studies have indicated that university students with a history of reading problems face persistent challenges in tasks that require manipulation of individual sounds or phonemes (e.g., Bruck, 1992; Gallagher, Laxon, Armstrong, & Frith, 1996; Snowling, Nation, Moxham, Gallagher, & Frith, 1997). It is frequently argued that phonological processing problems constitute the primary deficit in developmental dyslexia (e.g., Pennington, van Orden, Smith, Green, & Haith, 1990; Stanovich, 1988). This position is supported by findings that phonological processing skills of developmental dyslexics are poorer than their reading level would predict (e.g., Bruck, 1990; Stanovich, Siegel, & Gottardo, 1997), and that phonological processing shows a causal priority in longitudinal studies (e.g., Bradley & Bryant, 1985; Parrila, Kirby, & McQuarrie, 2004; Wagner et al., 1997) and exerts a distinctive influence on both the normal and abnormal development of reading skills (e.g., Badian, 1993; Kirby, Parrila, & Pfeiffer, 2003; Scarborough, 1990). While it seems clear that phonological processing problems persist (e.g., Ramus et al., 2003; Reid, Szczerbinski, Iskierka-Kasperek, & Hansen, 2007), it is far less clear that all university students with a history of reading problems experience phonological processing problems as adults (e.g., Rack, 1997), or that different domains of phonological processing skills – phonological awareness, rapid naming speed, and phonological memory – are equally affected.

Similarly, we have little information as to the extent to which different reading and writing skills remain compromised. Some existing studies have identified a group of adults who, despite a history of reading problems, have reading comprehension levels which have improved to within the normal range by adulthood (e.g., Bruck, 1992, 1993; Gallagher et al., 1996; Hatcher, Snowling, & Griffiths, 2002; Lefly & Pennington, 1991; Miller-Shaul, 2005; Pennington et al., 1986; Snowling et al., 1997); particularly if the time constraints are removed (e.g., Mosberg & Johns, 1994). Lefly and Pennington (1991) described this group as "compensated dyslexics" and estimated that 22 to 25 percent of children with dyslexia will eventually compensate for their initial difficulties. However, decoding problems – expressed in inaccurate and slow pseudoword reading – seem to persist even if reading comprehension problems are no longer detectable (e.g., Pennington et al., 1990). Similarly, problems with word reading accuracy (Bruck, 1990) and fluency (Gallagher et al., 1996; Pennington et al., 1990), text reading rate (Hatcher et al., 2002), and spelling (Gallagher et al., 1996) seem to persist into adulthood, perhaps indicating that lower level processes that build on automatized and accessible grapheme-phoneme correspondences are more difficult to compensate than higher level processes relying on a multitude of different skills.

Evidence of persistent difficulties raise the question of how complete is the compensation and what problems remain identifiable in this population. It seems clear that students with reading disabilities are entering postsecondary institutions in greater numbers today than in the past (e.g., Lewis & Farris, 1999). Whether they are all "compensated" in the sense that Lefly and Pennington (1991) intended is far from certain, whereas it is clear that they are all "high-functioning" (e.g., Deacon, Parrila, & Kirby, 2006) in that they are participating in post-secondary education. In this paper, we examine the current level of reading, spelling, and phonological processing of university students with a significant history of reading problems. We first focus on reading and spelling skills to examine if and where we can identify residual deficits and possible strengths. We then move our focus to phonological processing skills in an attempt to understand what deficits may remain even if reading and spelling problems are no longer identifiable.

The second issue we examine is whether a self-report of reading acquisition problems is a viable method to identify a sample of high-functioning, and possibly compensated, adults with a history of reading problems. Several recent studies have focused on individuals with an existing diagnosis of dyslexia (e.g., Ramus et al., 2003; Reid et al., 2007). This may lead to questionable ecological validity of the sample (see McGonnell et al., this issue, for details) and exclusion of those participants who have truly compensated for their earlier problems. Below, we examine whether individuals who report high levels of reading acquisition problems and have a recent diagnosis of dyslexia are systematically different from their peers who also report high levels of reading acquisition problems but do not have a recent diagnosis. If self-reports are valid, then both groups should perform more poorly than a comparison group in decoding, reading rate, and spelling measures, whereas reading comprehension problems should be less prominent. In addition, both groups should show some remaining phonological processing problems.

The performance patterns of university students with a history of reading problems can provide more realistic models and goals for children with dyslexia and for remediation programs aimed at helping these children than can the performance of normally achieving readers. To reach this end, however, a greater understanding is needed first of how these students are currently performing, and second, how they achieve their level of performance. This paper focuses on the first question.

Method

Participants

The *university students with a history of reading problems* (RP) group consisted of 28 university students (9 males and 19 females) who self-identified as having experienced reading acquisition problems and whose responses to the questions on the elementary education section of the Adult Reading History Questionnaire-Revised (ARHQ-R; Parrila, Corkett, Kirby, & Hein, 2003) indicated significant reading difficulties in childhood (see below for details). Ten of the RP participants had recent diagnoses and had received or were receiving services for students with learning disabilities. The average age of the RP group was 29.54 years (SD = 8.96). The participants with recent diagnosis (RP-D; mean age 34.20) were older than the participants without recent diagnosis (RP-ND; mean age 26.94). The participants in the RP group were all either current university students or recent graduates (less than six months at the time of initial testing). They were recruited through letters sent by the university's student support services, through announcements in undergraduate classes, and through posters advertising the study.

