

The Correlation between Eye Movement Data and Three Commonly Used Academic Reading Assessments

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Background

Most students develop basic word decoding skills in the early grades, but what plainly distinguishes more competent readers from their less proficient peers is the ability to do so efficiently and with good comprehension. Research has documented an association between reading efficiency and comprehension (e.g., Jenkins, et al., 2003; Rasinski, et al., 2005). This is often ascribed to individual differences in the distribution of cognitive resources between lexical-processing and comprehension. In this view, the ability to decode words and engage in the process of reading with automaticity (i.e., with little conscious effort or attention) serves to free up finite cognitive resources that can instead be devoted to information processing and the construction of meaning (e.g., LaBerge & Samuels, 1974). It follows that reading efficiency, leading to improved comprehension, is an important factor in academic achievement. This research examined the relationship between eye movement measures of reading efficiency and academic achievement in US elementary school students.

Method

The results described here were based on data collected from 292 students in grades 4 (n = 137) and 5 (n = 155), approximately 10 to 12 years old, who participated in a reading efficiency evaluation and completed three academic reading assessments during the spring of the 2015-2016 school year.

Eye Movement Recording

Eye movement recordings were obtained using a low-cost, portable eye movement recording system that uses goggles fitted with infrared emitters and sensors to measure corneal reflections at a sampling rate 60 Hz (Visagraph, Taylor, 2009). Students wore the goggles while reading standardized grade 4 passages from a normed test booklet (Figure 1). Each passage comprised 12 lines of text containing about 120 words. Data from the first and last line were discarded to minimize anomalies while starting and ending a passage. Analyses were based on data from the middle 10 lines, which contained 100 words. Each test passage was followed by a brief comprehension check involving 10 true/false questions.



Figure 1. Student reading text from a normed test booklet while eye movements were recorded using the Visagraph.

Academic Assessments

Academic achievement was measured using three assessments:

1. The Group Reading Assessment Diagnostic Evaluation (GRADE; Williams, 2001). This is a 60-90 minute norm-referenced group administered pencil and paper test. The GRADE is designed to assess vocabulary knowledge, sentence comprehension, and passage comprehension (there is also a listening comprehension component not used in this study).
2. The Reading Plus InSight assessment (Reading Plus, 2015). This is a 30-minute web-based adaptive assessment that measures three dimensions essential to successful independent silent reading: capacity (vocabulary & comprehension), efficiency (fluency & stamina), and reading motivation (self-efficacy, interest). InSight also yields an overall grade level proficiency score.
3. SBAC (Smarter Balanced Assessment Consortium, 2016). This is a computer-administered assessment aligned with the US Common Core State Standards (2010) and is intended to measure the development of skills students need to succeed and be ready for college and career. This 3.5 to 4 hour assessment includes reading, listening and speaking, writing, and research/inquiry components and yields an achievement level scale score.

Research questions:

1. How comparable are results obtained using the three academic assessments?
2. How strong is the relationship between measures of academic achievement and eye movement measures of reading efficiency?

Results

Academic Assessments

There were moderately strong correlations ($r > .60$) between most measures yielded by the three assessments of academic achievement (Table 1). Only correlations between InSight reading rates and other measures fell just short of this mark. In all cases the correlations were significant ($p < .001$). As would be expected, the strongest correlations were between summary measures (GRADE Total Test Standard Scores, InSight proficiency) and their sub-components.

		SBAC		GRADE			InSight		
		ELA	Math	TTSS	Comp	Vocab	Prof	Comp	Vocab
SBAC	ELA								
	Math	.79**							
GRADE	TTSS	.79**	.68**						
	Vocab	.73**	.65**	.94**					
	Comp	.78**	.64**	.96**	.81**				
InSight	Prof	.81**	.72**	.84**	.79**	.80**			
	Comp	.77**	.69**	.80**	.75**	.77**	.97**		
	Vocab	.80**	.72**	.82**	.79**	.77**	.89**	.85**	
	Reading Rate	.62**	.51**	.63**	.58**	.60**	.70**	.55**	.58**

Table 1. Relationships between measures included in three assessments of academic achievement. Abbreviations: ELA, English Language Arts; Math; TTSS, Total Test Standard Score; Comp, comprehension; Vocab, vocabulary; Prof, proficiency.

