Does knowledge of different orthographic regularities rely on a domain-general statistical learning mechanism?

An SEM analysis of a large-scale database

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Background: Morphological awareness

Definition and role for literacy skills

- MA reflects the implicit understanding of the **morphological structure of words** + ability to manipulate this structure.
- Makes possible **creating new words**, i.e., *derivational* (e.g.,"work + er"), *inflectional* (e.g., "work + ing") or *compound* (e.g., "work + sheet") morphology.

Empirical evidence

- Contributes to **reading accuracy** in orthographies of varying transparency, i.e., English, Italian, Portuguese, French, and Greek.
- Unlike its association with reading accuracy, its relationship with **reading fluency** has been less explored.

Carlisle, 2010; Nagy et al., 2013; Deacon & Kirby, 2004, Desrochers et al., 2017; Görgen et al., 2021; Diamanti et al., 2017.

Background: Morphological awareness

Empirical evidence with German school children

- Few studies + mixed results.

1. MA was the **most robust predictor** of reading fluency (4.0%, expl. var.) and spelling (6.8%).
2. MA **did not predict additional variance** in these outcomes in addition to phonological awareness and other variables.

Methodological limitations

- **Low reliabilities** + **underreporting** of psychometric properties.
- Sum scores without inspecting the **dimensionality** of the construct.

Görgen et al., 2021; Haasee et al., 2022; Bratlie et al., 2022.

Background: Word-specific orthographic knowledge

Definition and measurement

- WOK reflects **explicit representations** stored in memory about the correct spelling of words and word-units.
- **Orthographic choice task**: pseudohomophone (Y/N) (e.g., "tertle") vs. word (Y/N) (e.g., "turtle").

Empirical evidence

- WOK **predicts reading and spelling skills** in opaque (e.g., English) and transparent orthographies (e.g., Dutch).
- German: WOK **contributes to reading** at the *basic* (i.e., word-reading) and *complex* (i.e., sentence and text-reading) levels.

Barker et al., 1992; Olson et al., 1994; Deacon et al., 2013; Bekebrede et al., 2009; Zaric et al., 2021.

Background: General orthographic knowledge

Definition and measurement

- GOK involves an **implicit understanding** of the rules/patterns of which letters (a) may or may not be combined or (b) appear in specific positions in words.
- **Word similarity choice task**: which of 2 pseudowords most closely resembles a word, illegal (e.g., "bbaf") vs. legal pseudoword (e.g., "baff")

German: Mixed results

1. GOK explained a significant amount of unique variance in **reading and spelling**.
2. GOK significantly predicted spelling but **not reading**.

Apel et al., 2018; Rothe et al., 2013; Zaric et al., 2021; Görgen et al., 2021.

Background: WOK & GOK

- (1) GOK → (2) WOK.
- Statistical properties of letter combinations → GOK.
- Correlations between literacy skills and WOK > GOK.
  - Association varies by item type (WOK & GOK), i.e., higher correlations with pseudohomophones (vs. words) & illegal (vs. legal) pseudowords.
- WOK mediates relationship between GOK and reading & spelling.

Apel et al., 2018; Deacon et al, 2008; Rothe et al. (In preparation).

Statistical learning

Definition and importance

- SL: ability that allows cognitive systems to automatically detect underlying structures in the continuous stream of sensory stimuli.
- Underlies several cognitive functions (e.g., segmentation of continuous auditory input), but role for language skills is not clear.

Controversial construct

- *Pro*: When spelling, children draw not only on rule-based knowledge but also on the implicit processing of statistical regularities, e.g., **sublexical** GOK & **morphological** patterns.
- *Against*: results don't replicate + poor psychometric properties for SL tasks.

Frost et al., 2015; Deacon et al. 2008; Schmalz et al., 2018; Siegelman et al., 2016.

Aims of the present study

- Psychometric analysis of MA task (uni vs. multidimensional).
- Does MA, lexical processing, GOK, and age positively predict reading fluency?

Test for SL in a novel way

- If MA and GOK are influenced by SL...
- A model where a correlation between these is included should fit better than one that does not.

Method

Participants

- BMBF dataset (online study). 2,624 children (only complete cases).
- 3rd Grade (B = 608, G = 630); 4th Grade (B = 687, G = 699).
- Randomly divided total sample: *training* (80%) & *testing* sets (20%).

