

# **Executive functions and achievements in school: Shifting, updating, inhibition, and working memory**

Helen L. St Clair-Thompson & Susan E. Gathercole (2007)  
The Quarterly Journal of Experimental Psychology

Presented by: Min Ji Kang

# Abstract

The focus of this study was to investigate the relationship among scholastic attainment, shifting, updating, inhibition, and verbal and visuo-spatial working memory in 11- and 12-year old children.

Using exploratory factor analysis, the result pinpointed updating and inhibition as the 2 main executive functions.

- Updating Abilities → Verbal and Visuo-Spatial Working Memory
  - Verbal working memory ⇒ English
  - Visuo-spatial working memory ⇒ English, Mathematics, and Science
- Inhibition ⇒ English, Mathematics, and Science

# Introduction

- Executive Function: responsible for control and regulation of cognitive processes
  - Central Executive Function:
    - Integrate information from the working memory and long-term memory (updating)
    - Multi-coordination
    - Shifting between tasks (shifting)
    - Attend and Inhibit selectively (inhibition)
- Past studies:
  - Verbal and visuo-spatial working memory linked with education attainment
  - Executive functions (shifting, updating, and inhibition) related to scholastic achievement
  - Poor performance on working memory tasks linked with executive skills ⇒ Below standard in national curriculum assessments for English, math, and science

# Hypotheses

3 main goals:

1. Investigate the extent to which executive functions (shifting, updating, and inhibition) are unitary or separable in children
2. Investigate the executive functions' underlying performance on working memory span tasks
3. Assess the extent to which executive functions contribute to children's learning achievements

# Methods: Tasks

## Plus-Minus Task (shifting)

- Add 3, subtract 3, alternate between adding and subtracting 3 (2 minutes)

## Local Global Task (shifting)

- Global figure (ex. triangle) composed on local figures (ex. squares)
- List the number of lines from the global, local, and alternate (2 minutes)

## Letter Memory Task (updating)

- Recall last 4 letters presented on the screen

## Keep Track Task (updating)

- Recall the last word from each target category at the end of each trial

## Stop-signal Task (inhibition)

- Don't categorize monosyllabic words as animal or non-animal if there are 3 asterisks on the bottom of the word (otherwise, categorize)

## Stroop Task (inhibition)

- Name the color of the string of asterisks
- **BLUE** asked to name the color of the font

# Methods: Tasks cont.

## Listening Recall Task (verbal working memory)

- Hear a series of sentences and asked to judge the veracity of each; at the end of the trial, asked to recall the last word from each sentence

## Backwards Digit Recall Task (verbal working memory)

- Recall a sequence of digits in reverse order

## Odd-one-out Task (visuo-spatial working memory)

- Indicate an odd shape (3 images per trial)

## Spatial Span Task (visuo-spatial working memory)

- Indicate whether each shape was “normal” or a “mirror image” of an original shape that remains on one side of the screen

# Methods

- Participants

- 51 children from England (mean age: 11 years and 9 months)
  - 27 boys, 24 girls

- Procedure

- 6 executive tasks and 4 working memory tasks were given to all participants in the same order to avoid different carry-over effect and other external influence
  - Separated into 3 sessions
- School provided the participants' attainment scores on national curriculum tests in English, math, and science

# Results

- Principal Components Analysis (PCA) (factor loadings > .45 not used)

**Table 3.** *Factor loading scores from principal component analysis of executive measures*

	<i>Factor 1</i>	<i>Factor 2</i>
Plus minus task	.32	<b>.48</b>
Local global task	<b>.65</b>	.19
Letter memory	<b>.78</b>	-.01
Keep track task	<b>.77</b>	.12
Stroop task	-.15	<b>.86</b>
Stop signal task	.16	<b>.79</b>

*Note:* Values in bold are in excess of .45.

Due to both shifting tasks exceeding the value of .45 in Factor 1, data for those tasks were not used for further analysis.



