Using Tablets to Assess Working Memory Capacity in School Settings

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Introduction

Working memory (WM) refers to simultaneous storage and processing of information during an ongoing task (Baddeley, 2002). Capacity of domain-general central executive component is not sufficiently assessed by simple span tasks, such as digit span.

- Complex span tasks (e.g., Reading span task, (Daneman & Carpenter, 1980))

WM deficits are observed in broad cognitive impairments, such as SLI and childhood aphasia, and also in genetic syndromes such as Down syndrome (verbal WM) and Williams syndrome (visuo-spatial WM) (Majerus & Van der Linden, 2013).

- WM deficits are common in different learning difficulties such as dyslexia and dyscalculia
- Individual differences in WM capacity are related to academic achievement and scholastic skills, and to children's classroom behavior (Gathercole, Lamont, & Alloway, 2006)

WM is assessed using different types of tasks and batteries:

- Standard paper-and-pencil tests, behavioral ratings (WMRS), computerized test batteries (AWMA)
- Commonly used WM tasks are Complex Span tasks (Reading Span task, Counting Span task), backward span tasks (Digit Span task)

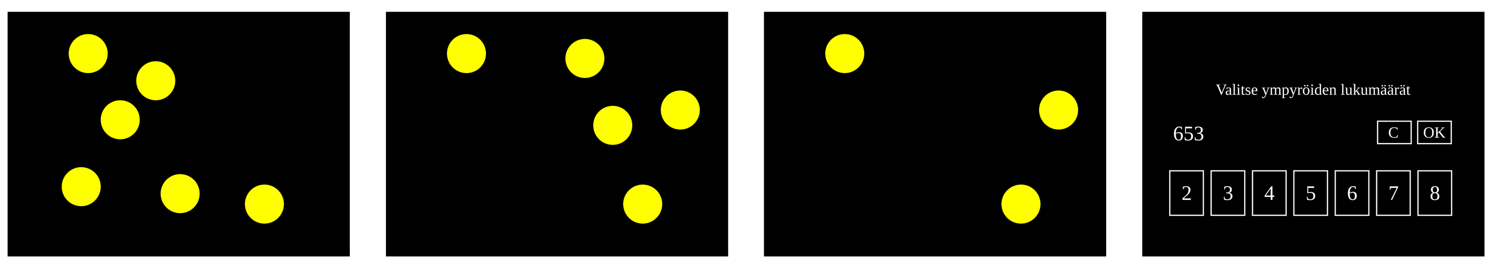

Figure 1: On level three of the Counting span task, the subjects were presented with series like the one shown here followed by a screen asking how many circles were displayed.

Why tablet tasks?

- Self-reliant group testing allows large sample sizes and screening
- Computer-paced WM tasks are better predictor of cognitive performance than self-paced WM tasks (McCabe, 2010)
- Reaction times are more realistic when no mouse is needed
- However, there can be distraction, noise and technical problems in a classroom during assessment

Main Objectives

The aims of the study were to develop self-reliant WM tasks for tablet and to examine (i) the process of using tablets in WM assessment in a classroom in a research setting and (ii) the quality of the developed WM tasks as assessment tools

- Predictive validity: tasks' relationships with scholastic achievement scores
- Concurrent validity: the tasks' relationships with each other and individual WM performance
- The reported distraction in the classroom during the testing
- The effect of class on WM performance

Methods

This study is part of a broader Tikapuu research project which will be reported elsewhere.

Participants

- A total of 705 sixth grade (12-year-old) children from 53 classes in 30 schools (63 testing sessions)
- Subsample of 190 children in individual testing (Digit Span reported here)
- In a testing session there were from 9 to 30 children (mean group size = 18 pupils)

WM span tasks for tablet

- Counting Span task (Figure 1), Reading Span task

Academic Achievement

- Grade Point Average, Math test, Literacy test

Individually administered STM/WM tasks (N = 190)