Measures

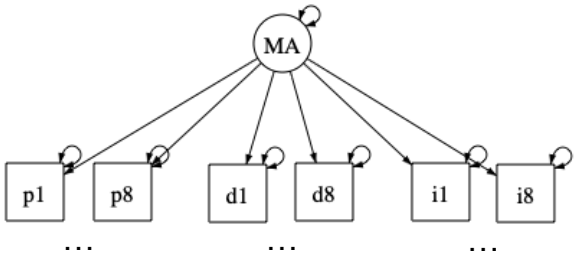
- **Criterion.** Reading fluency (*WLLP-R; VSL*)
- **Predictors.** Spelling (*WRT 3+/+4*), WOK (orthographic word-choice task), GOK (orthographic pseudoword-choice task), MA (plural formation, derivation, inflection).

Statistical analyses

- **CFA.** Psychometric properties MA task.
- **SEM.** Predicting reading fluency and testing SL mechanism (training + testing sets).

Results

1.



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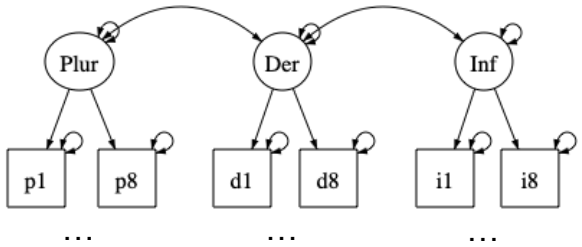

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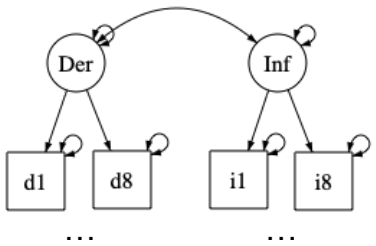

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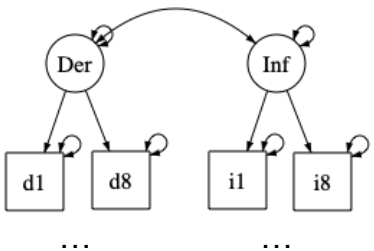


