Running head: THE EFFECTS OF TIMED AND UNTIMED TESTING

The effects of timed and untimed testing conditions on the reading comprehension performance of adults with reading disabilities.

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Abstract

This study examined the effects of extra time on the reading comprehension performance of a heterogeneous group of adults with reading disabilities. Sixty four adults participated. A clinic that assesses learning disabilities identified 22 as reading disabled, and 42 as normal readers. The 64 adults took a reading comprehension test under both timed and untimed conditions. Other skills measured included vocabulary, word reading, nonword reading, spelling, arithmetic, and short-term memory. Under timed conditions, there were significant differences between the participants with reading disabilities and the normally achieving participants. All of the reading disabled participants in the present study benefited from extra time, but the normally achieving readers performed similarly under the timed and untimed conditions. Further, in the untimed condition the performance of the individuals with a less severe reading disability was not significantly different that of the Average readers. The study suggests that extra time during testing is an appropriate accommodation to help individuals begin to compensate for reading disabilities.

Colleges, universities, employers, and testing services are attempting to offer reasonable accommodations for individuals with learning disabilities (McCusker, 1995). Colleges and universities are legally required to provide reasonable accommodations to enable students with learning disability (LD) to obtain an education equal to that of their non-learning disabled peers, and many employers are also committed to supporting individuals with learning disabilities. The most frequent accommodation provided to individuals with RD consists of modifications to testing conditions. The most common modification is extra time in examination, but this is not necessarily consistent across all domains and content areas. The practice of allowing individuals with LD extra time during tests and exams stems from the belief that these students take longer to read and process the questions (e.g., Geary & Brown, 1990, Kail & Hall, 1984; Stanovich, 1986). By allowing extra time, proponents believe, students with LD will at least have the opportunity to respond to as many questions as their normally achieving peers. Thus, the premise holds, providing extra time in exams and other testing situations will permit students with RD to be assessed at a similar level with their non-disabled peers.

But the practice of allowing extra time has been controversial (e.g. see Phillips, 1994, 1996). One argument against it holds that allowing extra time for individuals with LD is unfair to their normally achieving peers. Zuriff (2000) found weak support for the hypothesis that only learning disabled students benefit from extra time. Another argument is that extra time should be allowed only in situations involving a large amount of reading, and that extra time may not be appropriate for math or other tests involving limited reading (see Runyan, 1991). The practice is widespread, but only minimal research has examined the effects of extra time for individuals with LD. Further, within this research, the few studies that have been conducted have focused on the reading comprehension achievement of reading disabled college students working under timed and untimed conditions (i.e., Hall, 1988; Hill, 1984; Runyan 1991a, 1991b; Weaver, 1993). Little is known about the effects of such an accommodation for more heterogeneous samples of adults with LD.

Hill (1984) found that under timed conditions, the performance of students with LD was significantly lower than that of students who are not learning disabled. Students with LD obtained significantly higher scores in the untimed condition than in the timed condition, whereas the students without LD did not show an increase on their comprehension scores between conditions. In the untimed condition, there were no significant differences between the two groups. Runyan (1991a) found that extra time on a reading comprehension test resulted in notably higher scores for a group of university students with LD. But extra time on the reading comprehension test did not result in considerably higher scores for a control group of normally achieving university students. In a replication study with a larger and more academically diverse sample, Runyan (1991b) found that under timed conditions, the scores of the LD students were significantly lower than the scores of the normally achieving students. But under untimed conditions, the scores of the LD and normally achieving students were not significantly different. Perhaps even more importantly, the improvement from the timed to untimed conditions was significantly greater for the students with LD than it was for the normally achieving students.

In contrast, Halla (1988) found that untimed conditions resulted in significant improvements in reading comprehension performance both for college students with LD and for normally achieving students. In a study with college and university students, Weaver (1993) found that under untimed conditions students with LD showed significant improvement while the normally achieving college students did not. Perhaps most relevant to the discussion of appropriate and effective accommodations, the students with LD in the study showed greater improvement than the students without LD.

Studies conducted with adults with LD have, as noted, been predominantly with college students, with an emphasis on appropriate accommodations. However, some research focusing on RD across the lifespan has examined what appear to be persistent deficits in phonological processing skills, regardless of amount of education (e.g. Bruck, 1990, 1992; Shafrir & Siegel,

1994; Snowling, Nation, Moxham, Gallagher, & Frith, 1997; Wilson & Lesaux, 2001). Cognitive skills such as working memory and short-term memory have been identified as important to high-level cognition, such as reading comprehension and mathematics (e.g., Chiappe, Hasher & Siegel, 2000; Swanson, 1994). Swanson (1994) examined whether short-term memory and working memory contribute unique variance to achievement in children and adults with learning disabilities. The study demonstrated that, indeed, working memory and short-term memory are separate constructs. Verbal short-term memory contributed unique variance to reading comprehension, but working memory did not.

Individual differences in the accuracy and speed of single word reading account for the most substantial variance in comprehension (Perfetti, 1985). If an individual has difficulty at the word reading level, these problems will have a negative impact on reading comprehension. In order to gain meaning from the text to the same extent as normally achieving peers, individuals with LD need to be fluent in decoding at the word level (Kame'enui & Simmons, 2001). Some studies conducted with adults have shown that the accuracy of decoding improves with age (e.g., Gottardo, Siegel, & Stanovich, 1997). But whether this is the case or not, in addition to fluent decoding, effective reading comprehension requires vocabulary skills. It also requires the use of background knowledge to understand, and make inferences about, the text being read. Some theories (e.g. Perfetti, 1988; van Dijk & Kintsch, 1983) suggest that comprehension is an interactive process involving text, context, and the reader's knowledge. Extra time may allow the reader to process more text, but effective comprehension also depends on high-level component skills such as short-term memory, working memory, vocabulary, and background knowledge.

