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Early reading success and its relationship to reading achievement and reading volume: replication of '10 years later'

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Abstract Cunningham and Stanovich reported a longitudinal investigation over 10 years that examined the unique influence of exposure to print in explaining individual differences on various measures of reading achievement and declarative (general) knowledge. The present study replicated their investigation with a larger number of participants and additional measures of literacy and language skills. Fifty-four 1st graders were administered reading, spelling, vocabulary, IQ, and listening comprehension measures and then followed to the end of 10th grade. At the end of 10th grade, they were administered an IQ test and measures of reading comprehension, language ability, general knowledge, and exposure to print. Results showed that 1st grade reading skills were a strong predictor of 10th grade outcomes. Second and third-grade reading skills were predictive of individual differences in print exposure even after 10th grade reading comprehension and language ability had been partialed. Individual differences in print exposure also predicted differences in the growth of reading ability, word decoding, spelling, vocabulary, and listening comprehension throughout the elementary grades. Findings confirm the powerful, long-term benefits of providing children with a fast start in reading and support the reciprocal nature of strong reading skills and engagement in reading and reading-related activities.

Keywords Print exposure · Early literacy · Individual differences

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Introduction

There is a strong consensus in the research literature and in popular culture about the importance of broad and frequent reading. Research has demonstrated that exposure to print, or the amount a student reads, is a unique and powerful contributor to a variety of academic achievement skills, including oral language, basic reading skills, spelling, content/declarative knowledge, and vocabulary skills (Anderson, Wilson, & Fielding, 1988; Cunningham & Stanovich, 1991; Glaser, 1984; Mol & Bus, 2011; Stanovich & Cunningham, 1992, 1993; West, Stanovich, & Mitchell, 1993). Additionally, the amount a person reads appears to contribute to growth in broad cognitive skills (Mol & Bus, 2011; Stanovich, West, Cunningham, Cipielewski, & Siddiqui, 1996). As Cunningham and Stanovich (2003) aptly state in the title of one of their articles, "Reading Can Make You Smarter".

Prior to entering school, young children are provided exposure to print through shared book reading with caregivers. Quality early reading experiences give children the exposure to oral language, rich vocabulary, and the background knowledge needed to support their eventual independent reading comprehension (Cunningham & Zibulsky, 2011). Children who have spent more time engaging in shared storybook reading have larger, more advanced vocabularies and stronger language comprehension skills (Bus, van Ijendoorn, & Pellegrini, 1995; National Center for Family Literacy, 2008; Whitehurst et al., 1988; Wood, 2002). For example, Senéchal and Young (2008) have shown that parents' involvement in home-based, shared reading activities has a positive impact on children's acquisition of reading and reading-related skills. As a result, these children have a distinct advantage when they enter school and begin formal reading instruction.

The advantage of early exposure to print can result in a more successful entry into formal reading, and thus a greater ability and desire to read. Children provided with this advantage often learn to read with greater ease than their less prepared peers. By developing strong decoding skills, they engage in more reading, which in turn exposes them to more print, enabling them to develop vocabularies and comprehension skills far beyond those of their less skilled peers. Their exposure to print through frequent reading creates a widening academic achievement gap termed the "Mathew Effect," a Biblical reference in which the rich get richer and the poor get poorer (Stanovich, 1986; Walberg & Tsai, 1983). This pattern of reading-related differences can start early and help or hinder a child's entire academic career. There appears to be a clear, reciprocal relationship between reading skill and exposure to print: print exposure increases reading skill and skilled readers have more ability and interest in reading. Over time, skilled readers engage in more frequent reading that improves not only their reading skills but also reading-related skills such as vocabulary and declarative knowledge, and thus increases the achievement gap between themselves and their less-skilled counterparts (Cunningham & Stanovich, 1997;Stanovich, Cunningham, & West, 1998).

In a recent meta-analysis examining the effect of print exposure from infancy through young adulthood, Mol and Bus (2011) found that the role of print exposure becomes stronger (additive) as children get older. Their findings showed that print exposure explained increasing amounts of variance in the oral language skills of preschoolers and kindergarteners (12 %) and students in primary school (13 %), middle school (19 %), and high school (30 %). At the postsecondary level, print exposure explained 34 % of the variance in the oral language skills of undergraduate and graduate students. Although the aforementioned evidence suggests that reading should start early to take advantage of the positive effects of print exposure, Stanovich et al. (1996) have indicated that exposure to print is helpful regardless of children's cognitive ability or their level of reading comprehension. Therefore, it is crucial to ensure that young children are taught the word recognition skills needed for successful reading early in school so that they have the opportunity to become active and engaged readers. Likewise, it is equally important to provide broad and frequent reading experiences for older children, particularly those with low verbal abilities, because reading itself improves the language skills they need to become strong readers (Cunningham & Stanovich, 2001).

Cunningham and Stanovich (1997) conducted a longitudinal investigation designed to examine the unique influence of exposure to print in explaining individual differences on various measures of reading achievement and declarative (general) knowledge. This unique longitudinal study was designed to extend previous work in which they and their colleagues found print exposure to be a potentially powerful, experiential variable in explaining individual differences in vocabulary and declarative knowledge, even after controlling for differences in cognitive ability (Stanovich & Cunningham, 1992, 1993; West & Stanovich, 1991) and years of educational experience (Stanovich, West, & Harrison, 1995; West et al., 1993). In this study, they followed 27 students over 10 years to examine early reading acquisition and its relationship to reading experience and reading skills. The participants were administered a battery of reading and cognitive assessments in first grade, and then again in 3rd, 5th, and 11th grades. In 11th grade, they were also administered a set of print exposure measures developed by Stanovich et al. (Author Recognition Test, Magazine Recognition Test) as well as measures of vocabulary and declarative knowledge. A series of hierarchical regression analyses were conducted to examine the relationships among the measures. When they examined the relationship between the 11th grade measures, they found that even after controlling for cognitive ability, print exposure was a significant predictor of declarative knowledge and verbal ability.

The findings also showed that 1st grade reading comprehension was a significant predictor of 11th grade reading achievement, and that print exposure predicted a significant amount of additional variance in 11th grade reading comprehension. These findings demonstrated the importance of early reading success for later reading skills. The findings also indicated that measures of 1st grade reading skills predicted significant variance in 11th grade print exposure, even after 11th grade reading comprehension had been partialed. This finding suggested that regardless of one's reading comprehension level in 11th grade, a student who acquired reading skill in 1st grade was more likely to engage in reading over time. Additionally, their results showed that print exposure in 11th grade was a strong predictor of growth in reading comprehension skills across earlier grade levels. Cunningham and

Stanovich (1997) speculated that their results further confirm the importance of strong early reading experiences, and that "subsequent exercise of this habit [reading] serves to further develop reading comprehension ability in an interlocking positive feedback logic" (p. 943).

