Cognition and Math and Reading Overlap in Community College Students

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Introduction

Math and reading are related to one another at the level of disability level as well as along the continuum of skill (Unal et al., 2023). Cognitive correlates of math and reading in children are well-known separately, with a recent focus on the reason for their overlap. Domain general neurocognitive factors are a key plausible class of this overlap, and in children, such factors account for a substantial of the relation between reading and math (Cirino et al., 2023). Although such studies exist for children, there is very little known about these issues for students at later stages of learning. In this regard, an important population to consider are community college (CC) students, who are understudied, despite more than half of post-secondary education occurring at this level, and given that many CC students are at risk academically.

The present study aims to address this gap, particularly as doing so can provide insight to both theory (e.g., the developmental stability of this overlap and its concomitants) as well as practically (e.g., identifying factors that increase academic risk). Therefore, we assess plausible neurocognitive factors that been theoretically and empirically linked to math and reading (language, working memory, processing speed, nonverbal reasoning, attention), at least in younger populations. The goal is to examine the extent to which reading and math relate, as well as the extent that these neurocognitive predictors account for that overlap.

We expect all predictors to relate to achievement, with language and working memory as the strongest predictors, and accounting for the most overlap. We also expect more overlap and stronger prediction for complex outcomes (reading comprehension and math applications) relative to foundational skills (word reading and computations).

Participants/Procedures

Participants were 94 CC students enrolled in their first math class. Approximately half the students were taking developmental coursework, consistent with the college as a whole. Participants were administered four ***math*** and ***reading*** measures of the KTEA-3: Letter-Word Recognition, Reading Comprehension, Math Computation, and Math Concepts and Application. Participants also received measures of ***language*** (K-BIT-2 Vocabulary; CTOPP-2 Elision and Rapid Naming), of ***working memory*** (Symmetry Span and Reading Span), of ***processing speed*** (from the WAIS-IV), of ***nonverbal reasoning*** (K-BIT-2); finally, ***attention*** was assessed via a researcher-designed continuous performance task and a self-rating scale of behavioral inattention.

Multiple regression assessed unique contributions of neurocognitive predictors. Math and reading relations were established at foundational (word reading and computations) and at more complex (comprehension and applications) levels; partial correlations account for variables relevant in regression established reduction in overlap.

Table 1. Descriptive Data

Domain	Measure	Mean	SD
Language	K-BIT-2 Vocabulary[1]	45.1	5.98
Language	CTOPP-2 Elision[2]	8.05	2.55
Language	CTOPP-2 RAN Letters[2]	8.12	2.87
Language	CTOPP-2 RAN Numbers[2]	8.85	2.88
Processing Speed	WAIS-IV Coding[2]	9.22	3.10
Processing Speed	WAIS-IV Symbol Search[2]	10.0	2.78
Nonv Reasoning	K-BIT-2 Matrices[3]	97.0	13.7
Working Memory	Symmetry Span[4]	10.8	5.76
Working Memory	Reading Span[4]	16.8	7.54
Attention	CPT d'[4]	4.14	0.89
Attention	SWAN Inattention[4]	-10.7	9.77
Reading	Letter Word Recognition[3]	90.2	13.1
Math	Math Computations[3]	95.6	14.9
Reading	Reading Comprehension[3]	91.6	13.8
Math	Math Concept/Applications[3]	92.4	13.0

Note. [1]T-score. [2]Scaled Score; [3]Standard Score; [4]Raw Score.

Table 2. Correlations

	Foundation Read	*Foundation Math*	*Complex Read*	*Complex Math*
Vocabulary	**0.57**	**0.29**	**0.51**	**0.46**
Elision	**0.55**	**0.57**	**0.45**	**0.59**
RAN Letters	**-0.34**	**-0.39**	-0.06	**-0.28**
RAN Numbers	**-0.32**	**-0.36**	-0.09	**-0.28**
Coding	0.24	**0.36**	**0.32**	**0.35**
Symbol Search	0.08	-0.01	0.16	0.15
Matrices	**0.30**	**0.57**	**0.45**	**0.58**
Symmetry Span	0.11	0.23	0.25	**0.39**
Reading Span	**0.39**	0.27	**0.39**	**0.41**
CPT d'	0.20	0.07	0.30	0.18
Inattention	0.12	0.21	0.17	0.21

Note. Correlations ~ .28 or larger are $p < .001$ (and appear in bold); correlations ~.21 to ~.27 are $.001 < p < .05$; and correlations of .20 and below are $p > .05$.

Results

Nearly all predictor variables were significantly associated with all achievement variables, with the exception of symbol search, CPT d', and self-reported behavioral inattention.

For word reading, the predictors together accounted for R^2 = 50%, with unique prediction for <u>*vocabulary, elision, and reading span*</u> (all $p < .05$). For computations, all predictors together accounted for R^2 = 50%, with <u>*nonverbal reasoning and elision*</u> as the only unique predictors. For reading comprehension, R^2 = 44%, with unique prediction for <u>*nonverbal reasoning, vocabulary, and rapid naming*</u>; reading span and coding also contributed. For math applications, R^2 = 56%, with unique prediction for <u>*nonverbal reasoning, vocabulary, and elision*</u>; symmetry span also contributed. Substantive results were generally similar when covariates were considered.

The variables above were then considered with regard to achievement overlap. Partial correlations showed a reduction in foundational overlap, $r = .29$, $p < .001$ (**42% reduction**); language variables were clearly strongest in their contribution to overlap. For complex achievement, the partial correlation was $r = .20$, $p = .080$ (**65% reduction**); in this case language-specific and other predictors were equivalent contributors.

Discussion

Individual prediction was dominated by language, nonverbal reasoning, and working memory variables. Attention and processing speed were only weakly related to performance. Math and reading performances were strongly related, and neurocognitive variables reduced these relations, moreso for complex relative to foundational achievement. Language was the strongest predictor of this overlap, though moreso for foundational relative to complex achievement. Results are only partially consistent with extant literature but adds context and generalization for CC students. Future work should include more malleable factors (e.g., motivation), as well as broader views of achievement (e.g., course grades), larger samples, and domain-specific mathematical predictors of numerosity.

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