Indeed previous research on accommodations of extra time for reading comprehension suggest that college and university students appear to benefit from extra time to process text. But many skills play into reading comprehension performance. Thus it is questionable whether simply increasing the time to process text will improve reading comprehension for more

heterogeneous groups of adults with LD, who are not necessarily in an academic setting on a consistent basis.

This study examined whether the accommodation of extra time is appropriate and effective for a group of adults with reading disability (RD), many of whom have not pursued education beyond the completion of high school. Further, this study was designed to address methodological issues that may be considered problematic in previous research. In Runyan's studies (1991a, 1991b), and the Weaver (1993) study, during an extended time condition participants were instructed to read quickly for 20 minutes. At the end of the 20 minutes they were instructed to resume work on the same test from the point where they had left off, and to continue working until they completed the test. The score for the untimed condition was the score at the end of the final period. During the extra time participants were not permitted to review and change answers given during the timed condition. This is problematic. By design, any student who completes the test under the timed condition will not show improvement under extra time conditions, and there may be a ceiling effect. For instance, in the Runyan (1991a) study only 2 of the 15 normally achieving students did not finish the test in the allotted time (for another discussion see Zuriff, 2000).

The present study utilized two distinct conditions (i.e. timed and untimed) under which participants took alternate forms of a standardized reading comprehension test. Unlike previous studies, we examined not only the differences in reading comprehension performance between conditions but also whether there was a differential influence of vocabulary, short-term memory, and reasoning skills on reading comprehension performance.

Method

Participants

The 64 participants (33 females and 31 males) in this study were predominantly Caucasian, and were living in the greater Vancouver, British Columbia area. All participants were native English speaking adults. Some were self-referrals. Others were referred by

physicians, community agencies, and high school, college or university personnel. The participants ranged in age from 17 to 60. The average level of education was grade 12. The participants represented a wide socioeconomic range. None of the participants had previously been exposed to support services, remediation, or accommodations for RD.

Reader Classification & Planned Analyses

The participants were initially classified as RD and normal readers (NR) based on the Wide Range Achievement Test-Revised reading (WRAT-R; Jastak & Wilkinson, 1984). Participants with scores at or below the 25th percentile were classified as reading disabled and participants with scores at the 30th percentile or above were classified as normal readers. In order to obtain a more in-depth analysis of reading comprehension ability and the effects of the timed and untimed conditions, the NR group was further subdivided. The subgroup of Average readers scored between the 30th and 69th percentile, n=22. Above Average readers scored at the 70th percentile and above, n=20. The first set of analyses was conducted with these 3 groups (AA, Average, RD).

Given the wide range of performance and demographics within the RD group, we were interested to lean whether word reading ability would influence ability to benefit from extra time. In other words, is a certain level of word reading ability necessary in order to benefit from extra time? Therefore, following this first set of analyses with 3 groups, the RD group was further analyzed by subdividing it into two groups. severe RD participants scored between the 1st and 9th percentile on the WRAT-R reading, n=9. Below Average readers scored between the 10th and 25th percentile, n=13.

In addition to examining scores on the Nelson-Denny test under timed and untimed conditions, we also wanted to examine changes in scores between the two conditions. We calculated the difference between performance in the timed condition and the untimed condition by subtracting the scores obtained in each condition. Subsequent analyses were conducted on

these difference scores. In essence, we were interested in measuring the degree of benefit of extra time by each group across the two conditions, and as such calculated difference scores.

Measures

Reading

Nelson-Denny Reading Test (forms G & H): Reading Comprehension section (NDRT; Brown, Fishco, & Hanna, 1993). The Reading Comprehension section contains 7 reading passages and a total of 38 multiple-choice questions to be answered on paper with pencil. In the timed condition, the participants had 20 minutes to complete the test. In the untimed condition, the participants had up to 40 minutes to complete the test.

Wide Range Achievement Test – Revised (Jastak & Wilkinson, 1984): Reading subtest (blue form). This test involves reading a list of words of increasing difficulty. Each participant was required to read as many words as possible from the list. When ten consecutive words were read incorrectly, the task administration was discontinued. Sample words from the list included *in, stretch,* and *contagious.*

Woodcock Johnson Reading Mastery Test-Revised (form G) (Woodcock, 1987): Word identification. This subtest is made up of a word-reading list of increasing difficulty. Each participant was required to read as many words as possible from the list. When all items in a given level were failed, the task administration was discontinued. Sample words from the list included: *is, find,* and *mathematician.*

Woodcock Reading Mastery Test - Revised (form G) (Woodcock, 1987): Word attack. Designed to measure decoding skills, this subtest is made up of a list of pseudo-words of increasing difficulty. The participant was required to decode as many items as possible from the list. When all items in a given level were failed, the task administration was discontinued. Sample items from the list included: *dee, straced,* and *bafmotbem*.

Spelling

Wide Range Achievement Test – Revised (Jastak & Wilkinson, 1984): Spelling (blue form). This test is made up of orally presented words of increasing difficulty. The participant was required to generate the correct spelling. Sample items included: *must, enter,* and *character.*

Arithmetic

Wide Range Achievement Test - Revised (Jastak & Wilkinson, 1984): Arithmetic (blue forms). This test is made up of a page of computational written mathematics problems. Each participant was required to solve them to the best of his or her ability. Sample items included: 2+7 =__, 33-17 = __, and 4527÷9=__.

Vocabulary, Short-term Memory and Non-verbal Reasoning

Wechsler Adult Intelligence Scale-Revised: Vocabulary subtest (Wechsler, 1981). In this task, participants were asked to provide the meaning of words. Using manual scoring criteria, the responses were scored 0, 1, or 2 based on the quality of the recognized meaning provided. When three consecutive responses were scored 0, the task was discontinued. Sample words included *winter, consume,* and *remorse.*

Wechsler Adult Intelligence Scale- Revised: Block Design subtest (Wechsler, 1981). Within a specified time limit, participants were presented with a design, and were asked to recreate the design using up to 9 red and white colored blocks. When three consecutive items were failed, the task was discontinued.