One limitation of Cunningham's and Stanovich's study was its small sample size (n = 27), thus causing generalizations to be made with caution. The present study was designed to replicate their work with a larger number of students and more frequent and expanded assessment. For our study, we followed 54 students from the beginning of 1st grade to the end of 10th grade and assessed their skills in 1st, 2nd, 3rd, 5th, and 10th grades. We administered measures of reading, vocabulary, and spelling in 1st–5th grades; listening comprehension in 3rd and 5th grades; reading comprehension and language ability in 10th grade; cognitive ability in 1st and 10th grades; and print exposure and declarative knowledge in 10th grade. Like Cunnigham and Stanovich, we wanted to investigate the following questions: (a) Does print exposure (reading volume) explain additional variance in 10th grade reading comprehension, language, and general knowledge skills?; (b) Do print exposure and early literacy skills predict reading comprehension and general knowledge in 10th grade?; and (c) Does print exposure in 10th grade predict growth in decoding and reading comprehension skills in 1st through 5th grades? Because we had also administered measures of spelling, vocabulary, and listening comprehension, we also examined whether print exposure predicted growth in these skills in 1st–5th grade.

Method

Participants

The participants were 54 high school students, 25 male and 29 female, from a large middle class, rural school district in the midwestern U.S. The students were followed from the beginning of 1st grade through tenth grade. The mean age of the participants at the beginning of the first grade was 6 years, 9 months; at the end of the study 10 years later, the mean age of the participants was 16 years, 4 months (age range 15 years, 9 months–16 years, 11 months). All of the students were Caucasian. A cohort model was used in which a sample of students in first grade was selected and followed over 10 years. The study began with 156 students when they entered first grade in this school district. By the ninth grade, 77 of the 156 students were still available for follow-up testing and 54 students chose to continue their participation. There were no significant differences in the word decoding, overall reading, spelling, and vocabulary skills from 1st through 5th grade and listening comprehension from 3rd through 5th grade between the 54 participants and the 23 students who did not continue their participation in the study. All of the participants were monolingual and their home language background was English. Parental permission was obtained for each participant.

Instruments

Elementary school measures

Reading The measure of elementary school reading was the Woodcock Reading Mastery Test-Revised (WRMTR), Forms G and H (Woodcock, 1987). This test has two Clusters, each of which has two subtests. The Basic Skills Cluster is comprised of two subtests, Word Identification and Word Attack. On the Word Identification subtest, a student reads aloud a list of increasingly difficult words. On the Word Attack subtest, a student reads aloud a list of increasingly difficult pseudowords. For a response to be considered correct, the student had to produce a natural reading (pronunciation) of the word or pseudoword in order to be correct. A test–retest reliability of .96 was reported for the Basic Skills Cluster by the authors of the test. The Reading Comprehension Cluster is comprised of two subtests, Word Comprehension and Passage Comprehension. On the Word Comprehension subtest, a student completes three tasks. On Antonyms, s/he reads a word aloud and then responds orally with a word opposite in meaning; on Synonyms, s/he reads a word aloud and then responds orally with a word similar in meaning; and on Analogies, s/he reads a pair of words, determines the relationship between the words, then reads the first word of a second pair and uses the same relationship to supply a word to complete the analogy. On the Passage Comprehension, the student reads a short passage and identifies a key word missing from the passage, i.e., a modified cloze procedure. A test–retest reliability of .93 was reported for the Reading Comprehension Cluster by the authors of the test. The two Clusters are combined to form a Total Test score. A split-half reliability coefficient of .98 was reported for both forms of the Total Test.

Spelling The measure of spelling was the Test of Written Spelling-2 (TWS) (Larsen & Hammill, 1986). On this dictated word test, the student wrote the words spoken by the examiner. The response was marked as correct or incorrect. A test–retest reliability of .95 was reported for this test by the authors.

Vocabulary To assess vocabulary the Peabody Picture Vocabulary Test-Revised (PPVT), Forms L and M (Dunn & Dunn, 1981), was used. This individually administered test measures receptive vocabulary for standard American English. On this test, the student was shown four pictures and asked to identify the picture for the word spoken by the examiner. The response was marked as correct or incorrect. A median test–retest reliability of .82 was reported by the authors for the two forms of the test.

Listening comprehension The Woodcock Reading Mastery Test-Revised Passage Comprehension subtest, Forms G and H (Woodcock, 1987), was used to appraise listening comprehension. This cloze test consists of reading a short passage (1–2 sentences) aloud to a student and asking him/her to identify aloud a key word missing from the passage. The student was not permitted to read (see) the passage, but the passage could be repeated. Again, the response was marked as correct or incorrect. This subtest is generally used as a measure of reading comprehension; however, the aforementioned alternative procedure was recommended by Aaron (1989) as a diagnostic indicator in identifying problem readers and was used for this study. A test–retest reliability of .92 when used as a measure of reading comprehension was reported by the authors for the two forms of this subtest.

Cognitive ability The Test of Cognitive Skills (CTB/McGraw Hill, 1983) was used to assess a student's cognitive ability. The test consists of four subtests: Sequences tests the ability to recognize a rule or principle implicit in a pattern or sequence of figures, letters, or numbers; Analogies tests the ability to discern relationships among picture pairs and then to infer parallel relationships between incomplete picture pairs; Memory tests the ability to recall previously presented material; and Verbal Reasoning tests the ability to solve verbal problems by reasoning deductively, analyzing category attributes, and discerning relationships and patterns. The Sequences and Analogies subtests are nonverbal measures while the Memory and Verbal Reasoning subtests are verbal measures. A test–retest reliability of .91 was reported by the authors for this test.

Tenth grade measures

Reading The ISTEP Reading test (CTB/McGraw-Hill, 2001) was used to assess the participants' level of reading skill in 10th grade. When this study was completed, the test was used as a state-required, outcomes accountability assessment. The test is a group-administered, standardized measure of reading. The composite score is comprised of two subtests, Vocabulary and Comprehension. On the Vocabulary subtest, the student read a definition and then chose the correct word from a list of five words. On the Comprehension subtest, the student answered multiple-choice questions after reading a passage. An internal consistency reliability of .91 was reported by the authors for this test.

Language The ISTEP Language test (CTB/McGraw-Hill, 2001) was used to assess the participants' level of language skill in 10th grade. This test was also part of the state-required, outcomes accountability assessment. The test is a group-administered, standardized measure of language. The composite score is comprised of two subtests, Language and Language Mechanics. The Language subtest uses a multiple choice format to assess elements of writing and grammar including parts of speech, grammatical structures, familiarity with rules of written English, and knowledge of sentence structure and style. The Language Mechanics subtest uses a multiple choice format to assess skill in identifying common writing errors. An internal consistency reliability of .89 was reported by the authors for this test.