	Efficiency Measure Visagraph	Academic Reading Measures								
		GRADE			SBAC		InSight			
		Vocab Standard Score	Comp Standard Score	Total Test Standard Score	ELA Scale Score	Math Scale Score	Proficiency Index	Comp. Level	Vocab. Level	Reading Rate
Grade 4	Fixations	-.37**	-.34**	-.38**	-.33**	-.25**	-.39**	-.32**	-.38**	-.40**
	Regressions	-.28**	-.27**	-.30**	-.23**	-.19*	-.30**	-.26**	-.30**	-.25**
	Fixation Duration	-.31**	-.37**	-.36**	-.37**	-.30**	-.40**	-.34**	-.35**	-.39**
	Reading Rate	.43**	.44**	.47**	.47**	.33**	.55**	.44**	.49**	.55**
Grade 5	Fixations	-.52**	-.57**	-.58**	-.55**	-.51**	-.58**	-.50**	-.58**	-.54**
	Regressions	-.38**	-.44**	-.43**	-.42**	-.42**	-.43**	-.37**	-.44**	-.42**
	Fixation Duration	-.32**	-.34**	-.34**	-.28**	-.23**	-.36**	-.33**	-.33**	-.38**
	Reading Rate	.56**	.58**	.60**	.52**	.46**	.63**	.54**	.59**	.66**

Table 2. Intercorrelations between eye movement measures of reading efficiency and measures of academic achievement. Abbreviations as in Table 1. * $p < .05$ ** $p < .001$

Reading Efficiency Measures

The intercorrelation matrix indicated significant ($p < .001$) correlations between eye movement measures of reading efficiency and measures of academic achievement, though the correlations ranged from weak ($r < .50$) to moderately strong ($r > .60$). Assessment correlations with fixation duration were weakest, and especially so in grade 5. Assessment correlations with all other measures of reading efficiency were stronger in grade 5 (Table 2).

Conclusions

These results show that reading efficiency is significantly related to measures of academic achievement, and are consistent with the view that more efficient reading may contribute to improved academic outcomes. A challenge in evaluating these relationships arises from measurement differences between different academic assessments. Nevertheless, the pattern is clear.

References

- Common Core State Standards Initiative (2010). National Governors Association Center for Best Practices and the Council of Chief State School Officers. Washington, DC: Authors. www.corestandards.org.
- Jenkins, J. R., Fuchs, L. S., van den Broek, P., Espin, C., & Deno, S. L. (2003). Sources of individual differences in reading comprehension and reading fluency. *Journal of Educational Psychology, 95*(4), 719–729.
- LaBerge, D., & Samuels, S. J. (1974). Toward a theory of automatic information processing in reading. *Cognitive Psychology, 6*(2), 293-323.
- Rasinski, T.V., Padak, N.D., McKeon, C.A., Wilfong, L.G., Friedauer, J.A., & Heim, P. (2005). Is reading fluency a key for successful high school reading? *Journal of Adolescent & Adult Literacy, 49*(1), 22-27.
- Reading Plus (2015). *InSight: Measuring three domains*. Retrieved from: <https://www-cdn.readingplus.com/wp-content/uploads/2015/03/InSight-Measuring-Three-Domains.pdf>
- Smarter Balanced Assessment Consortium (2016). 2014-2015 *Technical Report* (updated October 5, 2016). Retrieved from: <https://portal.smarterbalanced.org/library/en/2014-15-technical-report.pdf>
- Taylor, S. E. (2009). *Visagraph III: Implementation guide*. Huntington Station, NY: Taylor Associates Communications.
- Vitu, F., & McConkie, G. W. (2000). Regressive saccades and word perception in adult reading. In A. Kennedy, R. Radach, D. Heller & J. Pynte (Eds.), *Reading as a perceptual process* (pp. 301-26). Amsterdam, The Netherlands: Elsevier.
- Williams, K. T. (2001). *The Group Reading Assessment and Diagnostic Evaluation (GRADE). Technical Manual*. San Antonio, TX: Pearson Education, Inc.