The comparison group consisted of 27 participants (9 males and 18 females) who reported no history of reading problems. The average age of the comparison participants was 25.11 years (SD = 6.35). ANOVA with age as a dependent variable and group (comparison, RP-D, RP-ND) showed a significant effect of age, F (2, 54) = 5.48, p = .007, η^2 = .174. Post hoc comparisons (Bonferroni tests at .05 significance level) indicated that the RP-D group was significantly older than the other two groups that did not differ. This difference resulted mainly from the RP-D participants taking a longer time after high school before enrolling at the university. The comparison group was recruited through announcements in undergraduate classes and through posters displayed throughout the campus and they were all current university students. All participants reported English as their spoken language of preference, had normal or corrected-to-normal vision, and had normal nonverbal (min. 31st percentile) and verbal (min. standard score 96) intelligence as measured by abridged versions of Raven's Standard Progressive Matrices (Sets C, D, and E; Raven, 1976) and the Peabody Picture Vocabulary Test-Third Edition (Dunn & Dunn, 1997).

Questionnaire

Both comparison and RP participants completed a questionnaire that consisted of three sections. The first section of the questionnaire addressed demographic information (e.g., gender, age, language background, education). The second and third sections were each divided into three subsections: (a) elementary education, (b) secondary education, and (c) post-secondary education. The second section of the questionnaire consisted of AHRQ-R, a modified form of Adult Reading History Questionnaire (Lefly & Pennington, 2000). The Adult Reading History Questionnaire was modified because the original questionnaire does not distinguish between levels of education such as elementary, secondary and post-secondary. This lack of differentiation between levels of education is potentially problematic when the questionnaire is administered to high-functioning individuals with a history of reading problems. In the original format, the questionnaire may not be sensitive enough to the severity of the initial problems if an individual has compensated for his or her initial reading difficulties. The revised questionnaire poses parallel questions at each level of education.

The elementary education section of the modified ARHQ-R (see Appendix) was used to determine the presence of a significant history of reading difficulties and contained 10 questions pertaining to the participant's reading, spelling, and educational experiences. Each question required a response on a five-point Likert scale (from 0 to 4), with higher numbers corresponding to responses indicating more trouble with reading skills, less print exposure, or poorer attitude towards reading. The participant's score was calculated by dividing her or his total score by the maximum possible score (40). Thus, the lowest possible score was 0 and the highest possible score was 1. The mean for the RP group was .62 (*SD* = .15; min = .39 and max = .88) and the mean for the comparison group was .12 (*SD* = .08; min = .00 and max = .26). Reliability (alpha) was .90. The RP-D group (mean = .71, *SD* = .13) reported a higher level of reading acquisition difficulties than the RP-ND group (mean = .58, *SD* = .14). An ANOVA with the three groups as the between factor showed a significant effect of group, F (2, 54) = 146.52, $p < .001$, $\eta^2 = .849$. Post hoc comparisons (Bonferroni tests at .05 significance level) indicated that both RP groups reported more reading acquisition problems than the comparison group (this was a selection criterion), and that the difference between the RP groups was also significant.

Materials

Word- and Nonword-Reading Accuracy and Rate

The Word Identification test from Woodcock Reading Mastery Tests-Revised (WRMT-R; Woodcock, 1998) was used to assess word reading accuracy. The test required the participants to read isolated words aloud. Words were graded in difficulty from pre-primer to adult level and presented on a computer screen one at a time. The participant's score was the number of correctly read words. A cut-off rule of six consecutive mistakes was applied. Cronbach's alpha reliability coefficient in our sample was .87.

Castles and Coltheart's (1993) regular, irregular, and nonword naming tasks were used to measure both word and non-word reading. There were 30 items in each word type, and the Regular Word Naming and the Irregular Word Naming tasks were divided further into high- and low-frequency conditions (15 words in each). Naming latencies were recorded using a microphone connected to a voice-onset reaction time key interfaced with the computer. Items were displayed one at a time on a computer screen; the item disappeared as soon as the participant's voice triggered the voice key. The experimenter initiated each trial and recorded the accuracy of each pronunciation. Cronbach's alpha reliability for the accuracy data was .56 for Regular Word Naming, .76 Irregular Word Naming, and .86 for the Pseudoword Naming task. The experimenter also marked trials on which the microphone failed to trigger the voice key or trials on which that the microphone picked up an extraneous response (e.g., breathing) instead of the actual pronunciation. The participant's response time (RT) for a condition represents the mean of the remaining RTs after removing outliers (± 2 *SD* from the participant's initial condition mean). RTs for Regular Word Naming and Irregular Word Naming (see Table 1) were then calculated by obtaining the grand mean across high- and low-frequency conditions.