Cognitive ability The Test of Cognitive Skills/2 (CTB/McGraw-Hill, 1993) was used to assess students' cognitive ability. The test consists of the same four subtests as the Test of Cognitive Skills that the participants had been administered in elementary school. A test–retest reliability of .83 was reported by the test's authors.

Print exposure measures The Author Recognition Test (ART) is a checklist on which students choose whether they are familiar with the name of a popular author by checking his/her name (Stanovich & West, 1989). There are 40 names of authors on the ART and 40 foils, i.e., names of persons who are not popular authors. This recognition checklist and others have been found to shown convergent validity with other measures of print exposure, e.g., daily activities diaries (e.g., see Allen, Cipielewski, & Stanovich, 1992), and to predict reading behavior in natural settings (e.g., see West et al., 1993). The measure has been used in several studies by Stanovich and his colleagues (e.g., see Cipielewski & Stanovich, 1992; Stanovich & Cunningham, 1993; West et al., 1993). The checklist used a signal detection method that allows for the control of response bias by taking into account the number of foils checked by the student. The list includes mostly "popular" authors who appear on best- seller lists. West and Stanovich included both fiction and nonfiction authors who were not regularly studied in a high school curriculum; thus, because the ART was intended as an indirect measure of free reading volume, it is intentionally biased toward out-of-school reading. The foils on the list were names taken from the Editorial Board of Volume 26 of the Reading Research Quarterly. The 80 full authors' names were listed in alphabetical order. For all participants, the instructions and scoring procedure were the same as that used by Cunningham and Stanovich, i.e., proportion of the target items checked minus the proportion of foils checked. In the instructions, students were told that guessing could be easily detected. As a result, few foils were checked by the participants. There was no time limit on this task (or on any of the remaining checklists), but all students completed each of the checklists in less than 5 min. For the ART, the reliability of the number of correct items checked was .90 (Cronbach's alpha).

The Magazine Recognition Test (MRT) is similar in design and logic to the ART, i.e., a checklist on which students choose the name of a magazine with which they are familiar, but was designed to tap a different type of out-of-school reading (e.g., see Stanovich & West 1989; Cunningham & Stanovich, 1997). In this case, the MRT was designed to balance the ART by sampling magazine reading rather than authors of books. On the MRT, there were 40 names of magazines and 40 foils. The names of the actual magazines were popular publications with wide circulation. The authors of the MRT used a wide range of genres, e.g., music, sports, fashion, outdoors, cars, technology. The 40 foil names on the MRT did not appear in the listing of The Standard Periodical Dictionary (Manning, 1988). The 80 names of the magazines were listed in alphabetical order. The instructions and scoring procedure for the MRT were the same as those used by Cunningham and Stanovich. For the MRT, the reliability of the number of correct items checked was .91 (Cronbach's alpha).

The index of print exposure was a composite variable that combined scores of the ART and MRT into a single score (ART and MRT had a correlation of .67). For each participant, scores on the ART and MRT were converted into z scores. These two z scores were averaged to form the print exposure score called ARTMRT. In their paper, Cunningham and Stanovich justified their use of these recognition checklists by reporting that the measures had been shown to be more valid and reliable than questionnaire measures.

General knowledge measures The Cultural Knowledge Checklist (CKC) is a recognition test that was designed to measure familiarity with individuals who have shaped modern society. Like the ART and MRT, this checklist is a proxy measure that samples a larger domain of knowledge (see Stanovich & Cunningham, 1993; Cunningham & Stanovich, 1997); that is, the checklist is designed to measure individual differences in cultural awareness, not to measure knowledge in an absolute sense. The checklist's authors chose the names of well-known individuals in several categories that were compiled from Hirsch (1987) and included musicians and composers, artists, scientists, and military leaders and explorers. The names used for this study were those used by Stanovich and Cunningham (1993). The names on the musicians and composers, artists, and scientists checklists were mixed with an equal number of foil names from the editorial board of the Modern Language Journal, Journal of Learning Disabilities, and Annals of Dyslexia. The foils for the military leaders and explorers checklist were other historical figures, e.g., scientists, politicians, who were not military leaders or explorers. The target names and foils were alphabetized in the checklists.

The multicultural checklist was designed as a companion measure to the CKC (Stanovich & Cunningham, 1993). The 30 items were taken from the Appendix of Multicultural Literacy items developed by Simonson and Walker (1988) as a response to the preponderance of male and European items in Hirsch's (1987) list. The 30 items were mixed with 15 foils from the editorial board of the Journal of Learning Disabilities.

For both checklists, the instructions and scoring procedure were similar to those on the ART and MRT, i.e., participants were told that guessing could be easily detected, so few foils were chosen by the participants. In all analyses, we used a composite general knowledge score called the Cultural Knowledge Test (CKT) that combined performance on the four knowledge measures from the CKC (musicians and composers, artists, scientists, military leaders and explorers) and the Multicultural Checklist. For each participant, scores on the checklists were converted into z scores. The z scores were averaged to form the general knowledge score called CKT.

Results

Tenth-grade relationships

Table 1 presents a correlation matrix showing the relationships among the elementary school measures and the 10th grade measures.

Hierarchical regressions similar to those conducted by Cunningham and Stanovich were conducted. In three fixed-order, hierarchical multiple regressions, the tenth grade IQ measure was entered first followed by the print exposure measure (ARTMRT). The same hierarchical model was conducted for the three criterion variables: ISTEP Reading, ISTEP Language, and the CKT (declarative knowledge). Print exposure accounted for 16 % unique variance in tenth grade reading comprehension on the 10th grade ISTEP Reading measure after IQ had been partialed ($p < .01$). Print exposure also accounted for unique variance in tenth grade language ability on the ISTEP Language measure (4.8 %, $p < .05$), and for substantial unique variance in declarative knowledge on the CKT (61.4 %, $p < .01$). In the case of general knowledge, the beta weight for print exposure was much larger than that for cognitive ability. In sum, print exposure was a significant predictor of 10th grade reading comprehension, language ability, and declarative knowledge after IQ had been partialed. These findings are largely similar to those reported by Cunningham and Stanovich in their longitudinal study. Table 2 reports the results of the hierarchical regression analyses.

First-grade skills and print exposure as predictors of tenth grade outcomes

In the next analyses, first grade reading ability on the WRMTR and the retrospective measure of print exposure, ARTMRT, were used to predict reading comprehension skill, language ability, and declarative knowledge in the 10th grade. The first set of analyses in Table 3 shows the results of the forced entry hierarchical regression analysis in which print exposure is entered subsequent to performance on the WRMTR in 1st grade. There was a moderate but significant correlation between 1st grade WRMTR and ISTEP Reading (.47), even after 10 years. The results showed that individual differences in print exposure predicted a significant amount of unique variance (21.3 %) in 10th grade reading comprehension skill. Likewise, there was a moderate correlation between 1st grade WRMTR and ISTEP Language (.51), and individual differences in print exposure predicted significant unique variance in 10th grade language ability (6.9 %) 10 years later. Print exposure also predicted substantial variance in general knowledge (51.9 %) on the CKT. The findings showed that early success in reading in 1st grade is related to individual differences in reading comprehension, language ability, and declarative knowledge 10 years later, and that the additional variance explained by print exposure was quite substantial in the case of declarative knowledge.

