Cross-Battery Cognitive-Math and Writing Relations by Age

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Introduction

Students' performance across several tests, including multiple cognitive and achievement tests, is often analyzed together to better understand their learning. Most studies examine how children's cognitive scores relate to their achievement scores using single cognitive and achievement tests, most commonly using the Woodcock-Johnson (Zaboski et al., 2018). These relations may not generalize to other tests as some differences have been found across tests. Developmental differences should also be considered as some evidence suggests cognitive-achievement relations shift throughout children's development (Caemmerer et al., 2018).

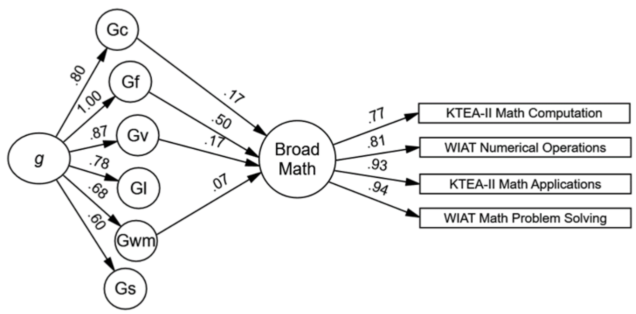
Research that incorporates multiple intelligence and achievement tests simultaneously, known as cross-battery analyses, can examine better defined constructs represented by many indicators. Cross-battery research can extend our understanding of how intelligence and achievement relate not just at the test-level, but at the broader construct level.

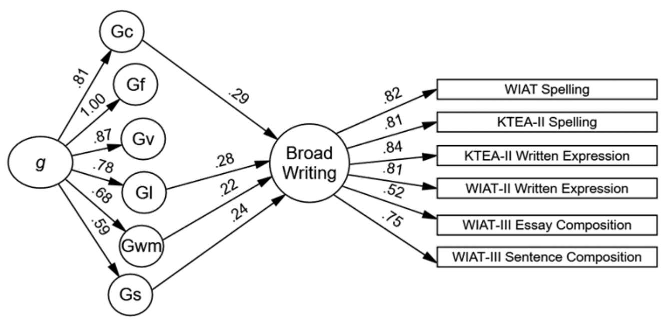
Method

- 3,927 participants aged 6 – 18 were drawn from 7 standardization and linking samples collected by Pearson Assessments.
- 6 intelligence tests (KABC-II, WJ III, WISC-III, WISC-IV, WISC-V, DAS-II) and 3 achievement tests (KTEA-II, WIAT-II, WIAT-III) were examined.
- To simultaneously analyze several tests, principles of planned missingness were applied. Cross-battery confirmatory factor analysis and structural equation modeling were used.
- Analysis steps:
  1. 8 invariance models were tested across samples and editions of the same test. Then, data were combined across samples and WISC & WIAT editions.
  2. CFA was used to establish a cross-battery intelligence CHC model. General intelligence (*g*) and 6 broad abilities were estimated by 66 intelligence subtests.
  3. Relations between cross-battery cognitive abilities and broad writing and broad math were tested.
     1. Direct paths from the 6 broad abilities and an indirect path from *g* to broad writing and broad math were tested. Gf's residual was constrained to zero in both models.
     2. All non-significant paths were deleted in one step.
  4. 10 potential interactions were individually tested between children's age and 5 broad abilities (excluding Gf). All other statistically significant predictors of the academic skill were controlled for.

Results

- **Model fit**: The fit of the cross-battery cognitive-broad writing and broad math models were adequate to good (CFI = .96, TLI = .95, RMSEA = .02, SRMR = .09).
- **Influence of *g***: General intelligence had large indirect effects on broad writing (β = .74) and broad math (β = .83).
- **Influence of CHC broad abilities**:





- **Developmental Differences**: Three interactions were statistically significant, after controlling for the direct effects of age (a continuous variable), the broad ability in the cross-product, and the other broad abilities that had significant effects in the cognitive-achievement models.
  - For interpretation and illustration purposes, the continuous age variable was divided into 3 age groups: 6-9 (n = 1,329), 10-13 (n = 1,392), and 14-18 years old (n = 1,206).

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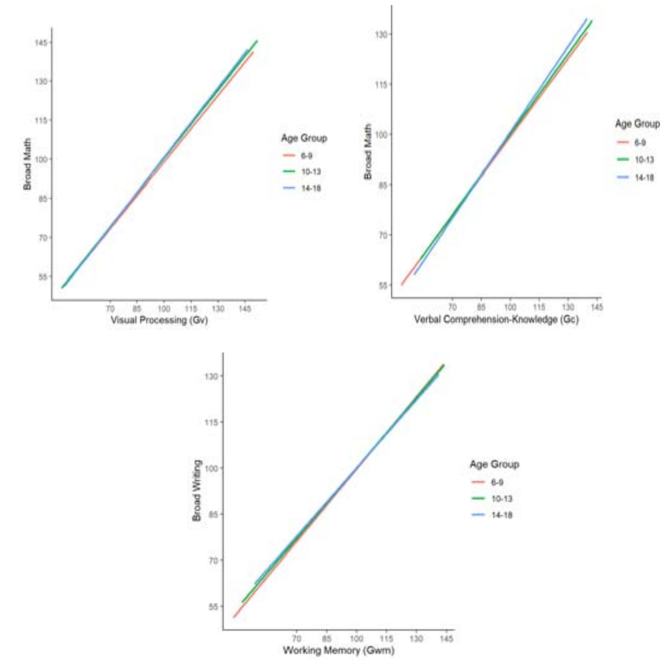
Statistically Significant Interactions



Conclusions

- **Youth's general intelligence (*g*), verbal comprehension-knowledge (Gc), and working memory (Gwm) significantly predicted their broad math and broad writing skills.**
- **Youth's learning efficiency (Gl) and processing speed (Gs) predicted their broad writing.**
- **Youth's visual processing (Gv) and fluid reasoning (Gf) predicted their broad math.**
- **The influence of fluid reasoning and *g* were difficult to separate.**
- **Most of the cognitive-broad math and broad writing relations were stable across age.**

Acknowledgments: **This study was supported by Texas Woman's University Woodcock Institute Research Grant.**

We are grateful to Pearson for sharing the data that made this study possible.