The Word Attack test from Woodcock Reading Mastery Tests-Revised (WRMT-R; Woodcock, 1998) was used as a second measure of decoding. Participants were required to pronounce nonwords presented on a computer screen one at a time. Testing was discontinued after six consecutive errors. The participant's score was the number of items correct. Cronbach's alpha reliability coefficient in our sample was .88.

The *Phonological Choice* task required the participants to choose as quickly as possible the pseudohomophone of a real word from a pair of pseudowords presented on a computer screen. Twenty pairs of pseudowords, 17 single-syllable pairs (e.g., fite – fipe; saip – saif) and 3 two-syllable pairs (doster – dawter; dazzin – duzzin; tracter – trastor) – were presented one pair at a time. An individual's score was the number of correctly selected pseudohomophones. Both accuracy and reaction time were recorded. Cronbach's alpha reliability coefficient for accuracy in our sample was .79.

Reading Comprehension and Rate

The Comprehension test (Form H) from the Nelson-Denny Reading Test (Brown, Fishco, & Hanna, 1993) was used to assess both reading comprehension and rate. The comprehension test contains seven reading passages and a total of 38 multiple-choice questions, each with five answer options. The time limit for the comprehension test is 20 minutes, and the first minute is used to determine the reading rate. As most participants in the RP group did not reach the end of the test before running out of time, we also calculated a proportion correct score for all participants to obtain an estimate of untimed comprehension.

Spelling

Peabody Individual Achievement Task-Revised (PIAT-R; Markwardt, 1989). In this task the participant listens to the experimenter saying a target word, then a sentence with the word and finally the target word again while shown four answer options on a computer screen. After listening to the examiner, the participant is asked to identify the response quadrant containing the correct spelling of the word. The task consists of 100 items. Items 1-15 were not administered because they were considered too easy for our participants. The participant's score was the total number of correctly identified spellings. Cronbach's alpha reliability coefficient in our sample was .79.

Wide Range Achievement Test - 3 Spelling (WRAT-3; Wilkinson, 1993). In this task the participant is required to write dictated words on a form with numbered spaces. The examiner first reads the word aloud, then reads a sentence in which the target word is embedded, and then repeats the target word. The task consists of 40 items. A cut-off rule of ten consecutive mistakes was applied. Cronbach's alpha reliability coefficient in our sample was .85.

Phonemic Awareness

A modified version of Rosner Auditory Analysis Test (Rosner & Simon, 1971) adapted from Sidhu (2001) was used to assess participants' phonemic awareness. The task consisted of 41 items and required participants first to repeat a spoken word, and then to repeat it after deleting a specified sound or sound sequence, usually resulting in a new word (e.g., swing without /w/ becomes *sing*; man without /m/ becomes *an*; and scold without /sk/ becomes *old*). The position of the phoneme(s) to be deleted varied within the list of 41 test words. Two practice items were given for the test, with feedback after each item. Testing was discontinued after six consecutive errors. Cronbach's alpha reliability coefficient for this sample was .91.

Phonological Memory

The Nonword Repetition task from CTOPP (Wagner, Torgesen, & Rashotte, 1999) was used to assess phonological memory. It consisted of 3 practice items and 18 test items. The task required the participants to listen carefully to some made-up words and repeat them as clearly as possible. The nonwords were of increasing difficulty. The participant's score was the total number of correctly repeated nonwords. A cut-off rule of four consecutive errors was applied. Cronbach's alpha reliability coefficient in our sample was .70.

Naming Speed

RAN-Colours (RAN-C). This task required participants to state as quickly as possible the names of five colours (blue, black, green, red, and yellow). The colours were presented on a laptop computer screen and arranged semi-randomly in five rows with ten colours per row. Prior to beginning the timed naming, each participant was asked to name the colours in a practice trial to ensure familiarity and lack of colour perception problems. Wolf and Denckla (2005) reported test-retest reliability for Colour Naming to be .90.

Digit Naming (*RAN-D*). This task was adopted from CTOPP (Wagner et al., 1999). This RAN task consists of a set of six digits (4, 7, 8, 5, 2, 3) that are displayed in random sequence six times for a total of 36 stimuli. Subjects are asked to name the digits from left to right as quickly as possible and the total time to complete the RAN task is recorded. Before naming the 36 digits, each participant was asked to name the digits in a practice trial. Wagner et al. (1999) reported test-retest reliability of .86 for Digit Naming for ages 18 to 24.

Results

Reading and Spelling Measures

Table 1 presents the means, standard deviations, and results from ANOVAs comparing the RP and comparison groups for all the reading and spelling measures. Results from MANOVAs examining the overall differences are reported below.