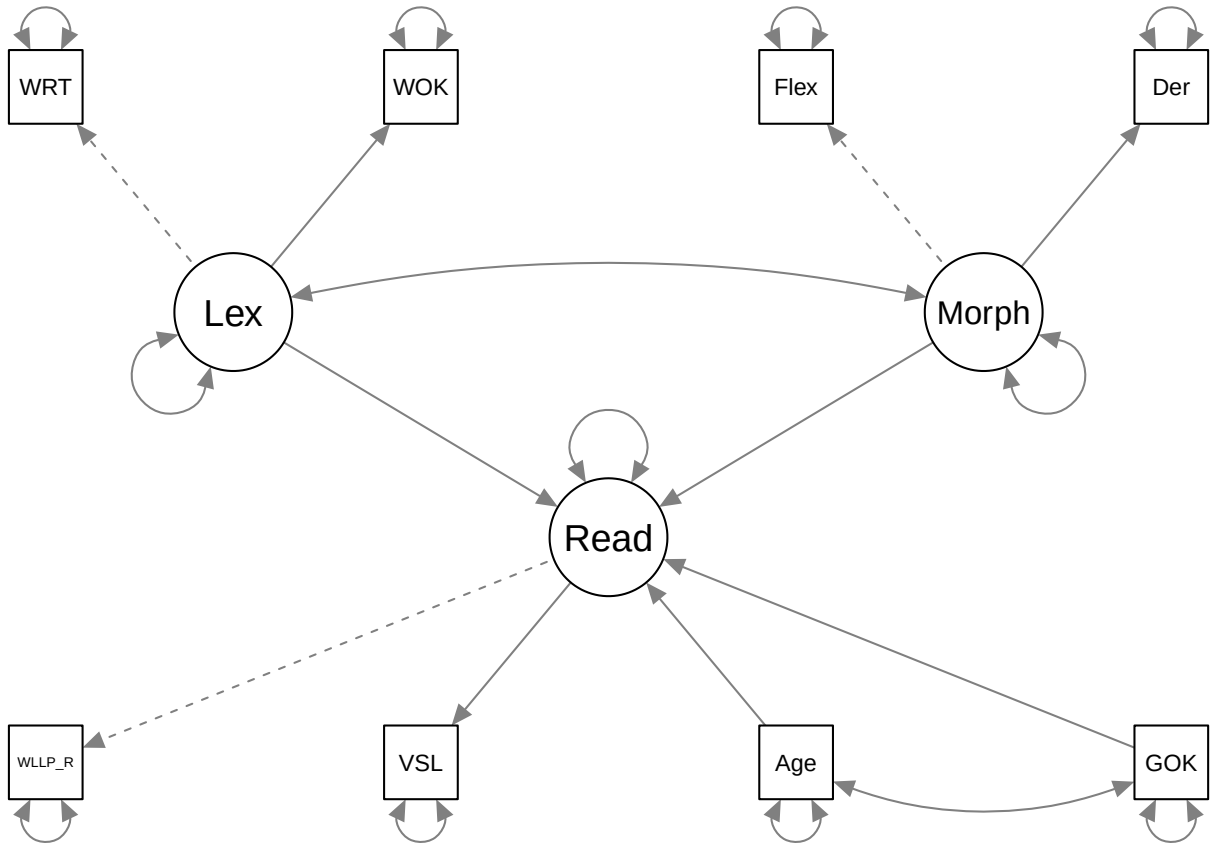
-2 items

Table 1: Fit indices for morphological awareness CFA models

	Model 1	Model 2	Model 3	Model 4
chisq.scaled	1056.46	705.78	245.12	144.85
df.scaled	252.00	249.00	103.00	76.00
pvalue.scaled	0.00	0.00	0.00	0.00
cfi.scaled	0.78	0.87	0.93	0.96
rmsea.scaled	0.04	0.03	0.02	0.02
srmr	0.08	0.08	0.06	0.06