Wechsler Adult Intelligence Scale- Revised: Digit span subtest (Wechsler, 1981). In this task, participants were asked to repeat a string of numbers presented orally in increasing length. The participants were asked to repeat digits forward and digits backward. When both trials of a particular item were failed, the task was discontinued. Sample items included: 5-8-2, and 3-2-7-9.

Procedure

The battery of tasks individually administered to participants included cognitive ability (short-term memory, vocabulary and non-verbal reasoning) and achievement (word reading, decoding, reading comprehension, spelling, and arithmetic). As in Halla's (1988) study, the Nelson-Denny test was administered twice, under timed and untimed conditions across the groups, using the two equivalent forms (G and H). The allocation of forms G and H was relatively equal across conditions and across groups within conditions. In the timed condition participants had 20 minutes to complete the test. In the untimed condition participants were told to complete the task at their own pace, but the test was discontinued once they had worked for 40 minutes. The Nelson-Denny is scored using education level (grade) norms, as opposed to age, and has norms for both the timed and extended time administration formats.

Results

Analyses Conducted

Word Reading, Arithmetic, and Cognitive Measures

Analyses with cognitive (vocabulary, short-term memory, nonverbal reasoning) and achievement measures (word reading, nonword reading, arithmetic) were based on percentile scores. A univariate analysis of variance (ANOVA) was conducted to examine the effect of group (RD: *reading disabled*, *Average readers*, AA: *above average readers)* on performance, as well as when the RD group was further disaggregated into two groups (below average, severe RD). Post-hoc analyses were conducted in order to examine differences between the groups (alpha level .05), and in order to examine the strength of association, effect sizes (eta-squared) were calculated.

Reading Comprehension Performance

Analysis of the reading comprehension performance was based on raw scores, number of errors, and number of items tried (attempts), and percentile scores. The sum of correct answers and number of errors was considered the number of items tried. Raw scores, based on

correct answers, were converted to percentile scores using the norms for the Nelson-Denny reading comprehension test. A univariate analysis of variance (ANOVA) was conducted to examine the effect of group (RD: *reading disabled*, *Average readers*, AA: *above average readers)* on reading comprehension, and the relation between reading group and number of items attempted was examined. ANOVA was also conducted when the RD group was further disaggregated into two groups (below average, severe), and post-hoc analyses were conducted in order to examine differences between the groups on reading comprehension (alpha level .05). Finally, in order to examine the strength of association, effect sizes (eta-squared) were calculated.

Age and Level of Education

Table 1 presents the mean age and mean years of education for each of the reader groups.

INSERT TABLE 1 HERE

No significant differences between the groups were detected for age, $F(2,63)= .47$, *ns,* $\eta^2=0.18$. However, there were group differences for years of education, $F(2, 63)= 4.73$, $p<.05$, $\eta^2=0.13$; Tukey post hoc tests indicated that the RD group had lower levels of education than the Average readers and AA readers. The pattern of results with four groups was quite similar. There were no differences in age across the four groups, and there were no significant differences between the severe RD and BA reader groups in years of education. The BA group and the Average readers did not differ significantly on years of education.

INSERT TABLE 2 HERE

Vocabulary, Non-Verbal Cognitive Ability, and Memory

Table 2 presents the means and standard deviations for the vocabulary, non-verbal cognitive ability, and memory for the three and four reader groups. No significant differences between the groups were detected for non-verbal cognitive ability, as measured by Block Design, $F(2,63)=.50$, *ns,* $\eta^2=0.02$. However, group differences were detected for Vocabulary,

$F(2,63)= 16.25$, $p<.001$, $\eta^2=0.35$. Tukey post hoc tests revealed that the RD group had lower scores than the Average and AA readers on Vocabulary, and that the AA readers had higher scores than RD and Average readers on Vocabulary. On the Digit Span measure of short-term memory, group differences were detected, $F(2,63)= 14.43$, $p<.001$, $\eta^2=0.32$; the Tukey post hoc tests indicated that the RD group had lower scores than the AA readers. No significant differences were detected for RD and Average readers.

When the cognitive measures were examined across the four groups, as shown in Table 2, there were no significant differences between the severe RD and BA reader groups. Similar to the findings of years of education, no differences were detected between BA readers and Average readers on the vocabulary and short-term memory (digit span) tasks.

Achievement Measures

INSERT TABLE 3 HERE

Table 3 presents means and standard deviations for each of the three and four reader groups on measures of reading, spelling and arithmetic.

Word Reading and Nonword Reading

As shown in Table 3, significant group differences were detected for performance on the W-J Word Identification, $F(2,63)= 97.45$, $p<.001$, and W-J Word Attack, $F(2,63)= 43.72$, $p<.001$. The Tukey post hoc tests revealed that for W-J Word Identification, the AA readers had higher scores than the two other groups, and the Average readers had significantly higher scores than the RD group. On the W-J Word Attack, Tukey post hoc tests revealed that the AA and Average readers had significantly higher scores than the RD group.

Analyses with the four groups revealed the same pattern of results whereby the RD groups differed significantly from their non reading disabled peers on measures of word identification and nonword reading.

Spelling and Arithmetic

As shown in Table 3, significant group differences were detected for WRAT-R Spelling, F (2,63)= 78.62, p<.001, η^2=0.72. The Tukey post hoc tests revealed that the AA readers had higher scores than the two other groups on WRAT-R spelling, the Average readers had higher scores than the RD participants. Significant group differences were also detected for WRAT-R arithmetic, F(2,63)= 10.793 p<.001, η^2=0.26. Tukey's post hoc tests indicated that there were no significant differences between RD and Average readers, and that the AA readers had higher scores than the other two groups.