Decoding. The Word Attack mean of 33 corresponds roughly to a grade equivalent (GE) of 7 and 40 to a GE of 12. In total, 21 of the 29 members in the RP group scored at or below a GE of 9, indicating persistent problems in decoding. A MANOVA with the three decoding accuracy scores as the dependent variables and group as the fixed factor showed a significant main effect of group, Wilks' $\lambda = .689$, $F\ (3, 51) = 7.68$, $p < .001$. The subsequent univariate tests indicated that the groups were significantly different on Word Attack, $F\ (1, 53) = 22.48$, $p < .001$, $\eta^2 = .298$, Pseudoword Naming, $F\ (1, 53) = 20.29$, $p < .001$, $\eta^2 = .277$, and Phonological Choice, $F\ (1, 53) = 4.16$, $p < .05$, $\eta^2 = .073$. RP-D and RP-ND groups were not significantly different, Wilks' $\lambda = .916$, $F\ (3, 24) = .74$, $p > .05$, $\eta^2 = .084$ (all *p*s> .210 in univariate tests, η^2s $< .06$).

In order to examine if there were any significant group differences in the response times for Pseudoword Naming (naming time) and the Phonological Choice list (choice time), a MANOVA was performed with group as a fixed factor. The results showed a significant main effect of group, Wilks' $\lambda = .498$, $F\ (2, 52) = 26.29$, $p < .001$. Follow-up univariate tests indicated that the groups were significantly different both on Pseudoword Naming, $F\ (1, 53) = 25.54$, $p < .001$, $\eta^2 = .325$, and on making phonological choices between two pseudowords, $F\ (1, 53) = 41.73$, $p < .001$, $\eta^2 = .441$. RP-D and RP-ND groups were not significantly different from each other, Wilks' $\lambda = .962$, $F\ (2, 25) = .49$.

Word Reading. In terms of the overall performance level, the Word Identification means of 97 and 102 correspond roughly to GEs of 12 and 17 indicating that word reading accuracy was well within the normal range for both groups. Three participants in the RP group scored at or below a GE of 9. The Regular Word Naming task showed a significant ceiling effect with 23 comparison participants and 17 RP participants reading all 30 words correctly. No participant read all the Word Identification words correctly, and only four participants (two in each group) made no errors in the Irregular Word Naming task. A MANOVA with Word Identification and Irregular Word Naming scores as the dependent variables and group as the fixed factor indicated that the difference between the groups was significant, Wilks' $\lambda = .613$, $F(2, 52) = 16.38$, $p < .001$. The subsequent univariate tests indicated that the groups were significantly different both on Word Identification, $F(1, 53) = 33.35$, $p < .001$, $\eta^2 = .386$, and on Irregular Word Naming, $F(1, 53) = 8.75$, $p = .005$, $\eta^2 = .142$. Within the RP group, individuals with no recent diagnosis (RP-ND) performed on average slightly better than individuals with recent diagnosis (RP-D). However, none of the differences were significant and effect sizes were small (all *p*s > .14; $.01 \leq \eta^2 \leq .09$).

Word reading fluency was clearly problematic for the RP participants. A MANOVA with the two RT scores (regular and irregular word naming times) as the dependent variable and group as a fixed factor showed a significant main effect of group, Wilk's $\lambda = .729$, $F(2, 51) = 9.46$, $p <.001$, and the subsequent univariate ANOVAs (see Table 1) showed that RP participants were clearly slower in naming both regular and irregular words than the comparison group. No significant differences were observed between the two RP groups (both *p*s > .6, and $\eta^2 \leq .01$).

Reading Comprehension. A MANOVA with the three scores as dependent variables and group as a fixed factor showed a significant main effect of group, Wilk's $\lambda = .790$, $F(3, 51) = 4.46$, $p = .007$. The subsequent univariate ANOVAs indicated that the two groups differed significantly on reading rate, $F(1, 53) = 10.86$, $p = .002$, $\eta^2 = .170$, and timed comprehension, $F(1, 53) = 7.59$, $p = .008$, $\eta^2 = .125$, but not on proportion correct, $F(1, 53) = 2.78$, ns., $\eta^2 = .050$. The two RP groups did not differ from each other on any of these measures (all *p*s > .3, $.01 \leq \eta^2 \leq .03$). These results indicate that reading rate and timed comprehension continue to be problems for university students who report a history of reading problems. However, reading comprehension per se, as indicated by percentage correct, is not compromised by slower reading speed.

Spelling. A MANOVA with the two spelling tasks as dependent measures and group as a fixed factor showed a significant main effect of group, Wilks' $\lambda = .547$, $F(1, 50) = 20.32$, $p < .001$. Follow-up ANOVAs indicated that the comparison and RP groups were significantly different on both PIAT-R, $F(1, 50) = 15.99$, $p < .001$, $\eta^2 = .242$, and WRAT-3, $F(1, 50) = 41.47$, $p < .001$, $\eta^2 = .453$. The PIAT-R mean of 89 corresponds roughly to a grade equivalent (GE) of 10 and 94 to a GE of 12.9. Eight RP participants scored at or below a GE of 9. The WRAT-3 mean of 39 corresponds to the beginning of high school level whereas the mean of 44 corresponds to the end of high school level. In addition, the participants in the RP-ND group spelled on average 3.2 more words

