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Kathryn S. McCarthy[1], Jonathan Steinberg[2], Kelsey Dreier[2], Tenaha O'Reilly[2], John Sabatini[3], and Danielle S. McNamara[4]

[1] Department of Learning Sciences, Georgia State University

[2]Educational Testing Service

[3]Department of Psychology, Institute for Intelligent Systems, University of Memphis

[4]Department of Psychology, Arizona State University

Author Note

Kathryn S. McCarthy https://orcid.org/0000-0002-6277-7005

Jonathan Steinberg https://orcid.org/0000-0002-6957-7735

Kelsey Dreier https://orcid.org/0000-0003-0357-3835

Tenaha O'Reilly https://orcid.org/0000-0002-8513-9719

John Sabatini https://orcid.org/0000-0002-0292-2039

Danielle S. McNamara https://orcid.org/0000-0001-5869-1420

Correspondence should be addressed to Kathryn McCarthy, College of Education & Human Development, Department of Learning Sciences, P.O. Box 3978, Atlanta, GA 30302. Email: kmccarthy12@gsu.edu

Abstract

This study revisits the effects of text complexity and individual differences on comprehension in the context of the Global-Integrated Scenario-based Assessment (GISA). High school students (n = 511) completed prior knowledge and foundational reading skill assessments followed by either a high or low cohesion version of a scenario-based comprehension assessment. Preliminary analyses indicate robust effects of prior knowledge, little effects of foundational reading skills, and no overall effects of the cohesion manipulations on comprehension performance.

Keywords: cohesion, prior knowledge, assessment

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Text *cohesion* refers to the degree to which relations between words, concepts, or ideas are explicit in the text. In general, increasing cohesion improves students' comprehension (e.g., Beck et al., 1991). However, research has also demonstrated that the effects of cohesion are influenced by aspects of the reader such as prior knowledge (McNamara & Kintsch, 1996) and reading skill (O'Reilly & McNamara, 2007). These findings highlight the complex relations between features of a text and aspects of the reader.

The current study furthers the exploration into the effects of text cohesion, reading skill, and prior knowledge[1] (PK) by examining multiple dimensions of PK. While PK has been shown to be one of the strongest predictors of comprehension success (Dochy et al., 1999), different types of prior knowledge affect comprehension in different ways. For example, domain knowledge is a stronger predictor of comprehension success than topic specific knowledge (Alexander et al., 1994) and deeper, conceptual knowledge is more influential than basic, factual knowledge (McCarthy et al., 2019). Further, different dimensions of PK may be more or less relevant for different domains (Tarchi, 2010).

The purpose of the current study was to examine how different dimensions of PK influence reading comprehension. Importantly, we consider these effects in combination with the impact of other critical aspects of comprehension success – basic reading skill and text cohesion.

This study examines these effects in the context of a scenario-based assessment. Unlike traditional assessments, the *Global-Integrated Scenario-based Assessment*, or GISA, targets purposeful reading and learning activities (Sabatini et al., 2013) such as studying for tests or

[1] We do not distinguish the term "prior knowledge" from "background knowledge" and consider them the same construct.

writing a paper. These scenarios require readers to integrate, evaluate, and synthesize multiple sources. Critically, these reading scenarios could be more dependent on prior knowledge than typical reading comprehension tests because they demand deeper comprehension and the sources are thematically related. We further examine the potential effects of text cohesion and the extent to which these effects depend on prior knowledge or reading skill in the context of GISA reading assessments.

Method

Materials

GISA Comprehension Test. Students completed one of two Global-Integrated Scenario-based Assessments (GISA): either the *history* GISA, on the topic of Women's Suffrage, or the *science* GISA, on the topic of Ecosystems. Texts from the existing GISAs were edited into a high and low cohesion form by adding or removing connectives and lexical overlap between sentences. Researchers confirmed the increase and decrease in cohesion using the Coh-Metrix Common Core Text Ease and Readability Assessor (T.E.R.A.; Jackson et al., 2016) to evaluate both referential and situation model cohesion.

Knowledge Tests. Students completed three knowledge tests. All students completed both the Women's Suffrage and Ecosystems multiple-choice prior knowledge (PK) test. These tests include both *basic*, factual items and *conceptual* items that required students to apply their knowledge. In addition to these tests, students completed a topical vocabulary test designed to test their familiarity with topic-specific content words for the GISA they completed.

Foundational Reading Skill Test. Students completed three subtests (vocabulary, morphology, and sentence completion) from the Reading Inventory and Scholastic Evaluation (RISE2; Sabatini et al., 2019) as a measure of foundational reading skill.