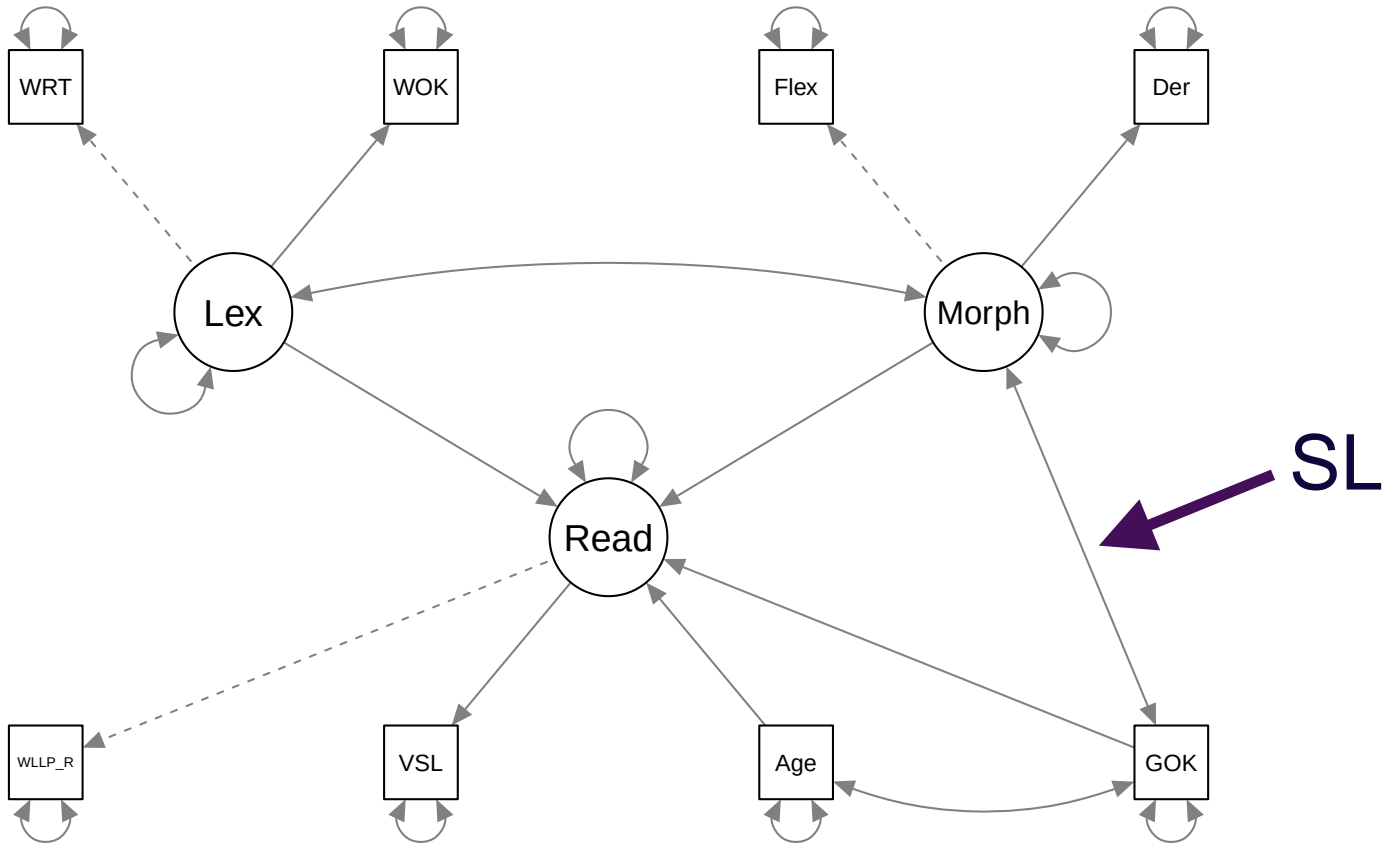
Results

SEM 1. Predicting Reading Fluency



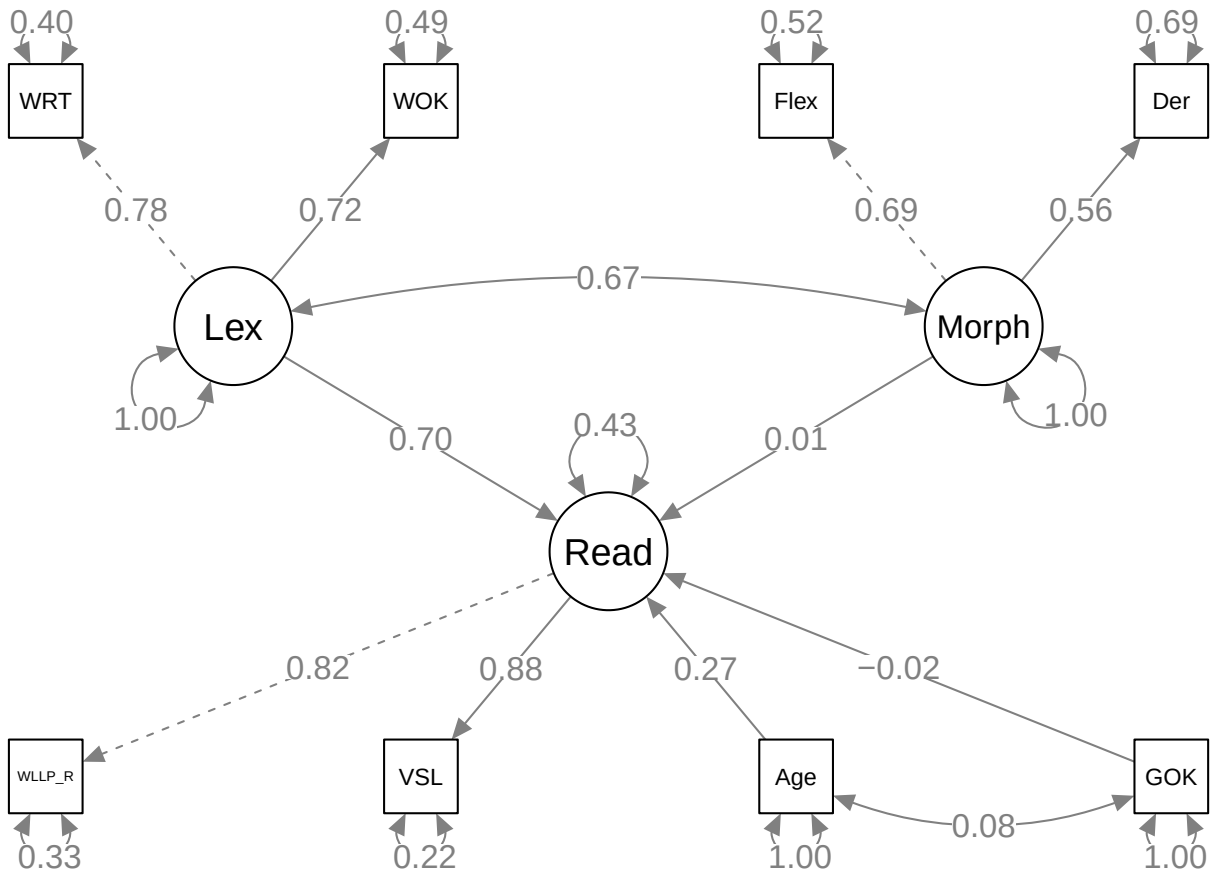
Results

SEM 2. Predicting Reading Fluency + SL parameter