Analyses with the four groups revealed the same pattern of results whereby the RD groups differed significantly from their non reading disabled peers on measures of spelling and arithmetic.

Nelson-Denny Reading Comprehension

INSERT TABLE 4 HERE

Table 4 presents the results for the reading comprehension performance of the three and four groups, under timed and untimed conditions. Ultimately, in order to make group comparisons related to performance under timed and untimed conditions, a univariate ANOVA, with number of items attempted in each condition as a covariate, was conducted. However before that, preliminary analyses were conducted to compare number of items attempted, number of correct answers (raw score), and percentile obtained.

Number of Items Attempted

In the timed condition, the groups differed significantly from each other on the number of items tried, F(2,63)=21.02, p<.001, η^2=0.41. Tukey post hoc tests revealed that the AA readers attempted more items than either of the other two groups, and that the Average readers attempted more items than the RD in the timed condition. However, in the untimed condition each group attempted to answer all of the items, thus there were no differences in number of attempts, F(2,63)=2.02, *ns,* η^2=0.06.

The analyses with four groups for number of attempts revealed no significant differences between BA and Average readers; this is consistent with the results of the analyses with three groups where the disabled readers attempted a similar number of questions as the Average readers.

Accuracy and Percentiles

Although the number of attempts, number of correct answers, and number of errors are related to one another, there were differences by group and within condition on these variables.

Timed Condition

In the timed condition, there were significant group differences for number of correct answers obtained, F (2,63)=40.52, p<.001, η^2=0.57. Tukey post hoc tests revealed that the AA readers had more correct answers than each of the other groups, and that the Average readers had more correct answers than the RD group. Similarly, there were group differences in the number of errors committed, F(2,63)= 5.39, p<.05, η^2=0.15; Tukey post hoc analysis revealed that the RD group made significantly more errors than the Average and AA readers. The ANOVA detected significant group differences for the Nelson-Denny percentile obtained in the timed condition, F (2,63)=24.26, p<.001, η^2=0.44. Tukey post hoc tests indicated that the AA readers had higher percentiles than the two other groups, and that the Average readers had higher percentiles than the RD group.

Untimed Condition

In the untimed condition, although the groups did not differ overall in number of attempts, group differences were detected on number of correct answers, F(2,63)=16.25, p<.001, η^2=0.34. Tukey post hoc tests revealed that the AA and Average readers had more correct answers than the RD group. For number of items correct in the untimed condition, there were no differences between the AA and Average readers, but the two groups demonstrated better performance than RD group. Group differences were also detected for the number of errors committed, F(2, 63)= 11.99, p<.05, η^2=0.38; Tukey post hoc tests indicated that the RD group

made more errors than Average and AA readers. Finally, in the untimed condition, there were group differences for the Nelson-Denny percentile obtained, F (2,63)=19.99, p<.001, η^2=0.39. Tukey post hoc tests indicated that the three groups differed significantly from each other on this measure, with AA readers scoring significantly higher than the Average readers and the RD group.

The analyses with four groups revealed that there were no differences between BA readers and Average readers for raw score and percentile in the untimed condition. However, there were differences between the Average readers and the severe RD group, whereby the Average readers performed significantly better than the severe RD group.

As shown in Table 4, there were no significant differences between the severe RD and BA reader groups on reading comprehension measures in either condition (timed, untimed) as measured by Tukey post hoc tests.

Effect of Reading Comprehension Condition and Between-Condition Analyses

The number of items attempted was used as a covariate for the group comparisons of reading comprehension performance under the two conditions. Examining reading comprehension percentiles revealed an effect of reader group however, the effect size for the untimed condition, F(3, 63)=17.58, p<.001. η^2 =.47, was much smaller than for the timed condition, F(3,63)=42.45, p<.001 η^2 =.68. Thus, although performance in comprehension was significantly different across groups, the untimed condition resulted in a decreased magnitude of difference between the groups.

INSERT TABLE 5 HERE

Difference Scores

Because all three groups obtained higher scores in the untimed condition as compared to the timed condition, we conducted analyses on the difference scores between the two conditions. ANOVA with post hoc analyses were conducted for difference scores on the four reading comprehension measures (number of errors, percentile, number correct, total tried) for

the three groups (AA, Average readers, RD group) in each condition (timed and untimed testing). As shown in Table 6, the ANOVA and Tukey's post hoc tests revealed no statistically significant results on the difference scores in number of errors, $F(2,63)=1.97$, ns, $\eta^2=.06$, and percentile $F(2,63)= .28$, ns, $\eta^2=.01$, across groups. However significant results were detected on the difference scores for number of items correct, $F(2,63)=7.91$, $p<.001$, $\eta^2=.20$, and total tried, $F(2,63)=12.91$, $p<.001$, $\eta^2=.30$. The RD group obtained the greatest difference on items correct across conditions as compared with Average and AA readers, for which difference scores across conditions were similar. Furthermore, the RD group obtained the largest difference on number of items tried across conditions. These results are consistent with the group results in the timed condition; in fact, the RD group had the lowest scores in the timed condition and thus had the most potential for gains in the untimed condition. Whereas in the timed condition, the AA group was at ceiling with respect to number of items tried which did not allow them to make any gains on that measure for the untimed condition. This finding is consistent with previous research in the area (e.g., Runyan, 1991a).

It is critical to note that because of this ceiling effect for the AA group, we re-ran the analyses without this group in order to rule out the possibility that the overall findings were simply a result of the performance of this subgroup. In the untimed condition, the univariate ANOVA with reader group as the factor (RD, Average) and number of items attempted as a covariate revealed a significant effect of reader group, $F(2, 43)= 11.083$, $p<.001$. Thus, even without the AA readers, the pattern of results is very similar without the Above average readers.