Table 1
Mean Performance Level on Decoding, Reading, and Spelling Measures

	Comparison (n = 27)		Reading Problems (n = 28)			
Measure	*M*	*SD*	M	*SD*	*F*	η^2
Word Attack	39.56	2.59	33.04	6.67	22.48***	.298
Pseudoword Naming						
Accuracy	27.52	1.64	22.11	6.03	20.29***	.277
RT	865.73	135.41	1123.43	229.10	25.54***	.325
Phonological Choice						
Accuracy	18.11	1.78	16.57	3.51	4.16*	.073
RT	2145.57	559.88	3916.64	1313.77	41.73***	.441
Word Identification	102.07	2.85	95.25	5.46	33.35***	.386
Regular Word Naming						
Accuracy	29.85	.36	29.46	.79		
RT	698.21	98.90	828.98	142.30	15.37***	.228
Irregular Word Naming						
Accuracy	28.22	1.25	26.29	3.17	8.75**	.142
RT	726.68	95.78	884.24	159.92	19.29***	.271
Reading rate	293.70	94.04	209.79	94.79	10.85**	.170
Comprehension	65.56	8.50	57.36	13.01	7.59**	.125
% correct	89.67	9.14	85.21	10.55	2.78	.050
PIAT-R	93.81	3.84	88.92	4.91	15.99***	.242
WRAT-3	49.00	3.16	42.54	4.02	41.47***	.453

Note. RT = Response time; PIAT-R = Peabody Individual Achievement Task-Revised Spelling Recognition; WRAT-3 = Wide Range Achievement Test – 3 Spelling
* $p < .05$; ** $p < .01$; *** $p < .001$

correctly in WRAT-3 than the RP-D group; the difference between the groups approached significance, F (1, 24) = 4.21, p = .051, η^2 = .149. No differences were observed between the two RP groups in PIAT-R, F (1, 24) = 0.76, p > .10, η^2 = .004.

Phonological Processing

Table 2 shows the descriptive statistics for the phonological processing measures and the results from ANOVAs comparing the RP and comparison groups. A MANOVA with the four phonological processing tasks as dependent measures and Group (2) as a fixed factor showed a significant main effect of group, Wilks' λ = .622, F (4, 50) = 7.61, p < .001. Subsequent ANOVAs showed significant differences between the groups on all four measures, with the RP group showing poorer performance (see Table 3 for F values, significance levels, and effect sizes). In addition, RP-ND group performed significantly better than the RP-D group on Phoneme Elision, F (1, 26) = 4.24, p < .05, η^2 = .140, and Nonword Repetition, F (1, 26) = 5.00, p < .05, η^2 = .161, whereas the difference between the two RP groups approached significance on RAN-Digits, F (1, 26) = 3.17, p = .087, η^2 = .109, but not on RAN-Colours, p > .400, η^2 = .023. Further pairwise comparisons indicated that while the RP-D group was significantly different from the comparison group in all phonological processing measures, RAN-Colours was the only measure that reliably differentiated the RP-ND group from the comparison group.

Performance Patterns of University Students with a History of Reading Problems

The above analyses have focused solely on the between group differences. In order to examine whether we could identify individuals with different patterns of relative strengths and weaknesses across the tasks, we created a performance profile for each RP participant across the tasks. Table 3 presents the results of this analysis. In Table 3, we assigned: (1) a *minus* sign into each cell where that individual's score was more than 1 SD below (accuracy measures) or above (response time measures) the comparison group's mean; (2) *zero* if the performance was between 1 SD below/above and the comparison group's mean, (3) a *plus* sign if the performance was at or above (accuracy measures)/below (response time measures) the comparison group's mean but less than 1 SD above/below it, and (4) *two plusses* if the performance was at or more than 1 SD above/below the comparison group's mean. Three accuracy variables with restricted or no variability in the comparison group – Phonological Choice, Regular Word Naming, and Irregular Word Naming – were left out

Table 2
Mean Performance Levels on the Phonological Processing Tasks

	Comparison (n = 27)		Reading Problems (n = 28)			
Measure	*M*	*SD*	*M*	*SD*	*F*	η^2
Elision	36.52	2.10	30.71	8.14	12.89***	.196
RAN-Colours	59.31	8.65	72.76	13.73	18.72***	.261
RAN-Digits	26.59	5.99	31.41	5.30	9.98**	.158
NWR	13.44	2.17	11.36	2.37	11.54***	.179

Note. RAN = Rapid Automatized Naming; NWR = Nonword Repetition.
** $p < .01$; *** $p < .001$

of Table 3. Performance profiles in Table 3 are roughly ordered first according to how well the individual performed on the reading comprehension variables, and then on how well they performed on the word reading variables. The ten RP participants with a recent diagnosis are identified with an asterisk next to their identification number.

