Su Yin Ang and Kerry Lee, National Institute of Education, Singapore

Executive Involvement in Visual Short-Term Memory and Working Memory in Children

Abstract

Previous research with adults found visuo-spatial short-term and working memory tasks engage executive resources. This study investigated the differential effects of executive suppression (random number generation, RNG) and articulatory suppression on a visual short-term memory task (Visual Patterns Test) and a visual working memory task (Patterns Memory) in 8- and 11-year-olds. In Experiment 1, executive suppression significantly impaired performances on both memory tasks, and the older children were more affected in the dual task condition. In Experiment 2, articulatory suppression impaired performances on both visual memory tasks, and all the children were affected equally in the dual task condition. These results suggest short-term and working memory performances are dependent on executive resources. The findings are consistent with the hypothesis that though the older children performed better than the younger children, they were more affected by suppression effects because they were more likely to employ cognitive strategies which engaged executive and phonological resources.

Introduction

• Working memory refers to a system that provides temporary storage and simultaneous processing or manipulation of information (Baddeley & Hitch, 1974).

Central executive - domain-free, controls and co-ordinates "slave" systems. 
Visual-spatial sketchpad - stores or maintains of visual and spatial information. Divided into visual (cache) and spatial (inner scribe) subcomponents (Logie, 1995). 
Episodic buffer - combines and stores information from long-term memory and short-term memory in episodic representations. 
Phonological loop - stores and rehearses verbal and auditory information.

• Study focused only on the development of the visual subcomponent. 
• Separation between short-term memory and working memory may not be as clear in the visual-spatial domain as it is in the verbal domain (Miyake et al., 2001). 
• Visual-spatial memory tasks may place higher demands on the central executive (Baddeley, 1996). 
• Adult dual-task studies have found random generation tasks impair performances on visual short-term and working memory tasks (Salway & Logie, 1995; Rudkin et al., 2007; Hamilton et al., 2003).

Experiment 1

• Dual-task paradigm; paired the RNG task with visual memory tasks. 
• It was expected that though older children might have a capacity advantage over younger children, under dual task conditions, the older children would likely be more affected by interference tasks that tap on the same resources required for the cognitive strategies they were more likely to employ.

Method

Participants and Design

• 61 8-year-olds: 28 boys; 45 11-year-olds: 24 boys. 
• 2 (age: 8-year-olds versus 11-year-olds) × 2 (task condition: single versus dual task conditions) × 2 (task type: Visual Patterns Test versus Patterns Memory Test).

Materials and Procedure

• Short-term memory task - Visual Patterns Test 
• Working memory/complex span task - Patterns Memory task

Results and Discussion

• Significant interaction effect between task condition and age (F(1,104) = 8.36, p < .01, partial η² = .07).
• Bonferroni-corrected t-tests showed performances on both the Visual Patterns Test and the Patterns Memory task were significantly impaired in the dual task condition, t = 4.80 and t = 9.07 respectively, p < .001.
• Analysis of the RNG task showed little evidence of a strategic trade-off in the dual task situations.

Experiment 2

• The first experiment suggests that executive resources are utilised in both visual short-term and working memory tasks in children. 
• To rule out the possibility that the impairment was simply caused by having to perform two concurrent tasks, an articulatory suppression task was paired with the visual tasks in this experiment. 
• Previous findings on the effect of articulatory suppression have been mixed (Hamilton et al., 2003; Pickering et al., 2001). 
• It was expected that the articulatory suppression task would impair performance but to a lesser extent than that by the executive suppression task.

Results and Discussion

• Main effects of the ANOVA were significant. 
• Finding suggests both groups of children were employing phonological recoding while performing the tasks (Palmer, 2000; Van Leijenhorst et al., 2007). 
• Data from both experiments analysed together showed: 
  - Impairment was not caused by performance of two tasks together because the RNG task affected performance on the Patterns Memory task more. 
  - The older children were more affected by the suppression tasks regardless of the type of tasks they were performing. 
  - It could be older children are generally more likely to use cognitive strategies than younger children while performing the visual tasks (Pickering, 2001).

Conclusions

• Impairment of the visual tasks by both executive and articulatory suppression is because the cognitive strategies employed to help encode and maintain mental representations of the patterns involved both executive and phonological resources. 
• Cognitive strategy use is qualitatively different in 8- and 11-year-olds. Older children employ more elaborate cognitive strategies which place a higher demand on executive resources, while younger children employ simpler strategies such as phonological recoding. 
• Developmental changes reflect changes in how the visuo-spatial working memory system interacts with the central executive (Hamilton et al., 2003).

References


Acknowledgements

This study was partially funded by a grant from the Education Research Fund (EP 2/02 KL), a grant from the Centre for Research in Pedagogy and Practice, National Institute of Education (CRP 9/05/KL) and a scholarship from the Singapore Millennium Foundation. We thank all who participated and helped out in this study. For a copy of this poster, please email the corresponding author at suyi47@yahoo.com.sg.