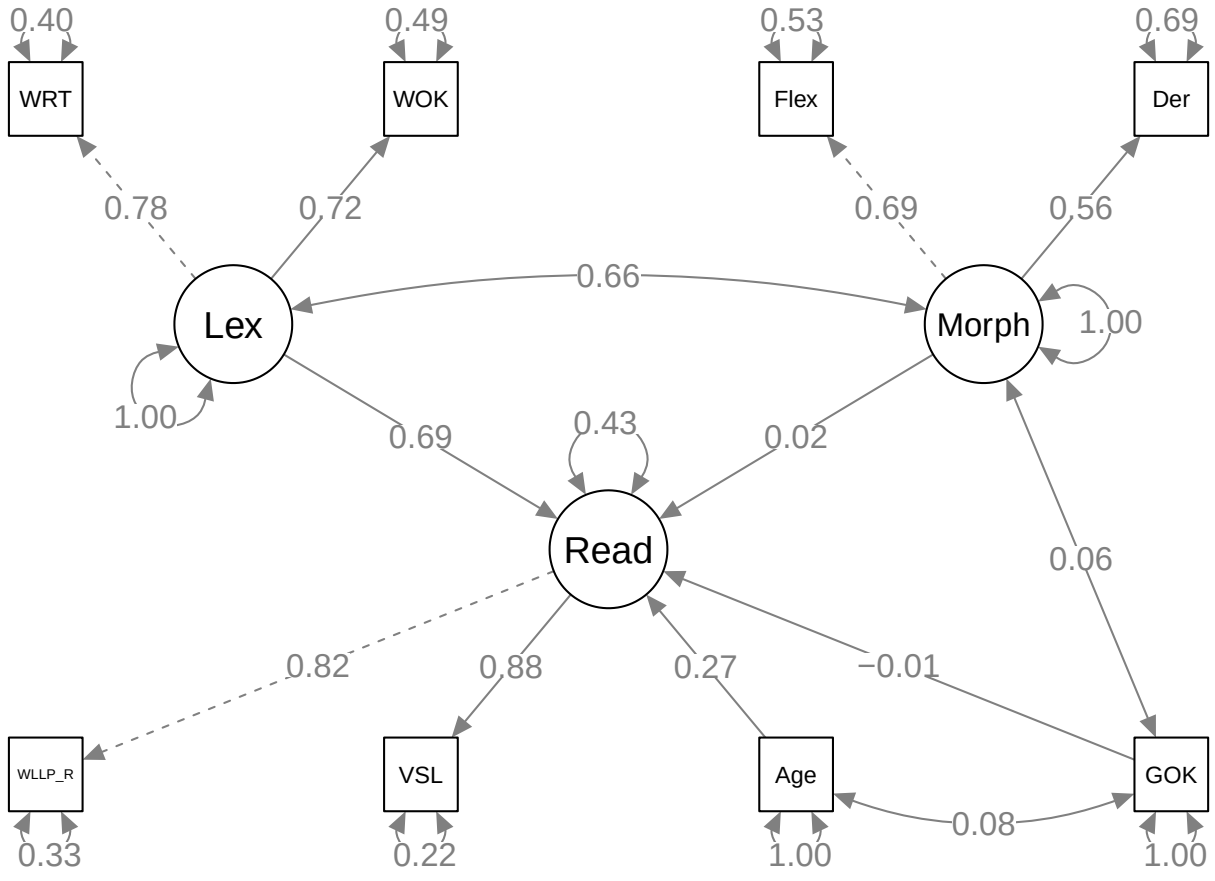
Results

SEM 1. Predicting Reading Fluency (training)



Results

SEM 2. Predicting Reading Fluency + SL parameter (training)