# Results

- Principal Components Analysis (PCA) (factor loadings > .45 not used)
  - Excluding both shifting tasks and including the 4 working memory tasks

**Table 4.** *Factor loading scores from principal component analysis of executive tasks and working memory measures*

	<i>Factor 1</i>	<i>Factor 2</i>
Letter memory	<b>−.82</b>	−.07
Keep track task	<b>−.70</b>	.18
Stroop task	.06	<b>.81</b>
Stop signal task	−.11	<b>.85</b>
Listening recall	<b>.71</b>	.08
Backwards digit recall	<b>.71</b>	.07
Odd-one-out task	<b>.83</b>	−.15
Spatial span	<b>.68</b>	−.41

Clear split suggests that updating abilities are closely linked to performance on both verbal and visuo-spatial working memory tasks.

*Note:* Values in bold are in excess of .45.

# Results

- Partial Correlation Coefficients

**Table 5.** *Partial correlation coefficients between executive functions, working memory, and scholastic attainment*

<i>Function partialled out</i>	<i>Executive function</i>		<i>Working memory domain</i>	
	<i>Working memory</i>	<i>Inhibition</i>	<i>Verbal</i>	<i>Visuo- spatial</i>
	<i>Inhibition<sup>a</sup></i>	<i>Working memory<sup>a</sup></i>	<i>Visuo- spatial<sup>a</sup></i>	<i>Verbal<sup>a</sup></i>
English	.62**	.31*	.33*	.42**
Mathematics	.45**	.36*	-.10	.50**
Science	.19	.34*	-.19	.35*

<sup>a</sup>Function partialled out.

\* $p < .05$ ; \*\* $p < .01$ .

Inhibition  $\Rightarrow$  English, Math, and Science (all  $p < .05$ )

Verbal Working Memory  $\Rightarrow$  English ( $p < .05$ )

Visuo-Spatial Working Memory  $\Rightarrow$  English, Math  
(both  $p < .01$ ), and Science ( $p < .05$ )

# Discussion/Conclusion

Goal #1: Investigate the extent to which executive functions (shifting, updating, and inhibition) are unitary or separable in children.

- Updating and inhibiting are unrelated
  - Supports past research that inhibition is dissociable from other executive functions
- Failed to identify shifting as a third executive function
  - Different from a study done with a sample of adults (Miyake et al. 2000)
    - Suggests less mental flexibility in young children

# Discussion/Conclusion

Goal #2: Investigate the executive functions' underlying performance on working memory span tasks.

- Both verbal and visuo-spatial working memory share a common association with updating skills but not with inhibitory processes
  - Worthy to note that all of the working memory tasks were non-verbal while most of the updating tasks were verbal
    - Possible direction for future study:
      - Investigate additional domain-specific components that can explain the relationship between working memory and updating functions.

# Discussion/Conclusion

Goal #3: Assess the extent to which executive functions contribute to children's learning achievements.

- Inhibition related to attainment in English, math, and science
  - Result consistent with previous research findings
- Beneficial to help structure educational settings for young children
  - Various activities used in classrooms require simultaneous process and storage of information as well as executive functions
  - Reduce learning activities that overload working memory to enhance learning for children with a poor working memory function

**Thank you for listening!**

# Effects of working memory training on reading in children with special needs

{Karin I. E. Dahlin (2011)}

{Reading and Writing}

Presented by {Soomin Cho}

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1. Abstract
2. Introduction
3. Hypothesis
4. Methods
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6. Discussion



# 1. Abstract

Purpose: Working memory of children with special needs could be enhanced by a cognitive training program

Hypothesis: **High correlations** between working memory and reading comprehension skills

Methods: **Neuropsychological** measures and **Reading** measures

Results: Working memory works as a crucial factor in the reading development

## 2. Introduction

### Past

- Working memory has a limited capacity

### Present studies

- children with ADHD may benefit in their behavior from working memory training
- Increased brain activity is associated with working memory functions

# 3. Hypothesis

- Working Memory ability would **increase** through the training with **a positive effect** on children's reading comprehension skills