Table 3 indicates that most RP participants showed significant weaknesses in two or more examined constructs. The first six performances show the profiles of those RP participants who displayed no significant weaknesses in any of the three reading comprehension variables, including reading rate, and the first individual (14*) was the only RP participant in this sample whose weaknesses were limited to only one examined variable, and who could be labeled as fully compensated. Participant 9 exhibited limited weaknesses with word reading and spelling recognition, whereas his decoding and phonological processing were within the comparison group's range. The next participant (18) displayed weaknesses in most word reading, decoding, and phonological processing measures and together with the remaining three participants (11*, 17, 10) showed remarkably good reading comprehension performance in spite of significant weaknesses in word recognition and decoding. Performance of participant 11* is particularly noteworthy in that it shows no other strengths than reading rate (the fastest reader in the RP group at 600 words per minute)

Table 3

Current Performance Profiles of University Students with a History of Reading Problems

	Comprehension			Word Reading			Decoding				Spelling		Phonological Processing			
ID	Percent Correct	Timed Comp.	Read-ing Rate	Word Ident. AC	RWN RT	IWN RT	Word Attack AC	Pseudo-words AC	Phono. Choice RT	Pseudo-words RT	WRAT	PIAT	Phon. Elision	Nonw. Repeti-tion	RAN-Colour	RAN-Digits
14*	0	+	0	+	+	+	++	+	-	+	0	+	0	0	+	0
9	0	+	0	-	-	0	0	0	0	0	0	-	0	0	++	0
18	+	+	0	-	0	-	+	-	-	-	0	0	-	-	-	-
11*	+	+	++	-	-	-	-	-	0	0	-	0	-	-	-	-
17	+	+	0	-	-	-	-	-	-	-	-	0	+	-	+	0
10	0	0	0	-	-	-	-	-	-	-	-	-	0	-	0	+
26	+	+	-	0	+	+	0	-	-	+		-	-	+	-	0
1	+	0	-	-	++	++	0	+	-	++	0	0	0	+	-	+
12*	++	++	-	-	0	+	-	0	-	-	-	0	-	-	-	-
24	+	+	-	0	0	-	-	-	-	0	-	+	+	+	0	+
21	0	0	-	0	-	-	+	-	-	-	-	+	+	++	-	0
7	++	0	-	-	0	-	-	-	-	-	-	-	0	-	-	0
27*	0	0	-	-	0	-	-	-	-	-		-	-	-	0	-

22*	0	0	-	-	-	-	-	-	-	-	-	0	-	-	-	0
19	0	-	0	-	-	-	-	-	-	-	-	-	+	-	0	0
4	0	-	0	-	-	-	-	-	-	-	-	0	-	0	-	0
25	+	-	-	-	-	-	-	-	-	-	-	-	+	0	+	0
5	0	-	-	-	+	++	-	-	-	+	-	-	-	0	-	0
13*	0	-	-	-	-	-	+	+	-	-	-	0	+	+	-	0
15*	0	-	-	+	-	-	-	-	-	-	-	-	0	0	0	0
23	0	-	-	-	-	-	-	-	-	-	-	-	-	-	0	-
6*	-	0	+	-	-	-	-	-	-	-	-	-	-	-	0	0
2	-	0	-	-	m	m	-	0	-	-	-	0	+	0	0	0
3	-	-	-	-	+	+	-	0	-	0	0	-	-	-	-	0
8	-	-	-	-	-	-	0	-	-	-	-	+	-	0	0	0
16*	-	-	-	-	0	0	-	-	-	-	-	-	-	-	-	0
28	-	-	0	-	0	-	-	-	-	-	-	0	-	-	-	0
20*	-	-	-	-	-	-	0	-	0	-	-	0	-	-	-	-

Note. AC = Accuracy; RT = Response Time; RWN = Regular Word Naming; IWN = Irregular Word Naming; WRAT = Wide Range Achievement Test-3 Spelling test; PIAT = Peabody Individual Assessment Test – R Spelling recognition test. - = performance 1 SD or more from the comparison group mean; 0 = performance poorer but within 1 SD of comparison group mean; + = performance better and within 1 SD of the comparison group mean; ++ = performance more than 1 SD better than comparison group mean; m = missing data and reading comprehension (97% correct). Finally, out of this first group of six participants, only two (18, 11*) show significant weaknesses in phonological processing, and both could be classified as double-deficit dyslexics (Wolf & Bowers, 1999).

The next eight performances in Table 3 are from RP participants whose reading rate was a weakness but comprehension was not. Most of these participants also displayed at least some relatively intact word reading skills whereas decoding and spelling – and particularly spelling to dictation – were clearly more problematic. In terms of phonological processing, performances were varied with some participants (12*, 27*, 22*, and possibly 7) showing more general problems, and others (26, 1, and 21) more limited problems. One participant (24) showed no specific phonological processing weaknesses despite decoding and encoding problems.

The third group of participants in Table 3 consisted of seven individuals who performed within one standard deviation of the comparison group mean on the percentage correct comprehension measure, but not on the timed comprehension measure. Not surprisingly, all but two individuals in this group also displayed slow reading speed. For these participants, reading rate problems may derive from remaining decoding and word reading problems. In addition, all showed specific weaknesses in spelling. Again, phonological processing results were more inconsistent.

