Working Memory and Language
A latent variable longitudinal study

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Introduction
Links between working memory and phonological awareness with vocabulary acquisition, language comprehension and reading have been widely reported (e.g., Jong & van der Leij, 1999; Gathercole & Alloway, 2008).

The central executive and the phonological loop components of the working memory model have been found to make significant contributions to language learning.

Despite extensive research in the area, the specific associations between working memory, phonological awareness, and language are not fully understood and remain the subject of debate.

Method
Summary
Central executive, phonological loop, phonological awareness, native and foreign vocabulary knowledge, language comprehension, and reading were investigated longitudinally in a population of children growing up in Luxembourg - a country in which Luxembourgish is mainly used in social interactions, and German and French are instructed in schools.

Participants
119 Luxembourgish speakers with both parents speaking Luxembourgish. Children were assessed in kindergarten and in 1st grade of 15 Luxembourgish schools.

Kindergarten
- 6 years old
- Emphasis on Luxembourgish
- Pre foreign language learners
- Pre readers and writers

1st Grade
- 7 years old
- Luxembourgish: 1 hour / week
- German: 8 hours / week
- Reading and writing in German

Material
Central executive
- Counting recall
- Backwards digit recall

Phonological loop
- Digit recall
- Nonword repetition

Phonological awareness
- Rhyme detection easy
- Rhyme detection diff.
- Alliteration
- Spoonerism

Syntactic comprehension
- Luxembourgish
- German

Expressive vocabulary
- Luxembourgish
- German

Reading
- Letter decision
- Word decision
- Single word reading
- Text reading

Fluid intelligence
- Raven’s matrices

Analyses
Structural Equation Modeling
Model relationships between latent constructs that are not directly observed but relate to observed variables
Reduce measurement error by having multiple indicators per latent variable

Analyses
Bidirectional relationships from Kindergarten to 1st grade solide lines = significant effects; broken lines = insignificant effects
When the autoregressive effects were included, no causal influence of the phonological loop on subsequent vocabulary skills and vice versa were found. In contrast, the strong forward link between the central executive and reading was upheld even when prior reading skills were taken into account. The opposite (i.e., influence of early reading skills on the central executive) was however not the case suggesting that the impact of the central executive on subsequent reading cannot simply reflect an earlier influence of reading on central executive functioning.

Discussion
The findings lend strong support to the position that the phonological loop is one of the main contributors to new word learning in both native and non-native languages by supporting the formation of stable phonological representations of new words in long-term memory. The results point however to a reciprocal relationship between phonological loop functioning and vocabulary acquisition rather than a simple one-way causal association. The phonological loop seems to exert indirect effects on language comprehension and reading via vocabulary knowledge. The central executive appears to make highly specific contributions to reading development. One explanation of these findings is that literacy classroom activities often impose heavy demands on the central executive, the capacity of which therefore has a direct effect on the frequency of task failure or success in these classroom activities which consequently influences the rate of learning. In conclusion, the presented evidence of (a) the stability of individual differences in young children’s working memory capacity and, (b) causal relations of working memory with learning reinforces the value of early screening of working memory abilities to identify children who are at risk of poor academic progress over the coming years.


