EXAMINING THE SHARED AND UNIQUE VARIANCES OF EXECUTIVE FUNCTIONS AND CHINESE READING COMPREHENSION **AMONG GRADE 1 STUDENTS**

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1 INTRODUCTION

• Executive functions (EF) are cognitive processes that drive goal-oriented behaviours in the prefrontal cortex (Best & Miller, 2010) • Tripriate model of executive functions lists working memory, inhibition and shifting as the three core executive functions and describes them as **uniquely separable** but also share common variance, referred to as common EF (Miyake & Friedman, 2012)

2 RESEARCH GAPS

1. Limited studies examined the contribution of common EF and individual EF components, specifically in the context of Chinese reading comprehension 2. No existing studies compared the contribution of the shared and the unique variance of EF on Chinese reading comprehension (CRc) **simultaneously**, since studies that examined the unique variance of EF typically controlled for the shared variance of EF

- Working memory is the ability to refine and update mental representations
- Inhibition is the ability to suppress any dominant, automatic responses when required
- **Shifting** is the ability to switch between tasks and mental sets

3 RESEARCH QUESTIONS

RQ1: Does *common EF* (i.e., the shared variance between EF) predict CRc?

• **H1:** Common EF would strongly predict CRc

RQ2: Does each EF component independently predict CRc?

- H2: Working memory would predict CRc.
- H3: Inhibition would predict CRc.
- **H4:** Shifting would not predict CRc.

RQ3: Does the shared or the unique variance of EF contribute more to CRc? **RQ4**: Do common EF and individual EF components still predict CRc after controlling for word reading?

4 METHODOLOGY

PARTICIPANTS

• 181 Mandarin-speaking Chinese children (M_{age}: 85.85 months)

MEASURES

- Verbal working memory: Digit Backward/Forward Span
- Inhibition: Expressive Attention (Chinese adaptation of Colour–Word Stroop task)
- Planned Connections (Chinese adaptation of Trail Making)
- Chinese reading comprehension: Passage Comprehension test from the Woodcock-Johnson tests of Achievement
- Word reading: Character recognition task

6 DISCUSSIONS AND LIMITATIONS

RQ1: Common EF Strongly Predicts CRc

• Structural equation modelling (SEM) was used to construct models with latent variables; path analysis was used to construct models only with observed variables

Model 2

Model 1

Reaction Time

5 RESULTS

Structural equation model of relationship between latent EF and Chinese reading comprehension



Note. EA= Expressive Attention; PC= Planned Connections. The path from EA Reaction Time to Latent EF was fixed for model specification, hence no p-value was generated. * p < .05, ** p < .01, *** p < .001

- Common EF was strongly associated with $CRc (\beta = .55)$
- Latent EF explained 30.5% of the variance of CRc, after accounting for measurement

error

Model 3

* p < .05, ** p < .01, *** p < .001

• <u>Supports H1:</u> Common EF strongly predicts CRc



Note. EA= Expressive Attention; PC= Planned Connections. Solid lines indicate significant regression paths, whereas dashed lines indicate insignificant regression paths. * p < .05, ** p < .01, *** p < .001

- Working memory ($\beta = .17$) and inhibition ($\beta = .17$) .33) were weakly and moderately associated with CRc, respectively
- Shifting was not associated with CRc
- The sum of the variance of EF components and measurement error explained 15.0% of the variance of CRc
- <u>Supports H2, H3, H4:</u> Working memory and inhibition do predict CRc independently, but not shifting

Model 4

Structural equation model of relationship between latent EF and Chinese reading comprehension

Path analysis model of relationship between each EF component and Chinese reading comprehension

- EF interacts interdependently to facilitate CRc
- Response sets are first held in the working memory, inhibition would then inhibit the wrong response sets in working memory, which then enables shifting to activate an alternative response set (Best & Miller, 2010)

<u>RQ2: Working Memory and Inhibition Predict CRc, But Not</u> Inhibition

- The ability to refer back to passages reduces the demand to hold information in the working memory
- The logographic nature of Chinese characters requires inhibition to distinguish characters in terms of radicals (e.g., 愉/happy vs 输/lose) and similar stroke patterns (e.g., 己/ self vs 已/already), this facilitates CRc
- Reading-specific shifting mechanisms rather than domaingeneral shifting mechanisms may be associated with CRc

RQ3: Common EF Contributes More to CRc Than Individual

<u>EF Components</u>

- Both common EF and inidivudal EF components are necessary for CRc, but CRc may rely more on common EF
- May be due to the reliance of EF components on other EF components to be activated to perform their role in CRc
- Implies that interventions should be designed to train EF in union rather than in silo to improve CRc performance

RQ4: Common EF and Inhibition Remain Significant After



Note. EA= Expressive Attention; PC= Planned Connections. The path from EA Reaction

Time to Latent EF was fixed for model specification, hence no p-value was generated.

after controlling for word reading



Note. EA= Expressive Attention; PC= Planned Connections. Unidirectional straight and curved lines represent regression paths, and bidirectional curved lines represent covariance paths. Solid lines indicate significant regression paths, whereas dashed lines indicate insignificant regression paths. * p < .05, ** p < .01, *** p < .001

- Common EF was moderately associated with $CRc (\beta = .41)$
- Latent EF and word reading explained 47.7% of the variance of CRc, this indicated that word reading accounted an additional 17.2% of the variance of CRc
- Inhibition (β = .24) was weakly associated with CRc
- Word reading ($\beta = .52$) was strongly associated with CRc
- Working memory was not associated with CRc after controlling for word reading

Controlling for Word Reading, But Not Working Memory

- The drop in beta coefficient for the association between common EF and CRc from β = .55 to .41 implies that common EF may be involved in word reading to facilitate CRc, while the moderate association implies that common EF is involved in comprehension beyond word level
- Beyond operating at a word level to facilitate CRc, inhibition may enable students to make inferences (Borella, 2006)

Limitations

1. Constructs were only operationalised with one task 2. Our CRc measure may measure more of word decoding skills rather than comprehension skills in younger children 3. Restricted generalisability of results due to developmental changes of EF across age

Reference

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