Working Memory and Fluid Intelligence in Children

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1. BACKGROUND

Working memory (WM) – the ability to store and manipulate information in the course of ongoing cognitive activities – and fluid intelligence (Gf) – the ability to reason under novel conditions – have been found to be highly related constructs. The underlying nature of the association remains however an issue of controversy. Furthermore, the vast majority of studies have focused on adults: Whether findings from the adult literature can be extended to children remains to be seen. The main aim of the present study was to explore the development of WM and Gf in a population of young children in order to clarify the relationship between these two aspects of fluid cognition.

2. METHOD

Summary

Working memory, verbal short-term memory (STM), and fluid intelligence 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 (6 years), in 1st (7 years), and in 2nd grade (8 years) of Luxembourgish schools.

Socioeconomic status: middle to upper middle class; 100% Caucasian

Tasks

Working memory: complex span tasks
- Counting recall
- Backwards digit recall
Short-term memory: simple span tasks
- Digit span
- Nonword repetition
Fluid intelligence: Raven Coloured Progressive Matrices (CPM)
- Raven A
- Raven AB
- Raven B

Analyses

Confirmatory Factor Analyses (CFA) to explore the structure of WM and Gf in young children: Evaluate adequacy of measurement model. 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.

Hierarchical regression models (HRM) to explore the specific contribution of different WM components to Gf: Latent predictors are entered into the regression equation in a pre-specified order.

3. RESULTS I: Structure of working memory and fluid intelligence

Three-factor CFA models for the different study waves

4. RESULTS II: Links between working memory, short-term memory, and fluid intelligence

For each study wave two sets of hierarchical regression analyses were performed to examine the specific effects of WM and STM to Gf.

After the effects of STM were controlled, the WM residual described additional variance in Gf in all three study waves, accounting for 31% of additional variance in Gf in kindergarten, 32% in first grade, and 77% in second grade. STM in contrast did not make any specific contributions to Gf after controlling for the variance shared with WM.

5. CONCLUSION

The present study has shown that in young children individual differences in verbal STM and WM were distinct, but associated. Whereas WM span task uniquely predict fluid intelligence, assessments of STM did not. These findings suggest that complex WM span task tap into a fundamental aspect of cognition that is shared with measures of fluid intelligence and that might represent the ability to effectively control attention in order to maintain task goal relevant information activated in the face of interference. The study further showed that despite its suggested strong visual perceptual component, the Raven’s Coloured Progressive Matrices was, as in adults, strongly linked to WM. The CPM therefore seems to tap into some higher order cognitive abilities that are shared with complex WM span tasks and are likely to reflect executive attention processes.