Effect Sizes

Demographic, Cognitive, and Achievement Measures. The eta squared (η^2) measure of strength of association indicated a small effect for level of education ($\eta^2=0.13$), block design ($\eta^2=0.02$), arithmetic ($\eta^2=0.26$). In contrast, moderate effect sizes were obtained for vocabulary ($\eta^2=0.35$), digit span ($\eta^2=0.32$), nonword decoding ($\eta^2=0.59$). Large effect sizes were obtained for measures of word reading ($\eta^2=0.76$), and spelling ($\eta^2=0.72$).

Reading comprehension. The eta squared measure of strength of association indicated a small effect for reading comprehension total tried untimed (η^2=0.06) and number of errors timed (η^2=0.15). In contrast, moderate effect sizes were obtained for reading comprehension in timed and untimed conditions, correct answers timed (η^2=0.57), and untimed (η^2=0.34), number of errors in the untimed condition (η^2=0.30), percentile timed (η^2=0.44) and untimed (η^2=0.39), as well as total tried timed (η^2=0.41).

Regression Analyses

INSERT TABLES 6 & 7 HERE

In order to examine the influence of cognitive and reading ability on reading comprehension performance under timed and untimed conditions, fixed order hierarchical regression analyses were conducted. We were also interested in these analyses to further examine the differential patterns between groups given the reduction in magnitude of differences in reading performances in the untimed condition.

In each analysis, decoding ability was entered first, followed by cognitive ability (Block Design), level of education (grade completed), vocabulary, and short-term memory (Digit Span). In order to look at the relation of cognitive measures and word reading ability to reading comprehension performance under different conditions, we examined the results of models with differential orders of entry of word reading.

When word reading was entered last, the results for the timed and untimed condition were very similar. As shown in Tables 6 and 7, under both the timed and untimed conditions, word reading accounted for the most significant amount of variance (timed: 59%, untimed: 47%), with vocabulary (timed: 42%, untimed: 26%) and short-term memory (timed: 47% untimed: 35%) also accounting for significant variance in reading comprehension performance. In these models, WAIS-R Block Design and level of education did not account for significant variance in reading comprehension.

However, when word reading ability was forced into the model in the first step, the pattern of results was very different and the results varied by reading comprehension condition. As shown in Table 6 under timed conditions, word reading ability and vocabulary together accounted for approximately 57% of variance in reading comprehension performance. WAIS-R Block Design, WAIS-R Digit Span, and level of education did not account for significant variance in reading comprehension under timed conditions. Whereas, as shown in Table 7, under untimed conditions only word reading ability was significant; WRAT3 accounted for approximately 42% of variance in reading comprehension. After word reading ability, no other variables accounted for significant variance in reading comprehension performance under untimed conditions.

Summary

Each of the subgroups of typical and disabled readers benefited from the untimed condition for reading comprehension. The differences across groups in the timed condition were consistent with the reader classification, thus the Average and AA readers performed significantly better than the RD readers. All groups benefited from extra time. But when analyzed as a whole, the RD group received more benefit from the extra time than the Average and AA readers did. However, when the RD group was subdivided into severe RD and BA readers, the benefit of extra time was localized to the BA group. During the untimed condition, the performance of the BA readers was not significantly different from that of Average readers. On the other hand, the severe RD group performance remained significantly lower than that of all other groups. The regression analyses demonstrated that reading comprehension performance was influenced not only by word reading ability, but also by vocabulary and short-term memory.

Discussion

Untimed conditions had a positive effect on reading comprehension for a group of adults with reading disabilities who had not had any prior support services or intervention for their

difficulties. The RD group benefited the most from the extra time. The untimed condition, though, did not eradicate differences in reading comprehension performance between groups. One may argue that this is a necessary but not sufficient condition to enable adults with reading disabilities to perform at grade level, depending on the severity of their deficits.

More specifically, when the reading disabled group was disaggregated, under untimed conditions the performance of the BA readers resembled that of the Average group. It is also important to note that this group's mean level of education did not differ significantly from the Average reader groups. The untimed condition gave the severe RD group the opportunity to respond to all the questions. But their vocabulary and short-term memory ability, which were lower than those of the BA readers, were apparently not sufficient to support their reading comprehension performance to the same extent as other groups in the study.

The BA reader group's word recognition skills were lower than those of the Average readers. But one could argue that those skills were developed to an adequate level to allow for average levels of reading comprehension if combined with extra time and increased higher level component processes including short-term memory and vocabulary. Since none of these adults have had any remedial services or interventions for their reading difficulties, the individuals in this group may be appropriate candidates for intervention to build their word reading skills as a direct route to improving comprehension performance.

The severe RD group performance did increase under untimed conditions, and as a result of the untimed condition they were able to attempt all the questions. But the untimed condition was not enough to enable them to perform at the same level as the Average readers. The extremely low scores for this group, on the word reading and nonword reading measures and their low scores on the vocabulary and short-term memory measures indicate that their basic level skills and higher level component processes are even less developed than those of the adults in the BA reader group. In addition to language and reading abilities as factors related to their reading comprehension it is important to consider that, in the aggregate, the RD group

likely lacks effective strategies to promote their reading comprehension. Previous research conducted with individuals with reading disabilities suggests this is the case (e.g., Mastropieri, Scruggs, & Graetz, 2003). This group had also completed the lowest mean level of education—11 years—indicating that many of the group members had not completed high school. It is important to note that when the RD group was disaggregated, the severe RD group had the least education. The Nelson-Denny test is scored using education level (grade) norms. But despite this, the severe RD group continued to attain very low percentiles in the untimed condition. This raises questions about the relation between word reading ability and other comprehension-related skills, years of experience with print, and the ability to benefit from extra time to raise reading comprehension performance to average levels.

