Developmental and Sex Differences in Cognitive Ability Influences on Writing

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Introduction

Individual differences in cognitive abilities have been used to explain individual differences in writing performance (Abbott & Berninger, 1993; Hayes, 2006; Kim & Schatschneider, 2017). These cognitive explanatory models are well-supported in the empirical literature (Benson, Kranzler, & Floyd, 2016; Cormier, Bulut, McGrew, & Frison, 2016; Decker, Roberts, Roberts, Stafford, & Eckert, 2016; Floyd, McGrew, & Evans, 2008; McGrew & Knopik, 1993; Niileksela, Reynolds, Keith, & McGrew, 2016). As writing development progresses, cognitive influences on writing change as children move through school. Specifically, these changes occur as the focus of writing shifts from learning how to write to using writing as a method to communicate and demonstrate knowledge (Abbott & Berninger, 1993; Hajovsky et al., in press).

Another variable that influences writing scores is sex. Girls show moderate advantages in written expression early on and this advantage persists across development (Reynolds, Scheiber, Hajovsky, Schwartz, & Kaufman, 2015). Research has also shown that cognitive explanatory models of writing differ between girls and boys during the emergent years of writing development. For example, previous findings suggest that fluency in retrieval of words explains more individual differences in writing for girls than for boys in grades 1–4; conversely, at the same time short-term memory processes explains more individual differences in writing for boys than for girls (Hajovsky et al., in press). One major limitation of these past sex-based findings is that measures of cognitive abilities important for writing were not all included in one sex-specific, developmental cognitive explanatory model. For example, given that processing speed (G*s*) has been shown to favor females (e.g., Camarata & Woodcock, 2006; Keith, Reynolds, Roberts, Winter, & Austin, 2011), it should be included as a potential moderating variable. Similarly, Auditory Processing (G*a*) has empirical support for influencing writing performance with differences across age (e.g., Cormier et al., 2016) and therefore should be included in developmental models of writing. The main purpose of this study is to extend prior research by including a fuller set of measures of cognitive constructs and examine whether the patterns and strength of relations between cognitive variables and writing generalize across grade level groups and between boys and girls.

Research Questions

1. **Which CHC-based cognitive abilities (i.e., G*c*, G*s*, *g*) explain individual differences in written expression?**
2. **Do the statistically significant cognitive influences on written expression differ by grade level or sex?**

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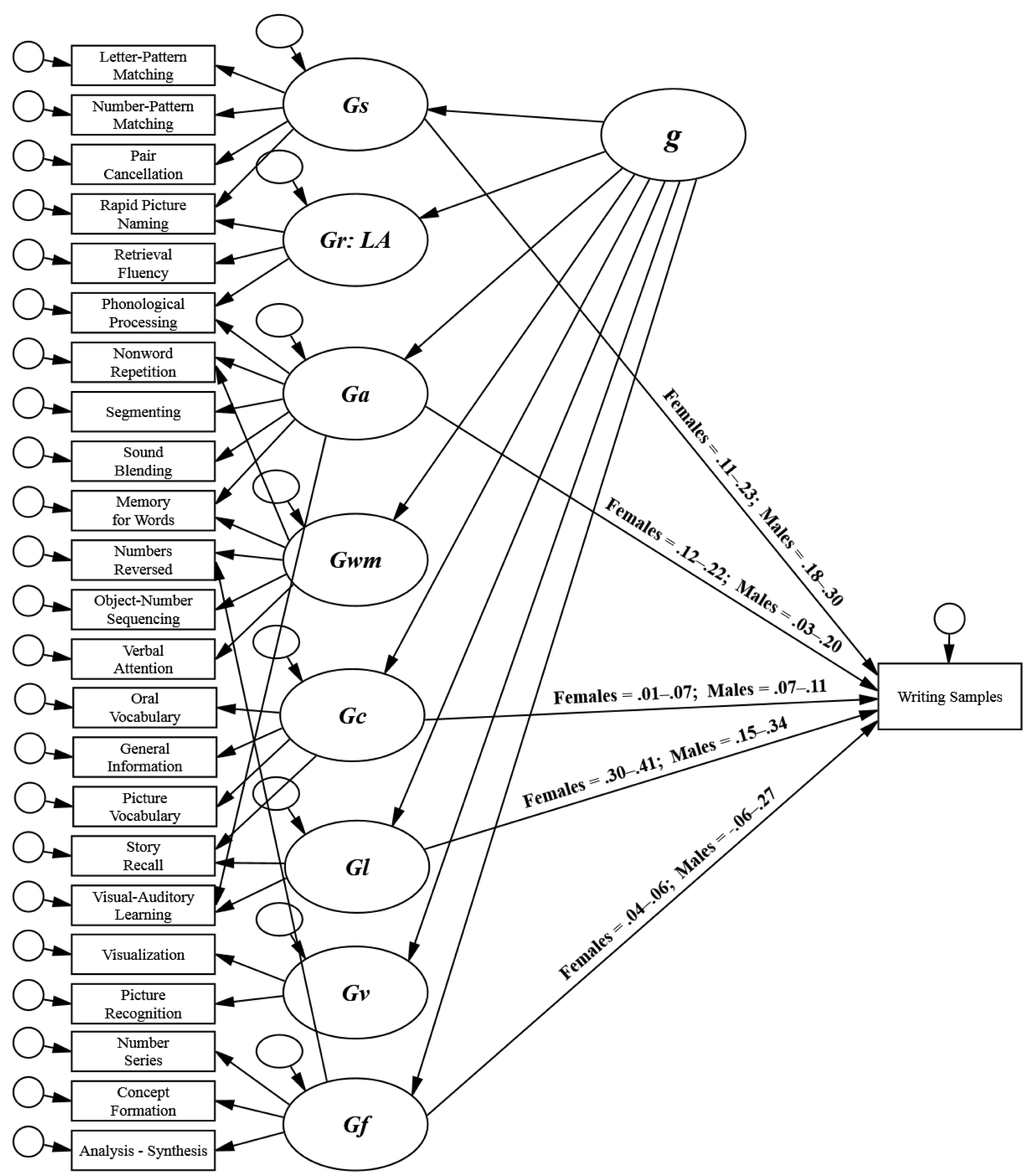
Table 1. Fit Statistics for Multiple-Group Structural Equation Models