Finally, the last seven individuals in Table 3 all showed weaknesses in reading comprehension, Word Identification, and in at least some of the decoding and spelling measures. In addition, phoneme awareness and phonological memory were clearly areas of weakness for most of the individuals in this group, and four of the seven individuals in this group exhibited slow performance in RAN Colours.

To summarize, there clearly is substantial variability in the performance profiles of university students with a history of reading problems. If we regard percentage correct (untimed reading comprehension) as the measure most indicative of compensation, then all but seven participants in this sample could be regarded as compensated. Of the compensated participants, a handful, such as cases 14*, 9, 26, and 1, seem to have compensated in most areas assessed in this study. On the other hand, most of the compensated participants (e.g., cases 11*, 17, 10, 7, 27*, 22*, 19, and 15*) showed significant remaining problems in several examined constructs. From the point of view of the tasks, it is interesting to note that all RP participant in this study performed poorer than the comparison group mean in WRAT-3 (spelling to dictation) and Phonological

Choice tasks that likely were the two tasks in this study that required the most developed understanding of grapheme-phoneme correspondences. Table 3 also indicates that with the possible exception of participants 14*, 9 (whose performance pattern could be explained by insufficient print exposure), and maybe 1, all of the participants in this study displayed problems in at least two of the areas of functioning (decoding, spelling, reading rate, phonological awareness) that are supposedly more difficult to compensate for and therefore good markers of the validity of self-reported earlier problems.

Discussion

The purpose of this study was to examine how university students who report a significant history of reading acquisition problems are currently functioning in reading, spelling, and phonological processing tasks. We called this group "high-functioning" on the basis that they were all participating in post-secondary education, and compared their performance to that of a comparison group consisting of university students who did not report reading acquisition problems.

The results indicated that in the word identification test, most participants with a history of reading problems functioned within the normal range, albeit significantly poorer than the comparison group. In contrast, many of them showed more severe problems in decoding and spelling-to-dictation measures, and likely also in reading rate, although this task does not have population norms. Finally, the only task that the university students with a history of reading problems in this study performed equally well as the comparison group was untimed reading comprehension. In other words, when these students are assessed on their ability to comprehend text at their own pace, the performance level of most of them is comparable to that of other university students. Table 3 indicated that all but seven participants were able to comprehend text at a level exhibited by the comparison participants. Thus, 21 of our 28 participants with a history of reading problems could be considered compensated at the level of being able to read to learn. It is interesting to note that using the same participant pool, Corkett, Parrila, and Hein (in press) reported that university students with a significant history of reading difficulties also do not report avoiding print-based learning strategies.

A considerably more complex picture of the extent of compensation is evident in other reading tasks. For example, only 16 participants were able to comprehend text as well as the comparison participants when the 20-minute time limit was considered, and only eight participants had both text reading rate and comprehension skills within one standard deviation of the comparison group mean. Almost all participants exhibited at least some weaknesses in the areas of word reading, decoding, and spelling. In general, we could argue that only two participants were fully or close to fully compensated, whereas all the others could at best be described as partially compensated. It also seems likely that reading rate, word identification, or spelling problems would impact the process of learning at some point. Not surprisingly, when some of the current participants were interviewed about their experiences, several mentioned struggling with heavy reading loads, completing tests on time, being dependent on spelling checkers, and avoiding courses in which they would have to learn a lot of new vocabulary. Note that the majority of our participants did not have a recent diagnosis of dyslexia and chose to complete their university studies without accommodations such as extended examination times to which having a diagnosis would entitle them. An interesting question for future studies is why many students who knew that they would likely qualify for services chose not to pursue them.

Somewhat surprisingly, many of our participants did not show a specific deficit in phonological awareness, whereas both grapheme-to-phoneme and phoneme-to-grapheme translation processes were clearly problematic to them. Rather than reflecting relatively good phonological awareness – and refuting the phonological deficit hypothesis – this result more likely reflects problems with the task when administered to this population: many participants reported using non-oral strategies, such as "writing" the target word in their head (e.g., *swing*), then thinking which of the letters could represent the sound to be deleted (e.g., /w/), and then "reading" the resulting answer (e.g., *sing*). Thus, the high literacy level of the participants likely changed the nature of the task fundamentally so that it no longer assessed their awareness of and access to the structure of oral language (Mattingly, 1972), but rather a much more limited ability to produce the correct spelling of a familiar word, match one sound to one of the graphemes in that word, and recognize the resulting new familiar word. One conclusion that could be made on the basis of our results is that more sensitive phonological awareness tasks that are less open to alternative means of completion need to be developed if we want to assess phonological awareness validly in this population.