The severe reader group's performance may be an example of Stanovich's (1986) 'Matthew Effect' whereby reading difficulties interact with such factors as self-esteem and motivation to produce significant individual differences in reading exposure, vocabulary acquisition, and reading comprehension in later years. As time passes, the gap between good and poor readers increases. The severe RD participants not only had the lowest scores on all of the measures administered, but also had the lowest level of education. Thus they have likely had the least structured instruction and exposure to literacy. Bruck (1985) found that adult dyslexics rarely engaged in literacy activities when not in structured educational environments. This is consistent with Stanovich's (1986) argument regarding the plateau of reading growth and literacy activity in dyslexics over time. One must consider literacy engagement as a confounding factor in performance on measures of reading and its underlying processes, as well as vocabulary. For the severe RD group, vocabulary accounted for significant variance in reading comprehension performance under both timed and untimed conditions. This was not true for any of the other groups under untimed conditions.

The group comparisons of reading comprehension performance under timed and untimed conditions are relatively straightforward, but the results of the regression analyses are

not. Taken together, the results of the regression analyses suggest that word reading ability, vocabulary and short-term memory play a differential role in reading comprehension performance under different conditions. Under both timed and untimed conditions, when word reading was forced in the model after the cognitive measures, vocabulary and short-term memory accounted for significant variance in reading comprehension performance. Under untimed conditions, when word reading ability was forced into the regression model first, it was the only variable that accounted for significant variance in reading comprehension performance. Yet under timed conditions, in addition to word reading, vocabulary accounted for significant variance in reading comprehension.

These results suggest that when time is a factor in the testing situation the levels of vocabulary and short-term memory have a significant effect on reading comprehension. Given the well established relation between reading comprehension and skills such as vocabulary (e.g. Nagy, 1988) and short-term memory (e.g. Swanson, 1994) we might have expected this relation to be sustained, or even amplified under untimed conditions. Under untimed conditions we might expect word reading to play a less significant role in comprehension and we might expect vocabulary and short-term memory to play a more important role, but this not the case. For the sample in the present study, under untimed conditions, vocabulary and short-term memory did not account for significant variance in comprehension performance. These results are puzzling and they warrant further investigation.

Possibly related, it is of note that the model that we fit, with the word reading cognitive measures, accounted for more variance in the timed condition than in the untimed condition. This suggests that under untimed conditions, unobserved variables are contributing to reading comprehension performance. These variables are not as influential under timed conditions. A likely candidate includes the ability to sustain attention and focus over a longer period of time. The trade off with providing more time to individuals with RD is that they must also then sustain focus longer, and some may find that problematic.

In addition to considering the effects of extra time on reading comprehension performance, the present study adds to the extant research on the cognitive and linguistic profile of adults with learning disabilities. Studies that have examined the phonological processing abilities of adults with learning disabilities indicate that the deficit persists regardless of education level attained (Bruck, 1990, 1992; Shafrir & Siegel, 1994; Snowling, Nation, Moxham, Gallagher, & Frith, 1997; Wilson & Lesaux, 2001). Shafrir and Siegel (1994) found deficits in phonological processing, reading, spelling, and short-term memory in a heterogeneous group of adults with reading disabilities. Their sample contained some adults with post-secondary education and some without. The phonological processing deficit was detected in both groups. Studies focusing strictly on dyslexic university students with age-appropriate word reading skills detected difficulties with phonological processing as evidenced by difficulties in the accuracy and speed of non-word reading (e.g. Bruck, 1990, 1992; Snowling, Nation, Moxham, Gallagher, & Frith, 1997; Wilson & Lesaux, 2001). For the heterogeneous adults with RD who had little higher education in the present study, phonological processing presented difficulties, and likely had an impact on their word reading ability.

Poor word recognition diverts mental resources from the processes needed for comprehension. Due to poor word recognition, these readers take longer than their non-learning disabled peers to read words. Research suggests they may also be using ineffective reading strategies (e.g. Bruck, 1990). Within Bruck's (1990) dyslexic sample, there was considerable individual variation on the standardized reading comprehension test. The good and poor comprehenders within the dyslexic sample did not differ on measures of word recognition, spelling, or nonverbal intelligence, but the good comprehenders in her study had higher PPVT and childhood IQ scores. These findings are consistent with the findings from the present study in that the reading disabled group showed tremendous variability. Once disaggregated, one group with higher vocabulary and short-term memory skills performed at average levels of comprehension under untimed conditions. The severely reading disabled

group had difficulties beyond the time required for reading comprehension. However, in light of the results of the regression analyses we must also consider that it was simply their better word reading skills that supported their reading comprehension performance under untimed conditions.

Some previous research has found that with extra time, college and university students with learning disabilities benefit from extra time while their non-learning disabled peers do not (e.g. Runyan, 1991a, 1991b). One significant difference to consider when interpreting the findings from the present study and Runyan's findings is the design itself. In Runyan's studies, there were no untimed and timed conditions. Rather, the participants were instructed to read quickly for 20 minutes. At the end of the 20 minutes, they were instructed to resume work on the same test from the point where they had left off and to continue working until they completed the test. The score for the untimed condition was the score at the end of the final period. During the extra time participants were not permitted to review and change answers they had given during the timed condition. The reading disabled participants in Runyan's study had significantly higher scores on the untimed format of reading comprehension, while the performance of the normally achieving group did not increase in the untimed version. Like the conditions in the Weaver (1993) study, Runyan's conditions involved an extended time condition as opposed to an actual 'untimed' condition where students begin the test with the impression that they can work at their own pace and review their answers. This design is problematic because by design, any student who completes the test under the timed condition will not show improvement under extra time conditions; in fact, what may occur is a ceiling effect. As such, in the Runyan (1991a) study only 2 of the 15 normally achieving students did not finish the test in the allotted time (for another discussion see also Zuriff, 2000).