Models Tested	χ^2 (*df*)	$\Delta\chi^2(\Delta df)$	*p*	RMSEA [90% CI]	CFI	AIC	MLE SRMR	MLE AGFI	MLE PNFI	SFLS SRMR	SFLS AGFI	SFLS PNFI
Multi-Group Measurement Invariance												
1. Configural	6693.839 (1230)	—	—	.035 [.035-.036]	.859	7545.839	.0528	.822	.676	.0497	.978	.792
3. First-order loadings	6862.559 (1340)	168.720 (110)	<.001	.034 [.033–.035]	.858	7494.559	.0559	.833	.733	.0546	.975	.859
4. Second-order loadings	6910.254 (1375)	48.998 (35)	.058	.034 [.033–.035]	.858	7472.254	.0575	.836	.751	.0564	.973	.878
Multi-Group Achievement Models												
1. All Free Model	8571. 336 (1483)	—	—	.037 [.036-.037]	.830	9205.336	.0616	.806	.719	.0606	.970	.865

Note. The ΔCFI used to assess measurement invariance. RMSEA = Root Mean Square Error of Approximation. CFI = Comparative Fit Index. AIC = Akaike Information Criterion. MLE = Maximum Likelihood Estimation. SFLS = Scale-Free Least Squares. SRMR = Standardized Root Mean Square Residual. AGFI = Adjusted Goodness of Fit Index. PNFI = Parsimony-Adjusted Normed Fit Index. MLE and SFLS estimators used to derive model fit statistics.

Figure 1. Multiple Group SEM of Cognitive Ability Influences on Writing Samples across Grades and Sex



Method

The co-normed standardization samples for the Woodcock Johnson IV Tests of Cognitive Abilities (WJ IV COG; Schrank, McGrew, & Mather, 2014a), the Woodcock Johnson IV Tests of Academic Achievement (WJ IV ACH; Schrank et al., 2014b), and the Woodcock Johnson IV Tests of Oral Language (WJ IV OL; Schrank et al., 2014c) were used to examine latent CHC-based cognitive ability (i.e., Gc, Gs, Gr, Ga, Gwm, Gl, Gf, Gv, and *g*) and written expression relations in school-age children. The demographic features matched those of the general U.S. population using the 2010 Census (McGrew, LaForte, & Schrank, 2014). The sample used for this study only included the school-age subsample, which includes grades 1-12 (N = 3,558). The sample was divided into six groups, split by grade level and sex: grades 1-4, males (n = 634) and females (n = 636); grades 5-8, males (n = 619) and females (n = 648); and grades 9-12, males (n = 499) and females (n = 522).

Multiple group structural equation modeling (MG-SEM) was used to develop a higher-order model of CHC cognitive abilities (e.g., Crystallized Knowledge [G*c*], Processing Speed [G*s*]) from the WJ IV COG and WJ IV OL Batteries (McGrew et al., 2014; Niileksela et al., 2016). The Writing Samples subtest from the WJ IV ACH Battery was used as the outcome variable for all groups (n = 6). Before testing cognitive ability influences on Writing Samples, we first tested the assumption of factorial invariance (configural, first-order weak, and second-order structural) across distinct groups (grade and sex groups). We then tested the statistical significance of the latent cognitive influences on Writing Samples across groups and interpreted effect sizes according to subjective criteria for educational variables (Keith, 2015).

Results

Main Findings

1. **Processing Speed (G*s*) effects decreased for females but increased for males across grade levels.**
2. **Auditory Processing (G*a*) effects differed across grades and sex. G*a* was important for females at all grades but increased over time, whereas G*a* was important in grades 9-12 for males.**
3. **Learning Efficiency (G*l*) was the most consistent influence across sex and grades.**
4. **Crystallized Knowledge (G*c*) and Fluid Reasoning (G*f*) were inconsistent. For males, G*c* was important at grades 5-8, whereas G*f* was only important at grades 1-4.**
5. **General intelligence (*g*) had very large indirect effects (β = .47-.57).**

Conclusions

Although more research is needed, the findings indicate some inconsistencies with past developmental and sex-based cognitive and writing relations research (Hajovsky et al., in press). A potentially important finding is the differential effect of Processing Speed on writing for males and females. For example, given females have an advantage in processing speed, they may approach sentence formation more efficiently, especially during the early years of schooling. Future research will explore additional alternative hierarchical models (e.g., bifactor model).

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