Results

Table 2: Fit indices for SEM models 1 and 2 in training test

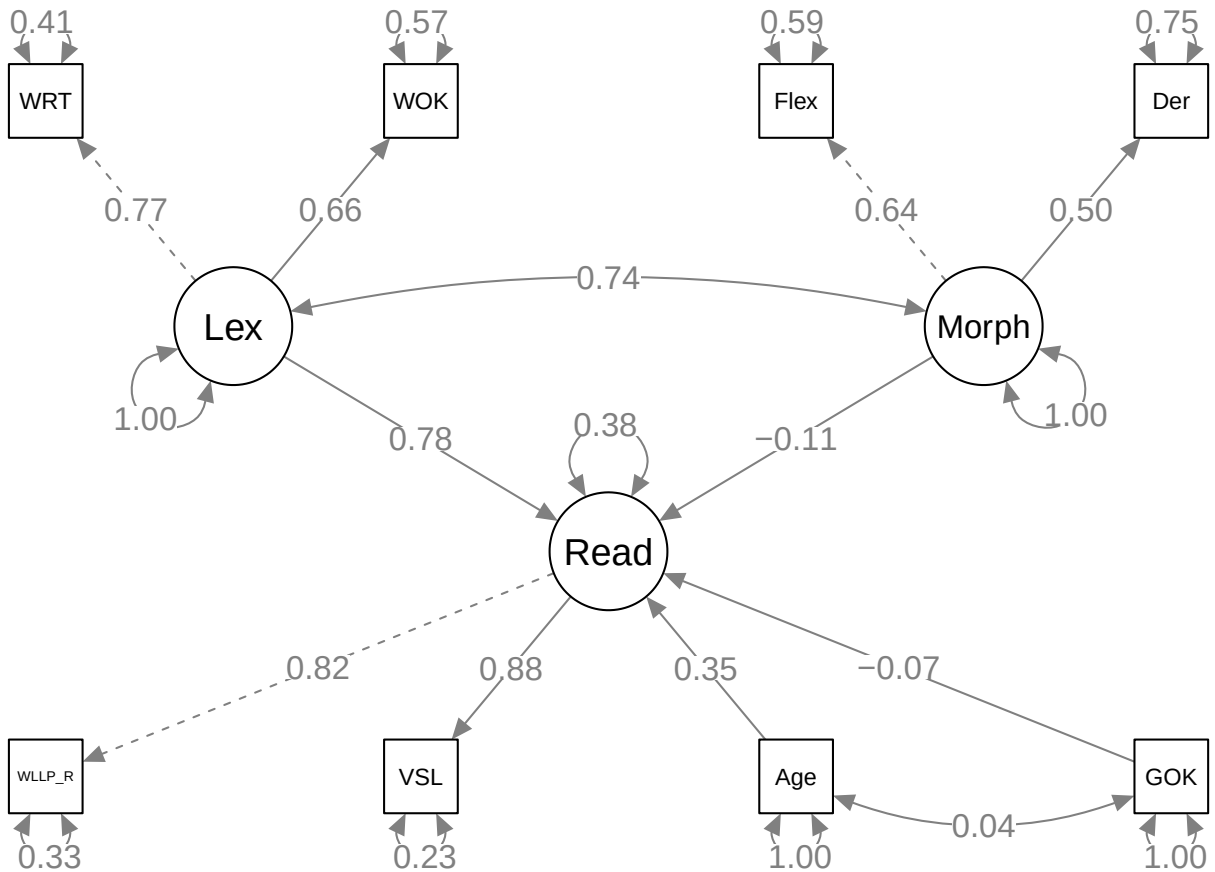
	fit_model1a_M	fit_model2a_M
chisq.scaled	355.78	354.31
df.scaled	16.00	15.00
pvalue.scaled	0.00	0.00
cfi.robust	0.92	0.92
rmsea.robust	0.10	0.11
srmr_bentler	0.08	0.08

Table 3: Scaled Chi-Squared Difference Test

	Df	AIC	BIC	Chisq	Chisq diff	Df diff	Pr(>Chisq)
fit_model2a	15	93395.78	93514.51	374.523	NA	NA	NA
fit_model1a	16	93398.58	93511.66	379.323	3.99	1	0.046