In addition, the facts that students could not review and change their answers and that they were told to work quickly in the beginning and then told to take their time in the latter part of the test do not lend themselves to re-creating the usual test scenario. This procedure is not

consistent with the fact that many students are taught such strategies as pacing themselves during a test, reviewing their answers, and even postponing answering a question that gives them difficulty, and then going back to that question if time permits.

All of the reading disabled individuals in the present study benefited from an untimed condition, having been instructed from the beginning to work at their own pace. The support for this accommodation is strengthened by the results. Under these conditions, the RD groups were able to attempt all questions. Further support is reflected by the facts that the untimed condition for the normally achieving individuals did not result in a significant increase in test performance, and that in the timed condition their performance was already well within the average range. The number of attempts for the Average readers increased in the untimed condition, but the overall percentile attained for the group was not significantly different. The findings that in the untimed condition the severe RD group was able to attempt all questions, and that the BA readers were able to perform at levels similar to the Average readers, are consistent with the goal of the accommodation. Using number attempted as a proxy for reading speed provided insight into reading comprehension performance under different timing conditions, but more work needs to be done. Future research in this area should further examine the relation between word reading ability, reading comprehension speed, and reading comprehension performance by including measures of reading fluency.

Future research should also be conducted to seek further insights into the seemingly differential and somewhat unexpected results related to the roles of word reading, vocabulary, and short-term memory under timed and untimed conditions. We are not able to draw any strong conclusions about the findings, but they raise intriguing questions about exactly which skills are most crucial when extra time is provided.

The lack of age-appropriate reading and related skills across all measures reflected the fact that the RD participants in the present study have not had any services or intervention for their difficulties. These individuals would likely benefit from support services, and in many cases

this was their reason for referral. In planning and evaluating effective interventions for this group, the emphasis should include word reading, vocabulary development, and strategies related to memory and comprehension. The study suggests that participants with reading disabilities who had typical vocabulary and short-term memory skills were better able to compensate for their decoding difficulties. The results suggest that overall, increased time for test taking is an appropriate accommodation to compensate for the reading difficulties of individuals with a reading disability.

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Table 1

Age and Years of Education

Three Reader Subgroups					
		Above Average n=20	Average n=22	Reading disabled n=22	
Age (years)	*M*	35.68 $_{a}$	37.53 $_{a}$	34.78 $_{a}$	
	SD	12.38	10.19	10.51	
Years of Education	*M*	13.95 $_{a}$	14.09 $_{a}$	11.95 $_{b}$	
	SD	2.91	2.40	2.36	
Four Reader Subgroups					
		Above Average n=20	Average n=22	Below average (RD) n=13	Severe RD n=9
Age (years)	*M*	35.68 $_{a}$	37.53 $_{a}$	33.97 $_{a}$	35.95 $_{a}$
	SD	12.38	10.19	8.62	13.25
Years of Education	*M*	14 $_{b}$	14 $_{b}$	13 $_{a\,b}$	11 $_{a}$
	SD	2.91	2.40	2.69	1.41

** Groups were classified by WRAT-R Reading

$_{a\ b\ c}$ Means in the same row that do not share subscripts differ at the level of $p<.05$ in Tukey post hoc analyses

Table 2

Cognitive Measures

Three Reader Subgroups					
WAIS-R Scaled Scores		Above Average n=20	Average n=22	Reading disabled n=22	
Vocabulary	*M*	13.40 $_{a}$	11.00 $_{b}$	9.00 $_{c}$	
	SD	3.07	2.11	2.07	
Block Design	*M*	11.45 $_{a}$	10.59 $_{a}$	10.77 $_{a}$	
	SD	3.15	2.17	3.23	
Digit Span	*M*	11.00 $_{a}$	8.68 $_{bc}$	7.09 $_{c}$	
	SD	2.96	2.50	1.40	
Four Reader Subgroups					
		Above Average n=20	Average n=22	Below average (RD) n=13	Severe RD n=9
Vocabulary	*M*	13.40 $_{a}$	11.00 $_{b}$	9.54 $_{bc}$	8.22 $_{c}$
	SD	3.07	2.27	2.11	1.99
Block Design	*M*	11.45 $_{a}$	10.59 $_{a}$	10.38 $_{a}$	11.33 $_{a}$
	SD	3.15	2.17	2.88	4.03
Digit Span	*M*	11.00 $_{a}$	8.68 $_{b}$	8.00 $_{bc}$	5.78 $_{c}$
	SD	2.96	2.50	.91	.97

$_{a\ b\ c}$ Means in the same row that do not share subscripts differ at the level of $p<.05$ in Tukey post hoc analyses

Table 3

Achievement Tests (Percentiles)

Three Reader Subgroups					
		Above Average n=20	Average n=22	Reading disabled n=22	
WJ Word Identification	*M*	70.10 $_{a}$	52.05 $_{b}$	9.82 $_{c}$	
	SD	16.70	17.08	7.92	
WJ Word Attack	*M*	67.25 $_{a}$	55.23 $_{a}$	15.95 $_{b}$	
	SD	19.97	22.51	12.40	
WRAT-R Spelling	*M*	64.35 $_{a}$	49.27 $_{b}$	6.50 $_{a}$	
	SD	20.69	16.19	7.64	
WRAT-R Arithmetic	*M*	52.35 $_{a}$	35.32 $_{b}$	19.59 $_{b}$	
	SD	25.70	23.55	23.09	
Four Reader Subgroups					
		Above Average	Average n=22	Below average (RD)	Severe RD n=9

		n=20		n=13	
WJ Word Identification	*M*	70.10 $_{a}$	52.05 $_{b}$	14.38 $_{c}$	3.22 $_{c}$
	SD	16.70	17.08	7.04	2.73
WJ Word Attack	*M*	67.25 $_{a}$	55.23 $_{a}$	19.54 $_{b}$	10.78 $_{b}$
	SD	19.97	22.51	13.29	9.36
WRAT-R Spelling	*M*	64.35$_{c}$	49.27$_{b}$	8.23$_{c}$	4.00$_{c}$
	SD	20.69	16.19	8.56	5.63
WRAT-R Arithmetic	*M*	52.35$_{a}$	35.32$_{ab}$	19.15$_{b}$	20.22$_{b}$
	SD	25.70	23.55	17.91	21.58