The following set of analyses in Table 3 entered performance on the 1st grade IQ test as the first step followed by 1st grade reading ability on the WRMTR with the ARTMRT score entered last. In these analyses, 1st grade IQ accounted for significant variance on all 10th grade criterion measures, while 1st grade reading ability explained significant unique variance only in 10th grade language ability (9.4 %, $p < .01$). However, even after the variance explained by 1st grade IQ and 1st grade reading ability had been partialed, print exposure accounted for significant unique variance in 10th grade reading ability (14.4 %, $p < .01$) and declarative knowledge (50.2 %, $p < .01$), although it did not explain significant variance in language ability ($p < .10$).

Table 1 Intercorrelations among print exposure, cultural knowledge, IQ, and 1st, 2nd, 3rd, 5th, and 10th grade variables

Testing measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. ARTMRT		.39**	.40**	.61**	.44**	.80**	.39**	.55**	.59**	.50**	.52**	.43**	.51**	.45**	.47**	.57**	.60**	.58**	.37**	.46**
2. Grade 1, IQ			.68**	.61**	.50**	.29*	.48**	.56**	.56**	.55**	.45**	.43**	.46**	.58**	.50**	.53**	.56**	.45**	.45**	.53**
3. Grade 10, IQ				.61**	.61**	.21	.54**	.59**	.59**	.55**	.38**	.36**	.48**	.62**	.54**	.56**	.59**	.51**	.35**	.53**
4. Grade 10, ISTEP reading					.72**	.54**	.47**	.62**	.60**	.60**	.75**	.59**	.68**	.62**	.47**	.51**	.64**	.57**	.46**	.66**
5 Grade 10, ISTEP language						.45**	.51**	.58**	.55**	.61**	.44**	.36**	.48**	.49**	.33*	.40**	.61**	.58**	.35**	.53**
6. Grade 10, cultural knowledge							.35**	.50**	.56**	.50**	.48**	.47**	.51**	.40**	.36**	.47**	.50**	.54**	.56**	.47**
7. Grade 1, WRMTR								.88**	.83**	.77**	.41**	.40**	.57**	.55**	.78**	.78**	.81**	.82**	.45**	.74**
8. Grade 2, WRMTR									.95**	.88**	.47**	.51**	.59**	.62**	.77**	.87**	.89**	.91**	.44**	.72**
9. Grade 3, WRMTR										.91**	.46**	.55**	.63**	.67**	.78**	.87**	.88**	.87**	.54**	.70**
10. Grade 5, WRMTR											.45**	.59**	.62**	.62**	.73**	.79**	.87**	.86**	.41**	.67**
11. Grade 1, PPVT												.57**	.77**	.52**	.36**	.40**	.44**	.38**	.49**	.59**
12. Grade 2, PPVT													.65**	.65**	.42**	.45**	.49**	.48**	.52**	.56**
13. Grade 3, PPVT														.70**	.49**	.57**	.57**	.53**	.48**	.61**
14. Grade 5, PPVT															.56**	.65**	.59**	.56**	.49**	.55**
15. Grade 1, TWS																.84**	.76**	.72**	.30*	.60**
16. Grade 2, TWS																	.90**	.87**	.34*	.62**
17. Grade 3, TWS																		.92**	.32*	.70**
18. Grade 5, TWS																			.36**	.61**
19. Grade 3, listening comp																				.57**
20. Grade 5, listening comp																				

* $p < .05$; ** $p < .01$

Table 2 ΔR^2 for each step in a hierarchical regression predicting a series of 10th grade criterion variables

Step/variable	ISTEP reading	ISTEP language	Cultural knowledge
1 Grade 10, IQ	.362**	.356**	.043
2 ARTMRT	.160**	.048*	.614**

** $p < .01$

Table 3 ΔR^2 for each step in a hierarchical regression predicting 10th grade criterion variables

Step/variable	ISTEP reading	ISTEP language	Cultural knowledge
1 Grade 1, WRMTR	.220**	.261**	.125**
2 ARTMRT	.213**	.069*	.519**
1 Grade 1, IQ	.368**	.254**	.085*
2 Grade 1, WRMTR	.041^t	.094**	.060^t
3 ARTMRT	.144**	.038^t	.502**

^{t} $p < .10$; * $p < .05$; ** $p < .01$

Predicting growth in reading ability from the retrospective measure of print exposure

Cunningham and Stanovich characterized the print exposure measure, ARTMRT, as a retrospective indicator of reading experiences occurring before the measure was administered in 10th grade. Although their earlier research had revealed strong relationships between exposure to print and reading and spelling skills, vocabulary growth, and fund of general knowledge even after individual differences in IQ had been partialed, at that time the retrospective value of the print exposure measure had not been investigated. In their longitudinal study, they used ARTMRT to predict growth in reading comprehension in the early school years, i.e., 1st, 3rd, and 5th grades, and also in 11th grade reading ability. Here, we performed several similar analyses using the participants' scores on 1st, 2nd, 3rd, and 5th grade reading measure, and on the 10th grade reading and language tests. Table 4 presents the results of these analyses.

In the first forced entry regression analysis, 1st grade performance on the WRMTR is entered first as a predictor of 2nd grade WRMTR performance and explains 76.9 % of the variance. Print exposure was entered second to determine whether ARTMRT measured in 10th grade would predict individual differences in reading ability from 1st to 2nd grades. The results showed that print exposure explained additional unique variance (5.3 %, $p < .01$) in 2nd grade reading ability after 1st grade reading skill had been partialed. Likewise, subsequent regressions indicated that print exposure explained additional unique variance from 1st to 3rd grade reading ability (8.3 %, $p < .01$) and from 1st to 5th grade reading ability (4.9 %, $p < .05$), but was not a significant predictor of changes in individual

Table 4 Composite index of print exposure (ARTMRT) as a predictor of reading comprehension and language growth at earlier points in time