Word reading results of this study were also somewhat surprising. The significant difference between the groups in Word Identification resulted mostly from errors that participants with a history of reading problems made with the last 20 words in this test. All of these words are of low frequency (maximum 7 and mean 1.9 according to the Kucera-Francis written frequency norms in MRC Psycholinguistic Database: Machine Usable Dictionary, Version 2.00) and all but three (*quixotic, obelisk*, and *epigraphist*) could also be classified as irregular (e.g., *edifice*, *amiable*, and *facetious*). Poor performance with these words could reflect decoding problems, but it is also possible that slower reading speed has over time led to reduced print exposure, and reduced print exposure has then resulted in slightly depressed reading vocabulary in relation to other university students. Alternatively, it is possible that the participants with a history of reading problems need more exposure (practice) with any specific word before it is processed automatically (or entered into the autonomous lexicon – Perfetti, 1992). If this is true, then the same print exposure would not have the same impact on reading performance across the two groups.

The second question we wanted to examine is the feasibility of using self-reports to identify participants with a history of reading problems. To do this we compared participants with a recent diagnosis of reading difficulties to those who reported a history of reading difficulties but did not have a recent diagnosis. The participants with recent diagnosis reported more reading acquisition problems and currently experienced more problems with the spelling to dictation and three of the four phonological processing tasks than participants without such diagnosis. However, no significant differences were observed between the groups in any of the reading tasks, and most participants in both groups showed problems in two or more areas of functioning that likely are the most difficult to remediate. This pattern suggests, with two qualifications, that identifying participants on the basis of their self-reported reading acquisition problems is a valid way of finding high-functioning individuals with a history of reading problems for large scale studies. The first qualification is that self-identified participants without recent diagnosis may have experienced less severe problems to start with. Only a population based (but not clinic based) longitudinal study could lead to a fully representative sample of high-functioning and possibly compensated individuals with reading disabilities, but in the absence of longitudinal data, self-reports of earlier problems appear to be a viable alternative. The second qualification is that we only had ten participants with a recent diagnosis, leading to reduced power in the statistical analyses. While examination of effect sizes leads us to believe that low power was not a significant problem is this study, the results need to be verified with a larger sample in future studies.

An additional limitation of the current study is the nature of the comparisons reported in Table 3. As these are individual level comparisons, they are naturally more prone to be affected by measurement error than group level comparisons. While the sample-specific reliabilities of most of the measures reported in Table 3 were .85 or higher, this was not the case for the Phonological Choice, spelling recognition (PIAT-R) and Nonword Repetition tasks, suggesting caution in interpreting their results at the individual level.

The results of this study have potential implications for identification and support of students with a history of reading problems. First, while many students were able to perform at a relatively high level on untimed word reading and comprehension tasks, the same was not true for reading rate, timed decoding, and spelling-to-dictation tasks. These seemed to be the tasks that were most sensitive to remaining difficulties and particularly the spelling and reading rate problems can have a negative impact on the student's performance in academic courses. Timed reading assessments and assessment of spelling skills should then be part of the battery of tests that are used to control access to accommodations and remedial services at the universities. Second, in terms of their reading and spelling skills, students without a recent diagnosis were not distinguishable from those with a diagnosis. While this finding needs to be replicated with a larger sample of students, it raises troubling questions of how many students who potentially could be assisted (sometimes simply by giving them more time to complete the assignments) to perform at a higher level are missing this opportunity, and why. When asked, some of our participants without diagnosis indicated that they did not want accommodations, whereas others believed that they would not qualify because they were "only" slow readers (and perhaps had a spelling problem). Our recommendations, then, are that the criteria for accommodations include not only reading accuracy but also reading rate and spelling, and that these criteria be communicated clearly at the beginning of each academic year in all large introductory classes within a university.

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Appendix

The instructions and the ten questions of the Adult Reading History Questionnaire-Revised used to calculate self-reported reading acquisition problems score.

Instructions:

Please circle the number of the response that most nearly describes your attitude or experience for each of the following questions or statements. If you think your response would be between numbers, place an "X" where you think it should be.

Questions:

How much difficulty did you have learning to read in elementary school?

None				**A great deal**
0	1	2	3	4

How much extra help did you need when learning to read in elementary school?

No help	**Help from: Friends**	**Teachers/ parents**	**Tutors or special class 1 year**	**Tutors or special class 2 or more years**
0	1	2	3	4

Did you ever reverse the order of letters or numbers when you were a child?

No				**A great deal**
0	1	2	3	4

Did you have difficulty learning letter and/or colour names when you were a child?

No				**A great deal**
0	1	2	3	4

How would you compare your reading skill to that of others in your elementary classes?

Above average **Average** **Below Average**

0__________1__________2__________3__________4

Which of the following most nearly describes *your* attitude toward reading as a child?

Very positive **Very negative**

0__________1__________2__________3__________4

How would you compare your reading speed in elementary school with that of your classmates?

Above average **Average** **Below average**

0__________1__________2__________3__________4

How much difficulty did you have learning to spell in elementary school?

None **Some** **A great deal**

0__________1__________2__________3__________4

When you were in elementary school, how many books did you read for pleasure each *year*?

More than 10 **6-10** **2-5** **1-2** **None**

0__________1__________2__________3__________4

How many comic books did you read for pleasure each *year*?

More than 10 **6-10** **2-5** **1-2** **None**

0__________1__________2__________3__________4