*WJ= Woodcock Johnson

$_{a\ b\ c}$ Means in the same row that do not share subscripts differ at the level of $p<.05$ in Tukey post hoc analyses

Table 4

Nelson-Denny Reading Comprehension Scores

Three Reader Subgroups				
		Above Average n=20	Average n=22	Reading disabled n=22
Number Correct Timed	*M*	30.40 $_{a}$	23.27 $_{b}$	12.68 $_{c}$
	SD	6.74	7.19	5.22
Number Correct Untimed	*M*	34.15 $_{a}$	29.82 $_{a}$	23.59 $_{b}$
	SD	2.66	6.50	7.58
Number of Errors Timed	*M*	6.28_{a}	5.22_{b}	8.95_{b}
	SD	4.91	3.66	5.54
Number of Errors Untimed	*M*	3.85_{a}	7.04_{b}	11.54_{b}
	SD	2.66	4.99	6.02
Number of Items Attempted	*M*	34.90 $_{a}$	28.50 $_{b}$	21.64 $_{c}$

Timed					
	SD	5.73	7.73	6.16	
Number of Items Attempted Untimed	*M*	38.00_{a}	36.86_{a}	35.14_{a}	
	SD	0.00	3.75	6.99	
Percentile Timed	*M*	60.65_{a}	36.95_{b}	9.82_{c}	
	SD	31.30	25.60	9.25	
Percentile Untimed	*M*	68.15_{a}	47.50_{b}	12.00_{c}	
	SD	22.20	30.08	9.30	
Four Reader Subgroups					
		Above Average n=20	Average n=22	Below average (RD) n=13	Severe RD n=9
Number Correct Timed	*M*	30.40_{a}	23.27_{b}	14.15_{c}	10.56_{c}
	SD	6.74	7.19	4.50	5.70
Number Correct Untimed	*M*	34.15_{a}	29.82_{abc}	26.23_{bc}	19.78_{c}
	SD	2.66	6.50	7.84	5.58
Number of	*M*	34.90_{a}	28.50_{b}	22.61_{bc}	20.22_{c}

Items Attempted Timed					
	SD	5.73	7.73	5.42	7.20
Number of Errors Timed	*M*	6.28_{a}	5.22_{bc}	8.46_{bc}	9.66_{c}
	SD	4.91	3.66	5.60	5.70
Number of Errors Untimed	*M*	3.85_{a}	7.04_{ab}	9.46_{bc}	14.55_{c}
	SD	2.66	4.99	5.66	5.45
Number of Items Attempted Untimed	*M*	38.00_{a}	36.86_{a}	35.69_{a}	34.33_{a}
	SD	0.00	3.75	6.95	7.38
Percentile Timed	*M*	60.65_{a}	36.95_{b}	11.08_{c}	8.00_{c}
	SD	31.30	25.60	9.54	9.04
Percentile Untimed	*M*	68.15_{a}	47.50_{b}	27.62_{bc}	12.00_{c}
	SD	22.20	30.08	20.58	9.30

Means for correct, errors and total tried are based on raw scores with a maximum of 38.
$_{a\ b\ c}$ Means in the same row that do not share subscripts differ at $p<.05$ based on Tukey post hoc comparisons.

Table 5

Difference scores (Untimed-Timed) on Reading Comprehension Measures

	Reading Disabled n= 22	Average n= 22	Above Average n= 20
Diff. Number Correct	10.90[a]	6.54[b]	3.75[b]
Diff. Percentile	11.40[a]	10.54[a]	6.40[a]
Diff. Total Tried	13.50[a]	8.36[b]	3.10[c]
Diff. Number Incorrect	2.59[a]	1.81[a]	0.65[a]

[a b c] Means in the same row that do not share subscripts differ at $p<.05$ in the Tukey significant difference comparison. Difference scores were obtained by subtracting scored in the untimed condition from scores in the timed condition. To calculate difference scores for number of errors, the reverse formula was used (Timed – Untimed).

Table 6

Fixed-order Hierarchical Regression Analysis Predicting Timed and Untimed Reading Comprehension Performance

Measures	Timed		Untimed	
	R^2	ΔR^2	R^2	ΔR^2
Step 1				
WAIS-R Block Design	.010	.010	.013	.013
Step 2				
Level of education completed	.040	.030	.029	.016
Step 3				
WAIS-R Vocabulary	.423	.384**	.261	.231**
Step 4				
WAIS-R Digit Span	.469	.080*	.353	.093*
Step 5				
WRAT3 Reading	.599	.096**	.474	.120**

WAIS-R= Wechsler Adult Intelligence Test

WRAT3 = Wide Range Achievement Test

***p*<.001, * *p*<.01

Table 7

Fixed-order Hierarchical Regression Analysis Predicting Timed and Untimed Reading Comprehension Performance

Measures	Timed		untimed	
	R^2	ΔR^2	R^2	ΔR^2
Step 1				
WRAT3 Reading	.487	.487**	.421	.421**
Step 2				
WAIS-R Vocabulary	.572	.085**	.443	.022
Step 3				
WAIS-R Digit Span	.589	.017	.463	.020
Step 4				
WAIS-R Block Design	.589	.000	.463	.000
Step 5				
Level of education completed	.599	.010	.474	.011

WAIS-R= Wechsler Adult Intelligence Test

WRAT3 = Wide Range Achievement Test

***p*<.001