Step/variable	R	ΔR^2	ΔF	Final β	Final F
Criterion variable grade 2, WRMTR					
1 Grade 1, WRMTR	.877	.769	172.91**	.779	146.89**
2 ARTMRT	.906	.053	15.03**	.249	15.03**
Criterion variable grade 3 WRMTR					
1 Grade 1, WRMTR	.839	.705	124.01**	.717	104.65**
2 ARTMRT	.888	.083	20.07**	.314	20.07**
Criterion variable grade 5, WRMTR					
1 Grade 1, WRMTR	.771	.594	76.13**	.677	55.51**
2 ARTMRT	.802	.049	6.93*	.239	6.93*
Criterion variable grade 3, WRMTR					
1 Grade 2, WRMTR	.945	.893	461.97**	.893	298.94**
2 ARTMRT	.952	.007	3.70[t]	.007	3.70[t]
Criterion variable grade 5, WRMTR					
1 Grade 2, WRMTR	.879	.772	175.89**	.865	115.99**
2 ARTMRT	.879	.001	.10	.025	.10
Criterion variable grade 5, WRMTR					
1 Grade 3, WRMTR	.906	.821	238.35**	.937	163.58**
2 ARTMRT	.908	.002	.52	−.053	.52
Criterion variable grade 10, ISTEP reading					
1 Grade 5, WRMTR	.603	.364	29.69**	.397	11.70**
2 ARTMRT	.698	.124	12.39**	.408	12.39**
Criterion variable, grade 10, ISTEP language					
1 Grade 5, WRMTR	.607	.369	30.35**	.515	16.65**
2 ARTMRT	.627	.025	2.07	.182	.182

[t] $p < .10$; * $p < .05$; ** $p < .01$

differences in reading from 2nd to 3rd, 2nd to 5th, and 3rd to 5th grade reading ability. In the latter three cases, the lack of additional unique variance explained by ARTMRT may have been due to the strong correlations between 2nd and 3rd grade (.95), 2nd and 5th grade (.88), and 3rd and 5th grade (.91) reading ability on the WRMTR.

In the final two forced entry regression analyses displayed in Table 4, 5th grade performance on the WRMTR was entered first as a predictor of 10th grade performance on the ISTEP Reading and ISTEP Language measures and ARTMRT was entered second. The results showed that print exposure was a significant predictor of individual differences in reading growth from 5th to 10th grade (12.4 % additional variance, $p < .01$); however, print exposure was not a significant predictor of growth in language ability.

Taken together, the findings suggest that individual differences in print exposure measured in high school are predictive of growth in reading ability several years earlier in elementary school and into high school.

Predicting growth in word decoding, spelling, vocabulary, and listening comprehension from the retrospective measure of print exposure

In several studies, Stanovich and others found that print exposure also makes unique contributions to a host of abilities including word decoding, spelling, vocabulary, and language development generally (e.g., Stanovich and Cunningham, 1993; Echols, West, Stanovich, & Zelig, 1996; Stanovich & Cunningham, 1992). In our study, we had administered measures of word decoding (the WRMTR Basic Skills Cluster, comprised of the Word Identification and Word Attack subtests), spelling (TWS), and vocabulary (PPVT) in 1st, 2nd, 3rd, and 5th grades, and also a measure of listening comprehension in 3rd and 5th grades. In the next four analyses, we used the measure of print exposure, ARTMRT, to predict growth in word decoding, spelling, vocabulary, and listening comprehension in the participants' early school years, i.e., 1st–5th grade. In addition, we determined whether print exposure would predict growth in 10th grade reading comprehension and 10th grade language ability when 5th grade performance on the aforementioned measures was partialed.

Table 5 presents the results of the analyses for word decoding. In the first forced entry regression analysis, 1st grade performance on the WRMTR Basic Skills Cluster (word recognition and pseudoword decoding) is entered first as a predictor of 2nd grade performance and explains 65.9 % of the variance. Print exposure was entered second to determine whether print exposure measured in 10th grade would predict individual differences in word decoding ability from 1st to 2nd grade. The results showed that ARTMRT accounted for additional unique variance (8.6 %, $p < .01$) in 2nd grade word decoding after 1st grade word decoding had been partialed. Likewise, subsequent regressions showed that ARTMRT in 10th grade explained additional unique variance from 1st to 3rd grade word decoding ability (11.3 %, $p < .01$), 1st to 5th grade word decoding ability (6.0 %, $p < .01$), but not from 2nd to 3rd, 2nd to 5th, and 3rd to 5th word decoding ability, although 2nd to 3rd grade word decoding approached significance ($p < .10$). In the latter three analyses, the lack of additional unique variance explained by ARTMRT may have been due to the strong correlations between 2nd and 3rd grade (.90), 2nd and 5th grade (.87), and 3rd and 5th grade (.93) word decoding ability. In the final two forced entry regression analyses displayed in Table 5, 5th grade performance on the word decoding measure was entered first as a predictor of 10th grade performance on the ISTEP Reading and ISTEP Language measures and ARTMRT was entered second. The results also showed that print exposure explained significant unique variance in 10th grade reading skill on the ISTEP (18.5 %, $p < .01$) that was not explained by 5th grade word decoding skill. Although ARTMRT added 4.3 % variance, print exposure was not a significant predictor of individual differences in 10th grade language growth ($p < .10$).

Table 6 presents the results of the analyses for spelling. In the first forced entry regression analysis, 1st grade performance on the Test of Written Spelling (TWS) is entered first as a predictor of 2nd grade TWS performance and explains 70.7 % of the variance. Print exposure was entered second to determine whether the ARTMRT in 10th grade would predict individual differences in spelling ability from 1st to 2nd grade. The results showed that ARTMRT explained additional unique variance

Table 5 Composite index of print exposure (ART/MRT) as a predictor of word decoding growth and reading comprehension and language growth at earlier points in time

Step/variable	R	ΔR^2	ΔF	Final β	Final F
Criterion variable grade 2, word decoding					
1 Grade 1, word decoding	.812	.659	100.6**	.704	87.2**
2 ARTMRT	.864	.086	17.3**	.313	17.3**
Criterion variable grade 3, word decoding					
1 Grade 1, word decoding	.800	.640	92.5**	.676	83.2**
2 ARTMRT	.868	.113	23.4**	.359	23.4**
Criterion variable grade 5, word decoding					
1 Grade 1, word decoding	.760	.578	71.3**	.670	55.7**
2 ARTMRT	.799	.060	8.45**	.261	8.45**
Criterion variable grade 3, word decoding					
1 Grade 2, word decoding	.911	.831	255.1**	.843	157.3**
2 ARTMRT	.917	.011	3.39^t	.124	3.39^t
Criterion variable grade 5, word decoding					
1 Grade 2, word decoding	.875	.766	170.0**	.870	113.8**
2 ARTMRT	.875	.001	.008	.009	.008
Criterion variable grade 5, word decoding					
1 Grade 3, word decoding	.918	.843	278.1**	.965	200.5**
2 ARTMRT	.920	.004	1.33	−.079	1.33
Criterion variable grade 10, ISTEP reading					
1 Grade 5, word decoding	.476	.226	15.20**	.232	3.53^t
2 ARTMRT	.641	.185	16.00**	.494	16.00**
Criterion variable grade 10, ISTEP language					
1 Grade 5, word decoding	.531	.282	20.43**	.414	9.80**
2 ARTMRT	.570	.043	3.22^t	.238	3.22^t