Procedure

High school students (n = 511) completed the prior knowledge tests and a GISA. All students completed the RISE, Women's Suffrage PK test, and Ecosystems PK test. Half of the students then completed the Women's Suffrage GISA and the other half completed the Ecosystems GISA. Students were randomly assigned to the high or low cohesion form of the assessment. The GISA test includes a topic-related vocabulary test and the scenario-based comprehension assessment.

Data Analysis

To examine the examine the effects of text cohesion, reading skill, and prior knowledge on reading comprehension performance, we conducted a series of linear mixed effects model analyses. GISA forms (Ecosystems, Women's Suffrage) were examined separately. Individual differences were entered as fixed factors and participants and items were entered as random factors. The baseline model included only random effects. Cohesion (high, low) was entered first (m1) and then reading skill (m2). The prior knowledge tests were entered one at a time from most specific to most general. That is, topic-specific vocabulary was entered in m3, followed by the congruent domain PK test (science for the Ecosystems GISA and history for the Women's Suffrage GISA) in m4. Alternative topic PK test was entered in m5 and m6 included the most critical interaction term (cohesion form x conceptual prior knowledge).

2 The RISE has been renamed as ReadReady.

Results

Descriptive measures appear in Table 1. In general, students did not perform as well on the Women's Suffrage tests than on the Ecosystems tests. Preliminary analyses indicated that all PK and comprehension test scores were moderately and significantly correlated (r = .31-.62). There were no significant differences in PK or reading skill as a function of the cohesion manipulation (all ps > .05).

Table 1. Average scores by assessment

Assessment	Points Possible	M	SD	% Correct
RISE	38	32.51	6.67	85.6
Women's Suffrage PK Vocabulary	35	19.30	6.93	55.1
Women's Suffrage PK Basic	16	8.75	2.69	54.7
Women's Suffrage PK Conceptual	9	4.72	2.08	52.4
Ecosystems PK Vocabulary	57	38.31	12.60	67.2
Ecosystems PK Basic	16	10.21	3.56	63.8
Ecosystems PK Conceptual	14	7.55	3.95	53.9
Women's Suffrage GISA Low	33	11.36	7.75	34.4
Women's Suffrage GISA High	33	11.19	7.43	33.9
Ecosystems GISA Low	33	14.95	7.27	45.3
Ecosystems GISA High	33	15.21	7.45	46.1

Science (Ecosystems) GISA

Likelihood ratio tests (Table 2) indicated no effect of the cohesion manipulation on Ecosystems GISA performance. Reading skill improved model fit (m2). The science knowledge tests (m3 and m4) added to the model, but the history PK tests (m5) did not. Of note, there was no significant interaction between cohesion form and science PK (m6).

Table 2. Likelihood Ratio Tests for Predicting Ecosystems GISA Comprehension Score

Model	Variables	AIC	BIC	χ^2	p
eco.m0	Random intercepts (student, item)	8538.9	8566.2		
eco.m1	+ Cohesion	8540.6	8574.7	0.26	0.61
eco.m2	**+ RISE Total**	**8484.1**	**8525.0**	**58.57**	**> .001**
eco.m3	**+ GISA PK Test**	**8465.6**	**8513.3**	**20.49**	**> .001**
eco.m4	**+ Sci PK (Basic, Conceptual)**	**8376.6**	**8438.0**	**93.01**	**> .001**
eco.m5	+ History PK (Basic, Conceptual)	8377.8	8452.9	2.74	0.25
eco.m6	+ Cohesion * Sci PK Conceptual	8379.8	8461.7	0.03	0.87

Note. Significant effects appear in bold

The best fitting model (m4; Tables 2 & 3) revealed that only the science knowledge measures were significant predictors. Although the estimates are relatively low overall, they indicate that conceptual PK was the strongest predictor, followed by basic PK, followed by the vocabulary PK.

Table 3. Coefficient Table of Fixed Effects Predicting Ecosystems GISA Comprehension Score

	Estimate	SE	t	p
Text Cohesion	0.02	0.02	0.90	0.37
RISE	0.01	0.01	0.41	0.68
Ecosystems PK Vocab	**0.03**	**0.01**	**2.12**	**0.03**
Ecosystems PK Basic	**0.06**	**0.02**	**4.00**	**> .001**
Ecosystems PK Conceptual	**0.09**	**0.01**	**6.44**	**> .001**

Note. Significant effects appear in bold

History (Women's Suffrage) GISA

Likelihood ratio tests (Table 4) indicate, again, that cohesion had no effect. Reading skill, vocabulary, and history PK all added unique variance explained. In contrast to the Ecosystems

data, the science PK test added unique variance explained to the model (m5). Again, the

interaction between cohesion form and PK was not significant.