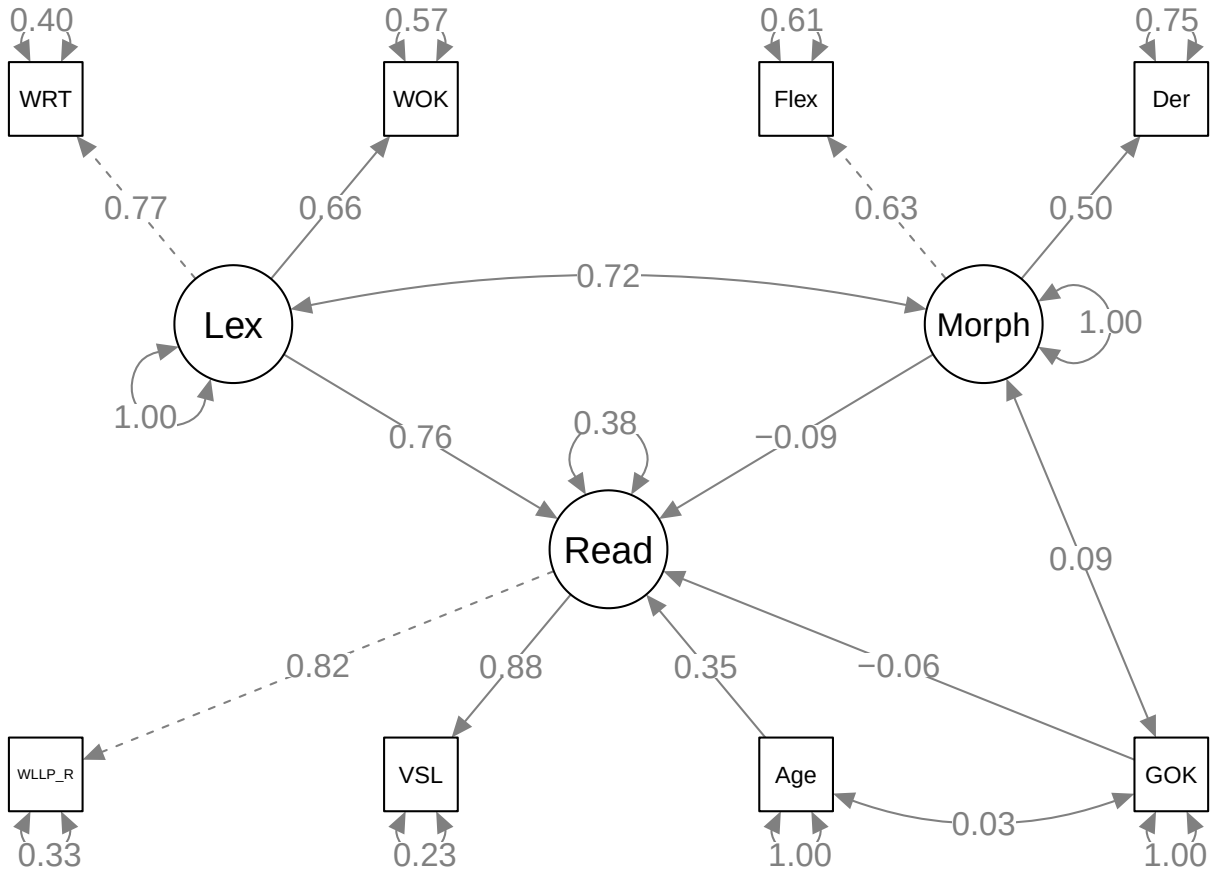
Results

SEM 1. Predicting Reading Fluency (testing)



Results

SEM 2. Predicting Reading Fluency + SL parameter (testing)



Results

Table 4: Fit indices for SEM models 1 and 2 in testing test

	fit_model1b_M	fit_model2b_M
chisq.scaled	99.99	97.92
df.scaled	16.00	15.00
pvalue.scaled	0.00	0.00
cfi.robust	0.90	0.90
rmsea.robust	0.11	0.11
srmr_bentler	0.09	0.08

Table 5: Scaled Chi-Squared Difference Test

	Df	AIC	BIC	Chisq	Chisq diff	Df diff	Pr(>Chisq)
fit_model2b	15	22706.31	22795.44	111.669	NA	NA	NA
fit_model1b	16	22706.46	22791.34	113.812	1.94	1	0.164

In summary

MA task

- CFA: Best fit for 2-dimensional structure (F1: Inflection, F2: Derivation -2 items).

Does MA, lexical processing, GOK, and age positively predict reading fluency?

- Only lexical processing & age.

Testing for SL in a novel way using SEM: additional parameter for a correlation between MA and GOK.

- No intervention of an SL mechanism. Same fit in two models using both datasets.
- Could not fully cross-validate models: SL parameter significant in training set but not in testing set.

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