^{t} $p < .10$; * $p < .05$; ** $p < .01$

(3.9 %, $p < .01$) in 2nd grade spelling after 1st grade spelling had been partialed. Likewise, subsequent regressions showed that ARTMRT in 10th grade explained additional unique variance from 1st to 3rd grade spelling (7.6 %, $p < .01$), 1st to 5th grade spelling (7.4 %, $p < .01$), but not 2nd to 3rd, 2nd to 5th, and 3rd to 5th spelling, although 2nd to 3rd grade spelling approached significance ($p < .10$). In the latter three analyses, the lack of additional unique variance explained by ARTMRT may have been due to the strong correlations between 2nd and 3rd grade (.90), 2nd and 5th grade (.87), and 3rd and 5th grade (.93) spelling ability. The results also showed that print exposure explained significant unique variance in 10th grade reading skill on the ISTEP (11.7 %, $p < .01$) that was not explained by 5th grade spelling skill on the TWS.

Table 7 presents the results of the analyses for vocabulary. In the first forced entry regression analysis, 1st grade performance on the Peabody Picture Vocabulary Test (PPVT) is entered first as a predictor of 2nd grade PPVT performance and

Table 6 Composite index of print exposure (ARTMRT) as a predictor of spelling growth and reading comprehension and language growth at earlier points in time

Step/variable	R	ΔR^2	ΔF	Final β	Final F
Criterion variable grade 2, TWS					
1 Grade 1, TWS	.841	.707	125.25**	.737	85.0**
2 ARTMRT	.863	.039	7.74**	.222	7.74**
Criterion variable grade 3, TWS					
1 Grade 1, TWS	.759	.576	70.53**	.614	43.2**
2 ARTMRT	.807	.076	11.06**	.311	11.06**
Criterion variable grade 5, TWS					
1 Grade 1, TWS	.720	.518	55.90**	.577	32.5**
2 ARTMRT	.769	.074	9.22**	.307	9.22**
Criterion variable grade 3, TWS					
1 Grade 2, TWS	.900	.811	322.7**	.828	133.4**
2 ARTMRT	.907	.011	3.23^{t}	.129	3.23^{t}
Criterion variable grade 5, TWS					
1 Grade 2, TWS	.867	.752	157.5**	.796	92.5**
2 ARTMRT	.873	.011	2.30	.125	2.30
Criterion variable grade 5, TWS					
1 Grade 3, TWS	.921	.848	291.0**	.897	175.3**
2 ARTMRT	.922	.001	.36	.040	.36
Criterion variable grade 10, ISTEP reading					
1 Grade 5, TWS	.571	.326	25.18**	.330	6.66*
2 ARTMRT	.666	.117	10.71**	.418	10.71**
Criterion variable grade 10, ISTEP language					
1 Grade 5, TWS	.581	.338	26.50**	.489	12.60**
2 ARTMRT	.596	.017	1.35	.160	1.35

^{t} $p < .10$; * $p < .05$; ** $p < .01$

explains 33 % of the variance. Print exposure was entered second to determine whether the ARTMRT in 10th grade would predict individual differences in vocabulary growth from 1st to 2nd grade. The results showed that while ARTMRT explained 2.3 % additional variance, it was not a significant predictor. Likewise, ARTMRT was not a significant predictor of individual differences in vocabulary growth from 1st to 3rd, 1st to 5th, 2nd to 5th, and 3rd to 5th grades, although the analyses from 1st to 5th and 2nd to 5th grades approached significance ($p < .10$). However, the results showed that ARTMRT accounted for additional unique variance in vocabulary growth from 2nd to 3rd grades (6.4 %, $p < .05$). The results also showed that print exposure explained significant unique variance in both 10th grade reading skill (13.5 %, $p < .01$) and language ability (6.2 %, $p < .05$) on the ISTEP that was not explained by 5th grade vocabulary skill on the PPVT.

Table 8 presents the results of the analyses for listening comprehension, which had been measured in the 3rd and 5th grades. In the forced entry regression analysis,

Table 7 Composite index of print exposure (ARTMRT) as a predictor of vocabulary growth and reading comprehension and language growth at earlier points in time

Step/variable	R	ΔR^2	ΔF	Final β	Final F
Criterion variable grade 2, PPVT					
1 Grade 1, PPVT	.574	.330	25.6**	.482	13.4**
2 ARTMRT	.594	.023	1.83	.178	1.83
Criterion variable grade 3, PPVT					
1 Grade 1, PPVT	.767	.588	74.2**	.690	44.8**
2 ARTMRT	.777	.016	2.08	.149	2.08
Criterion variable grade 3, PPVT					
1 Grade 1, PPVT	.516	.267	18.9**	.386	8.07**
2 ARTMRT	.559	.046	3.40^{t}	.250	3.40^{t}
Criterion variable grade 3, PPVT					
1 Grade 2, PPVT	.650	.422	38.0**	.530	22.8**
2 ARTMRT	.697	.064	6.34*	.280	6.34*
Criterion variable grade 5, PPVT					
1 Grade 2, PPVT	.653	.427	38.7**	.564	24.6**
2 ARTMRT	.680	.036	3.40^{t}	.210	3.40^{t}
Criterion variable grade 5, PPVT					
1 Grade 3, PPVT	.696	.484	48.75**	.629	29.8**
2 ARTMRT	.705	.013	1.32	.132	1.32
Criterion variable grade 10, ISTEP reading					
1 Grade 5, PPVT	.623	.388	32.93**	.437	16.2**
2 ARTMRT	.723	.135	14.44**	.411	14.4**
Criterion variable grade 10, ISTEP language					
1 Grade 5, PPVT	.486	.237	16.12**	.361	7.56**
2 ARTMRT	.547	.062	4.51*	.279	4.51*

^{t} $p < .10$; * $p < .05$; ** $p < .01$

3rd grade performance on the listening comprehension measure is entered first as a predictor of 5th grade listening comprehension and explains 32.1 % of the variance. Print exposure was entered second and accounted for additional unique variance (7.4 %, $p < .05$) in 5th grade listening comprehension. The results also showed that print exposure explained substantial unique variance in both 10th grade reading skill (28.3 %, $p < .01$) and language ability (11.5 %, $p < .01$) on the ISTEP that was not explained by 5th grade listening comprehension.

Does early success in reading in early elementary school predict inclination toward reading in high school?