Table 4. Likelihood Ratio Tests for Predicting Women's Suffrage GISA Score

Model	Variables	AIC	BIC	χ^2	*p*
wmsf.m0	Random intercepts (student, item)	7938.8	7965.7		
wmsf..m1	+ Cohesion	7940.2	7973.9	0.57	0.45
wmsf.m2	**+ RISE Total**	**7892.4**	**7932.7**	**49.88**	**> .001**
wmsf.m3	**+ GISA PK Test**	**7841.3**	**7888.4**	**53.07**	**> .001**
wmsf.m4	**+ History PK (Basic, Conceptual)**	**7799.4**	**7859.9**	**45.93**	**> .001**
wmsf.m5	**+ Sci PK (Basic, Conceptual)**	**7782.2**	**7856.2**	**21.15**	**> .001**
wmsf.m6	+ Cohesion * Hist PK Conceptual	7783.2	7864.0	0.97	0.33

The best fitting model (m5; Tables 4 & 5), revealed interesting effects. Cohesion was a

significant predictor. History vocabulary and conceptual PK were significant, but basic history

PK was only marginally significant. Further, science conceptual PK was a significant predictor,

with estimates similar to the history PK tests. Note, however, that the impact of Ecosystems

knowledge (Estimate = .05, Table 5) on Women's Suffrage GISA is smaller than the impact of

Ecosystems knowledge of Ecosystems GISA (Estimate = .09, Table 3).

Table 5. Coefficient Table of Fixed Effects Predicting Women's Suffrage GISA Score

	Estimate	SE	*t*	*p*
Text Cohesion	**0.05**	**0.02**	**2.48**	**0.01**
RISE	0.01	0.01	1.09	0.27
Women's Suffrage PK Vocab	**0.05**	**0.01**	**3.89**	**> .001**
Women's Suffrage PK Basic	0.02	0.01	1.95	0.05
Women's Suffrage PK Conceptual	**0.04**	**0.01**	**3.54**	**> .001**
Ecosystems PK Basic	0.02	0.02	1.37	0.17
Ecosystems PK Conceptual	**0.05**	**0.02**	**2.88**	**>.01**

Note. Significant effects appear in bold

Discussion

This study demonstrated that prior knowledge is a strong predictor of reading comprehension. More specifically, conceptual prior knowledge is a stronger predictor than more basic, factual knowledge. These findings are consistent with extant research on the impacts of prior knowledge on students reading comprehension (Dochy et al., 1999; McCarthy et al., 2019). However, we failed to replicate other extant findings (e.g., McNamara & Kintsch, 1996; O'Reilly & McNamara, 2009) in that our cohesion manipulation had little effect on comprehension test performance.

There are a few potential explanations for these discrepancies. The first is that the texts were manipulated in a variety of ways in order to raise and lower the cohesion of the text as a whole. We did not consider the degree to which our changes were relevant to the specific questions or tasks within the assessment. It is also of note that the items within the GISA include some longer strings of text (e.g., "is the following summary a good summary of the larger passage?") We did not manipulate these texts. In future work, we intend to conduct a closer examination of the text content that was changed in the cohesion manipulation and explore how these changes might be relevant to specific comprehension test items and to examine the cohesion of the items themselves. It is also possible that the sequencing and scaffolding elements in the GISA may have mitigated some of the effects of cohesion, but more worked is needed to explore this hypothesis.

The study also revealed differential effects across the two GISA domains. It is possible that these differences reflect generalizable variations across the domains of science and history (e.g., Tarchi, 2010). However, it may also a function of the specific topics within those domains. Ecosystems reflects a broad, central topic in the study of science, whereas Women's suffrage is,

unfortunately, a relatively niche topic within the scope of American history. This is consistent with the findings that students generally had less knowledge of Women's suffrage than of ecosystems. Thus, the contribution of science knowledge to history GISA performance may reflect readers tapping into more general knowledge in order to comprehend the unfamiliar topic. These differences may explain why text cohesion emerged as a significant predictor in the Women's Suffrage GISA, but not in the Ecosystems GISA. However, this relation warrants further investigation. In future work, it will be important to replicate these manipulations across a greater variety of topics and domains to better disentangle the relations between text cohesion and readers' prior knowledge and reading skill.

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