- Digit Span Forward and Digit Span Backward

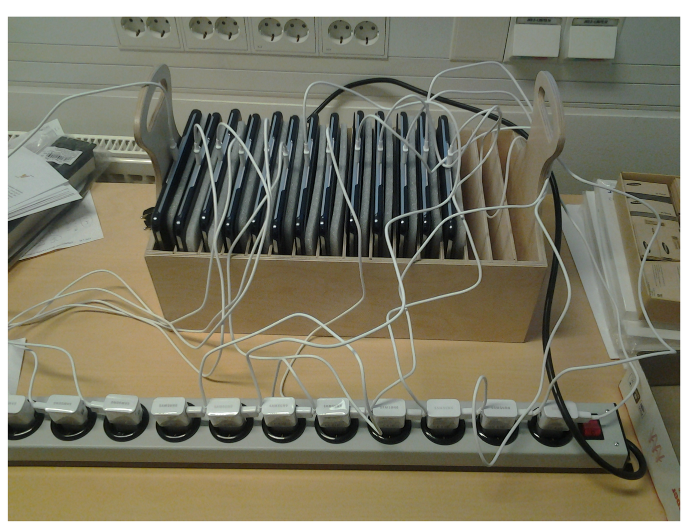

Figure 2: Tablet carrying case and charging station

30 tablets with the experiment application installed were used in 63 testing sessions. To ensure the devices could be used in the sessions without interruption their battery needed to be charged every night. A carrying case was built for the tablets (Figure 2). To ensure no data was lost, the data logs were copied from the tablets by a Raspberry Pi computer into a flash drive.

Tablets used in testing were Samsung Tab 3 (GT-P5210) devices. They were running Android 4.2.2 with minimal set of features turned on. For example, no network connection was needed during the tasks. The tasks were run on top of OpenSesame Runtime for Android (version 2.8.3). The tasks were designed with OpenSesame, an open-source experiment builder (Mathôt, Schreij, & Theeuwes, 2012).

Results

	CountingSpan	ReadingSpan	Literacy	Math	FluidIntelligence
ReadingSpan	0.41***				
Literacy	0.41***	0.45***			
Math	0.46***	0.33***	0.43***		
FluidIntelligence	0.39***	0.32***	0.26***	0.41***	
GPA	0.40***	0.35***	0.44***	0.35***	0.38***

Table 1: Correlations between Tablet tasks and Academic Skills (N=705)

	CountingSpan	ReadingSpan	DigitSpanFw
ReadingSpan	0.33***		
DigitSpanFw	0.33***	0.27***	
DigitSpanBw	0.41***	0.22**	0.43***

Table 2: Correlations between tablet tasks and Wechler's Digit Span Task (N=190)

	Math	Literacy	GPA
CountingSpan	0.36***	0.34***	0.30***
ReadingSpan	0.21***	0.40***	0.27***

Table 3: Partial correlations controlling for Fluid intelligence (N=705)

	Sessions reported	Examples
Related to school	22/63	central radio, school bell
Related to pupil	17/63	asks for help, comes late
Related to teacher	14/63	suddenly enters/leaves the class
No reported distraction	28/63	-
Technical problems	1/705	The screen goes black

Table 4: Classroom distractions, technical problems (by sessions)

- The analyses of interclass correlation (ICC) reveals that in the Reading Span task the ICC = 0.04 and in the Counting Span task the ICC = 0.01. This means that 4 % of the variance in Reading Span task and 1 % of the variance in the Counting span task can be explained with child's class.

Conclusions

The validity and reliability of both tablet tasks are similar to each other and comparable with previous literature (Van de Weijer-Bergsma, Kroesbergen, Jolani, & Van Luit, 2015).

- The results showed positive mutual correlations between two WM tablet tasks. The Counting Span is strongly related to arithmetic, Reading Span strongly with literacy tasks, but both tasks seem to tap the domain-general executive component.
- Both self-reliant tablet tasks correlate with Digit Span tasks, conducted individually. The results show, that Counting span task has higher correlations with both DS tasks than Reading Span task. It might be explained with both involving numerical material to process.
- The correlations remained significant even when Fluid intelligence was taken into account.
- There were distraction in the classrooms during testing, but the data indicate that the child's class had minimal influence on the WM performance
- This study suggests that if standardized properly, WM tablet tasks could be adopted for research and screening purposes. However, for diagnosing WM deficits individually conducted, more broad neuropsychological assessment is needed.

More information: http://geanis.com/tikapuu

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