The previous analyses used exposure to print as a predictor variable of the criterion abilities, e.g., reading comprehension, language ability, word decoding, spelling, vocabulary, and listening comprehension. Cunningham and Stanovich also found

Table 8 Composite index of print exposure (ARTMRT) as a predictor of listening comprehension growth and reading comprehension and language growth at earlier points in time

Step/variable	R	ΔR^2	ΔF	Final β	Final F
Criterion variable grade 5, listening comprehension					
1 Grade 3, listen comp	.566	.321	24.53**	.457	15.2**
2 ARTMRT	.628	.074	6.22*	.293	6.22*
Criterion variable grade 10, ISTEP reading					
1 Grade 5, listen comp	.340	.116	6.81*	.176	2.40
2 ARTMRT	.631	.283	23.98**	.557	23.98**
Criterion variable grade 10, ISTEP language					
1 Grade 5, listen comp	.400	.160	9.91**	.295	5.62*
2 ARTMRT	.524	.115	8.07**	.354	8.07**

* $p < .05$; ** $p < .01$

that print exposure and the aforementioned variables are strongly related, and may be reciprocal in nature. In their paper, they asked the following questions: a) Which cognitive variables predict the reading habits of adolescents, and b) Does the speed at which students learn to read in their early years predict engagement with print in adolescence? Here, we performed analyses similar to those of Cunningham and Stanovich to determine which variables predict both reading comprehension and language ability in 10th grade and whether speed of reading acquisition in elementary school predicts engagement with print in 10th grade.

In the first analysis in Table 9, 10th grade reading ability on the ISTEP Reading measure was entered first to control for the direct association between print

Table 9 Hierarchical regression analysis predicting exposure to print (ARTMRT) in 10th grade (with 10th grade reading)

Step/variable	R	ΔR^2	ΔF	Partial r
Criterion variable ARTMRT				
1 Grade 10, ISTEP reading	.609	.370	30.58**	
2 Grade 1, WRMTR	.620	.014	1.18	.150
2 Grade 1, IQ	.609	.001	.04	.028
2 Grade 1, PPVT	.616	.009	.71	.117
2 Grade 2, WRMTR	.649	.051	4.50*	.285
2 Grade 2, PPVT	.615	.007	.60	.108
2 Grade 3, WRMTR	.672	.082	7.61**	.360
2 Grade 3, PPVT	.622	.016	1.33	.159
2 Grade 5, WRMTR	.632	.030	2.52	.217
2 Grade 5, PPVT	.615	.008	.69	.116
2 Grade 10, IQ	.609	.002	.15	.054

* $p < .05$; ** $p < .01$

Table 10 Hierarchical regression analysis predicting exposure to print (ARTMRT) in 10th grade (with 10th grade language)

Step/variable	R	ΔR^2	ΔF	Partial r
Criterion variable ARTMRT				
1 Grade 10, ISTEP language	.442	.19	12.60**	
2 Grade 1, WRMTR	.482	.037	2.45	.214
2 Grade 1, IQ	.481	.036	2.40	.212
2 Grade 1, PPVT	.571	.131	9.89**	.403
2 Grade 2, WRMTR	.573	.133	10.09**	.407
2 Grade 2, PPVT	.527	.083	5.86*	.321
2 Grade 3, WRMTR	.610	.178	14.44**	.470
2 Grade 3, PPVT	.556	.114	8.39**	.376
2 Grade 5, WRMTR	.532	.088	6.28*	.331
2 Grade 5, PPVT	.518	.073	5.08*	.301
2 Grade 10, IQ	.472	.029	1.89	.191

* $p < .05$; ** $p < .01$

exposure and current reading ability. Then, listed next in the table are the alternative second steps in the regression analysis. Because Cunningham and Stanovich had used the PPVT as a measure of general ability and also because the test is a direct measure of vocabulary, a skill important for reading comprehension, we included this measure in the analysis along with the 1st and 10th grade IQ tests. The results showed that both 2nd and 3rd grade reading ability on the WRMTR predicted significant unique variance (5.1 and 8.2 %, respectively) in print exposure even after 10th grade reading ability had been partialed. None of the other variables, including the IQ measures and the PPVT, accounted for unique variance in print exposure after accounting for 10th grade reading ability. Likewise, neither 1st nor 5th grade reading skill accounted for unique variance in print exposure. A likely explanation for the latter finding may be that 5th grade reading ability had reached a point where additional advances in reading skill are not as substantial when compared to earlier years; thus, since 10th grade reading ability on the ISTEP explained 37 % of the variance in print exposure, the additional 3.0 % variance explained by 5th grade WRMTR is not sufficient to show significance. The findings suggest that successful acquisition of reading in the early years—in this case, by 2nd grade—is important for predicting engagement with literacy activities in the secondary school years, and perhaps beyond.

In the second analysis displayed in Table 10, 10th grade language ability on the ISTEP Language measure was entered first to control for the direct association between print exposure and current language ability. Then, the table lists the alternative second steps in the regression analysis. Here again, we included the PPVT in the analysis for the reasons mentioned earlier. The results showed that 2nd, 3rd, and 5th grade reading ability on the WRMTR predict significant unique variance (13.3, 17.8, and 8.8 %, respectively) after controlling for 10th grade language ability. Individual differences on the PPVT also accounted for significant unique variance in print exposure at the 1st (13.1 %), 2nd (8.3 %), 3rd (11.4 %), and 5th (7.3 %) grade levels. However, neither the 1st nor 10th grade IQ measures accounted for unique variance after 10th grade language ability had been partialed. The findings suggest that successful acquisition of reading and facility with language in the early years is important for predicting engagement in literacy activities in the secondary school years. In addition, the findings suggest that individual differences in vocabulary, even in 1st grade, are important for predicting participation in literacy activities later in school, and most likely, beyond secondary schooling.

Discussion

The findings of this longitudinal study revealed productive relationships between early reading skills in primary school (1st grade), 10th grade reading and language skills, and declarative knowledge. Like Cunningham's and Stanovich's study that the present investigation was designed to replicate, speed of initial reading acquisition in 1st grade, i.e., performance on the WRMTR, was moderately related to 10th grade reading comprehension and language ability, and strongly related to declarative knowledge in 10th grade (Table 3). Even when cognitive ability was partialed, early reading skill predicted 10th grade language ability, i.e., parts of speech, grammatical structures, rules of written English, sentence structure and style, and approached significance in predicting reading comprehension skill and declarative knowledge 10 years later. In several of the analyses, speed of initial acquisition by 1st grade in overall reading (Table 4), word decoding (Table 5), spelling (Table 6), and vocabulary (Table 7), was related to ability in these skills in later grades. For example, early success in reading (measured in 1st grade) on the WRMTR predicted growth in reading ability throughout elementary school (2nd–5th grades), and reading skill in 5th grade predicted growth in reading and language on the ISTEP Reading and Language measures in 10th grade. Likewise, early success in word decoding, a critical skill for reading comprehension, predicted growth in decoding skill throughout elementary school, and word decoding in 5th grade predicted growth in both reading and language ability in tenth grade. In addition, early success in spelling and vocabulary in 1st grade and listening comprehension in 3rd grade predicted growth in these skills throughout elementary school. These findings highlight the critical importance of a fast start in word decoding, reading comprehension, and spelling for success in these skills later in school. Likewise, the findings demonstrate the effects of early language ability, in this case vocabulary and listening comprehension, for growth in these skills over time.