# 4. Methods

- Fifty-seven children with special education needs

# 4. Methods

## 4-1. Neuropsychological Measures

- A. Nonverbal reasoning ability
- B. Verbal working memory
- C. Visual-spatial working memory
- D. Response inhibition

# 4. Methods

## A. Nonverbal reasoning ability

- a. Raven's Coloured Progressive Matrices

## B. Verbal working memory

- a. Digit Span

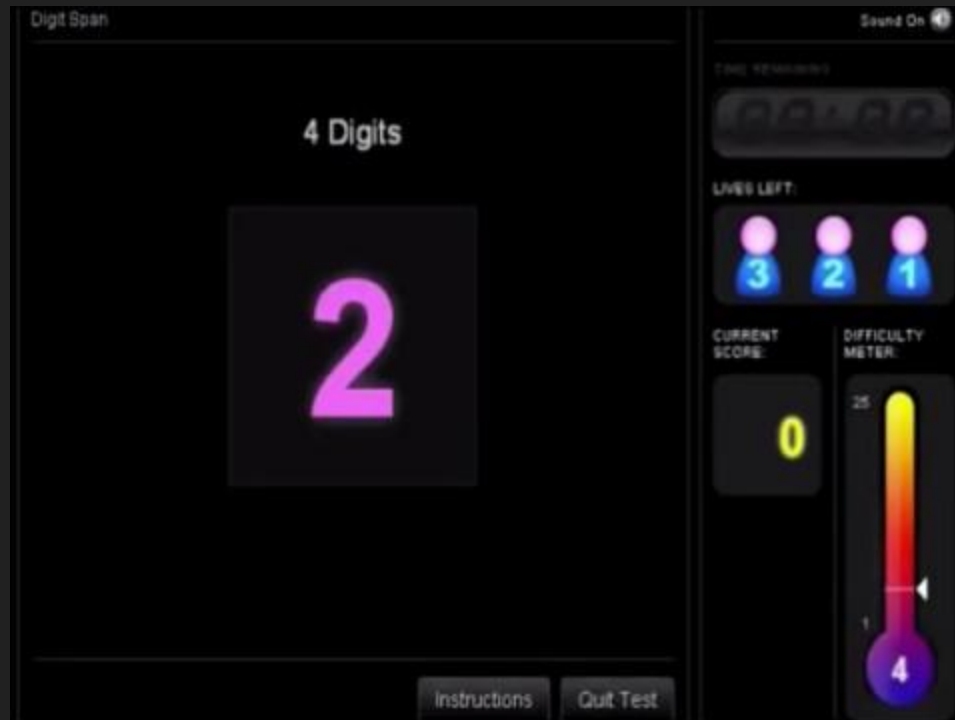
## C. Visual-spatial working memory

- a. Span Board

## D. Response inhibition

- a. Stroop

# Digit Span



# Spatial Span





# Stroop

RED BLUE PURPLE YELLOW  
BLACK GREEN PURPLE ORANGE  
RED GREEN BLACK BLUE  
YELLOW PURPLE PURPLE RED  
ORANGE PURPLE BLUE GREEN  
BLACK BLACK ORANGE RED

# 4. Methods

## 4-2. Reading Measures

- a. Reading comprehension
- b. Word decoding
- c. Orthographic knowledge

# 4. Methods

## A. Reading Comprehension

- a. Narrative texts from the Progress in International Reading Literacy Study

## B. Word Decoding

- a. the Phonological non-word reading test

## C. Orthographic knowledge

- a. The Orthographic verification test

# 4. Methods

## 1. Completing a set of assessments

- a. nonverbal reasoning
- b. working memory
- c. Reading

## 2. Within the same time intervals

- a. Pre-test
- b. post-test, 5–6 weeks later
- c. Post-test, 6–7 months later.

# 5. Results

- The effect of training was tested by **comparing the outcome score at post-test** in the treatment group scores **at pre-test**.
- Four measurements were improved
  - Span Board forward
  - Span Board backward
  - Digit backward
  - Nonverbal problem solving (Raven)

# 5. Results

- The treatment group enhanced its results of working memory measures
- The WM measures Span board forward and back were related to reading comprehension
- Comparison of the experimental group with an additional control group showed that the training indeed enhanced children's working memory.

# 6. Discussion

## 1. Limitation

- a. a **large difference in size** between the treatment group and the control group
  - i. including more children in the treatment group.

## 2. Practical Implication

- a. WM training may **facilitate** reading comprehension processes **directly**, and not via improvements in word-level reading processes.

Thank you

For Your Attention



# How Does Fiction Reading Influence Empathy? An Experimental Investigation on the Role of Emotional Transportation

P. Matthijs Bal, Martijn Veltkamp (2013)

PloS one

Presented by Kahyun Kim

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1. Abstract
2. Introduction
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# 1. Abstract

This study examined whether **fiction reading** has an effect on the reader's **empathy** by conducting two experimental studies. The researchers predicted that if readers read **fiction** and they were **emotionally transported** into the story, then they would become **more emphatic**. The participants self-reported by filling out several scales after reading either the fiction or the non-fiction text. The results indicated that their **hypothesis was supported** and that empathy was influenced for over a period of one week. No effect was found for non-fiction (control condition) readers.

## 2. Introduction

- Reading books is one of the activities that people perform in their daily lives
- Fictional narrative experience may affect how people feel in their daily lives (e.g., providing personal insights)
- Fiction is correlated with empathy
- Question: Does **reading fiction** really cause to **higher empathy** or is it that highly emotional people tend to read more fiction?

Reference: Oatley K (2002) Emotions and the story world of fiction. In Green MC, Strange JJ, Brock TC, editors. Narrative Impact. Social and Cognitive Foundations. Mahwah: Lawrence Erlbaum. 39–70.

### 3. Hypothesis

Reading **fiction** is **correlated** with **empathy**, as long as the reader is **emotionally transported** into the text.

# 4. Methods

## Materials

- Computer

### Study 1

- Fiction: *The Adventures of the Six Napoleons* by Arthur Conan Doyle
- Control: *De Volkskrant*, the Dutch newspaper

### Study 2

- Fiction: *Blindness* by José Saramago
- Control: *NRC Handelsblad*, the Dutch newspaper

# 4. Methods

## Materials

- Scale from ***Bussele and Bilandzic*** (emotional transportation)
- The empathic concern scale of **Davis** (empathy)
- Scales from **Djikic** et al. (positive emotions and negative emotions)
- ***Narrative Understanding scale*** (comprehension)
- ***Attentional Focus scale*** (attention)