Perhaps the most revealing findings from this longitudinal study are those related to print exposure. When print exposure was used as a criterion variable, early success in reading by 2nd grade (on the WRMTR) predicted variance in exposure to print even after the variance explained by 10th grade reading comprehension skill on the ISTEP was partialed (Table 9). Likewise, early success in reading by 2nd grade predicted variance in print exposure even after the variance explained by 10th grade language ability on the ISTEP was partialed (Table 10). These findings are similar to those of Cunningham and Stanovich, although there are minor but potentially important differences in our results. In their longitudinal study, Cunningham and Stanovich found that 1st grade reading ability predicted variance in print exposure in 11th grade, but that 3rd and 5th grade reading ability were more robust predictors of print exposure than 1st grade reading skill. In our study, only 2nd and 3rd grade reading ability predicted variance in print exposure when 10th grade reading ability was partialed, although 2nd, 3rd, and 5th grade reading ability also predicted variance in print exposure when 10th grade language ability was partialed. Nonetheless, like those of Cunningham and Stanovich, our findings indicate that early success in reading and early development of language skills by 2nd grade may be indicative of a predilection toward the habit of reading and more engagement in reading-related activities. Likewise, the findings suggest that children who fall behind in reading in 1st grade but catch up with their peers by 2nd or 3rd grade may have a positive prognosis for engaging in reading that will further develop both their reading and language skills.

In their study, Cunningham and Stanovich conducted analyses in which the print exposure measures administered in 11th grade were used as cumulative indicators of individual differences in reading ability several years prior to 11th grade, i.e., in 1st, 3rd, and 5th grades. In our study, we conducted similar analyses by using the ARTMRT as a cumulative indicator of individual differences in reading ability, word decoding, spelling, and vocabulary from 1st, 2nd, 3rd, and 5th grades; listening comprehension from 3rd to 5th grade; and through high school by 10th grade. The findings in Tables 4, 5, 6, 7, 8 show that print exposure predicted individual differences in reading ability and word decoding throughout the elementary grades and also into 10th grade on the ISTEP Reading measure. In addition, print exposure predicted individual differences in spelling from 1st to 5th grades and also accounted for unique variance in 10th grade reading on the ISTEP that was not explained by 5th grade spelling. Print exposure also predicted individual differences in 5th grade vocabulary when 1st grade vocabulary was partialed, and in listening comprehension from 3rd to 5th grades. In addition, print exposure accounted for unique variance in 10th grade reading and language ability on the ISTEP not explained by 5th grade vocabulary or listening comprehension skills. The findings demonstrate not only the cumulative effects of a fast start in reading, spelling, and language skills but also indicate the powerful effects of print exposure on reading, spelling, and language skills throughout 1st–5th grades and into high school.

In addition to the aforementioned findings, exposure to print measured by the ARTMRT predicted additional unique variance in declarative knowledge on the Cultural Knowlwdge composite. For example, print exposure accounted for substantial variance (61.4 %) in declarative knowledge when 10th grade IQ was partialed (Table 2). Interestingly, the findings in Table 2 show that individual differences in IQ were less important for predicting individual differences in declarative knowledge than for reading ability and language skill in 10th grade. This finding suggests that reading volume is more important than cognitive ability for developing a store of declarative knowledge. Likewise, exposure to print explained substantial variance (50.2 %) in declarative knowledge after both 1st grade reading ability and 1st grade cognitive ability had been partialed (Table 3). In addition, print exposure accounted for additional unique variance in 10th grade reading skill on the ISTEP when 5th grade reading ability (Table 4) and 5th grade word decoding skill (Table 5) were partialed. The aforementioned findings demonstrating the influence of print exposure on declarative knowledge and reading ability replicated those of Cunningham and Stanovich, and thus may be expected. The results suggest that there may be an ongoing relationship between reading volume and declarative knowledge; that is, students who read well are likely to read more and increase their store of declarative knowledge. The findings also suggest that print exposure may be important for developing a fund of general knowledge regardless of a student's cognitive ability (Cunningham & Stanovich 1998; Stanovich & Cunningham, 1993; Stanovich, 1993).

Our study had limitations similar to those described by Cunningham and Stanovich in their investigation. For example, although our study had twice the number of participants as the Cunningham and Stanovich study, our sample size is small. Also, the print exposure checklists, ART and MRT, are indirect measures of reading experience over time. In addition, there was a strong correlation (.80) between the composite measure of print exposure, ARTMRT, and the composite measure of declarative knowledge, the Cultural Knowledge measure. In their study, Cunningham and Stanovich expressed concern that these checklists could be measuring a general ability to retain knowledge rather than print exposure and declarative knowledge. However, they also reported that print exposure had predicted unique variance in reading comprehension and reading-related skills in other studies in which measures other than checklists, e.g., questionnaires, diaries (e.g., Stanovich & Cunningham, 1992; Stanovich & West, 1989), and different print exposure checklists (e.g., Stanovich & Cunningham, 1993; West & Stanovich, 1991) were used. Our study is a correlational investigation, although Cunningham, Stanovich, and Maul (2011) have argued that the multiple regression techniques used in an investigation of this type can be used to strengthen the power of correlational results and lead to inferences that are stronger than those drawn from simple correlations.

Our replication of Cunningham's and Stanovich's longitudinal study adds to the ample and growing body of evidence that points to the powerful, long-term benefits in providing children with a strong start in reading. Our findings support further the reciprocal nature of strong reading skills (decoding, comprehension) and engagement in reading (print exposure).

As early as first grade, a pattern is established whereby children with strong early reading skills engage in reading more than their less skilled peers. Through reading, they strengthen not only their reading skills but also reading-related and cognitive skills such as spelling, vocabulary, listening comprehension, and declarative knowledge. The roots for this productive habit can be seen in early exposure to print through caregiver shared reading experiences and effective early reading instruction in which strong decoding skills are established. Some researchers have conceptualized this relationship between strong reading skills, engagement in reading, and development of reading-related and cognitive abilities as a "virtuous circle" (Snowling & Hulme, 2011). Other researchers have described the process by which children who fail to establish early reading skills find reading to be difficult and unrewarding, avoid reading and reading-related activities, and fail to develop reading-related and cognitive abilities as a "vicious circle" that is disastrous for their cognitive development and school achievement (Pulido & Hambrick, 2008). An early start in learning to read is crucial for establishing a successful path that encourages a "lifetime habit of reading" (Cunningham & Stanovich, 1997, p. 94) and for avoiding the decline in motivation for reading that can have devastating effects on reading growth and cognitive development over time.

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