# 4. Methods

## Participants

### Study 1

- 66 Dutch undergraduate students
  - 36 fiction, 30 control
  - 52% female

### Study 2

- 97 Dutch undergraduate students
  - 50 fiction, 47 control
  - 74% female



# 4. Methods

## Procedure

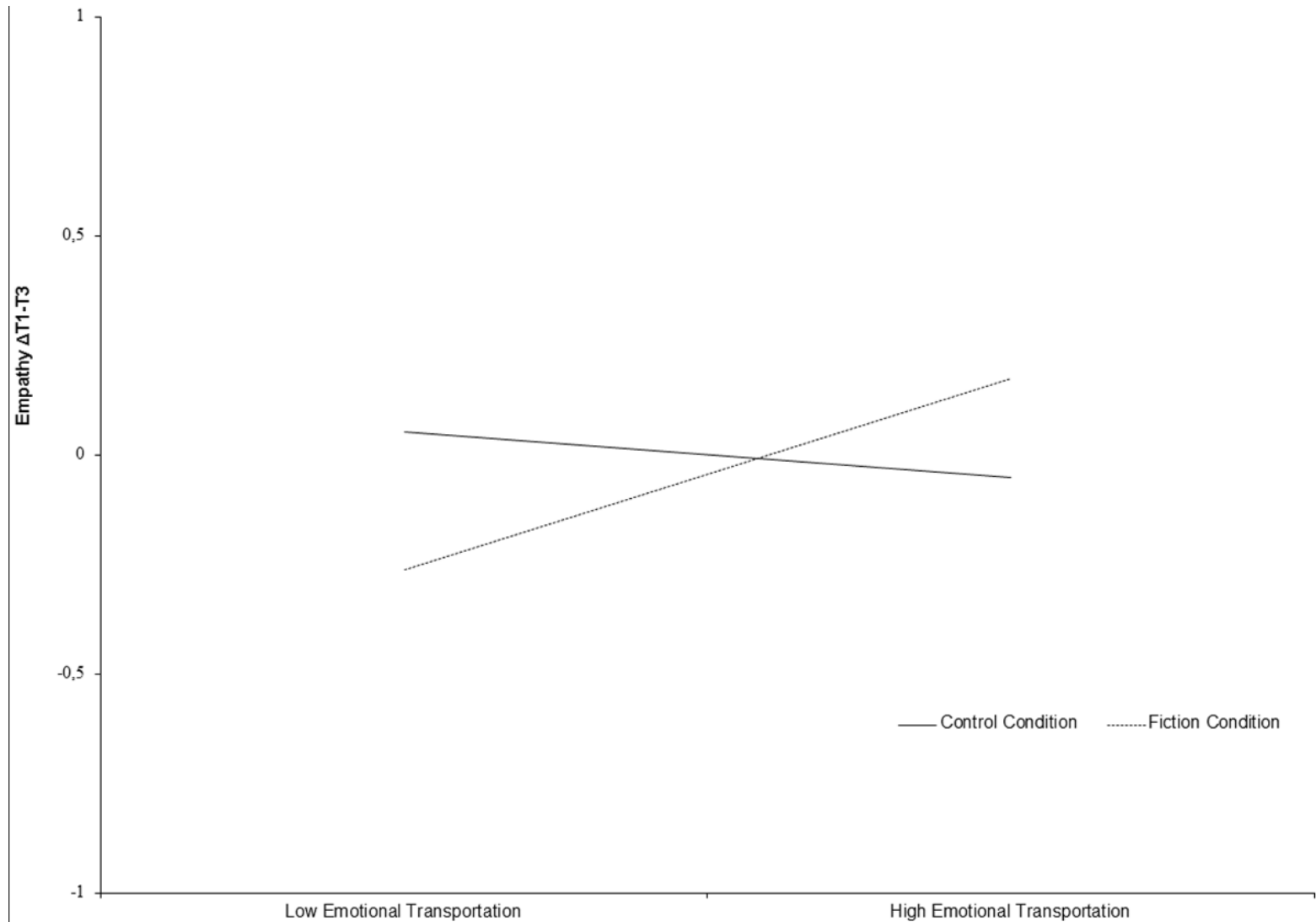
- In T1: Demographic variables, a range of study irrelevant scales, the empathy scale
- Read either newspaper/fictional book for one week
- In T2: self-report
  - Study 2: controlled for positive and negative emotions
- Write down summary
- In T3: fill out digital questionnaire, the empathy scale, irrelevant scales

# 5. Results

## Study 1

- Empathy (T1) was a strong predictor of empathy (T3) ( $p < 0.01$ ).
- Narrative understanding, attentional focus, emotional transportation were unrelated to empathy (T3).
- Low transportation, low empathy (fiction)
  - Hypothesis supported

# 5. Results



# 5. Results

## Study 2

- Narrative understanding, attentional focus, emotional transportation were **unrelated** to empathy (T3).
- While readers became lower in empathy, when transportation **increased** somewhat, empathy **increased** as well (**fiction**)
- Readers who were **low** in transportation, the effect was **negative (non-fiction)**
  - Hypothesis partially supported

## 6. Discussion

- In Study 1, empathy was enhanced
- In Study 2, low transportation led to lower empathy
- Effects not attributed to difficulty of texts and positive or negative emotions

