

Developmental impairments of working memory:

Implications for learning

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Key features of working memory

- Capacity to hold material in mind and manipulate as necessary for brief period
- Mental workspace
- Limited in capacity
- Catastrophic loss
- Large degree of individual variation





Assessing working memory

Typically, use complex memory span tasks

Listening span

Series of spoken sentences: child makes true/ false judgment, then recalls final word of each sentence

e.g., *lions have four legs* *true*
 grass is yellow *false*

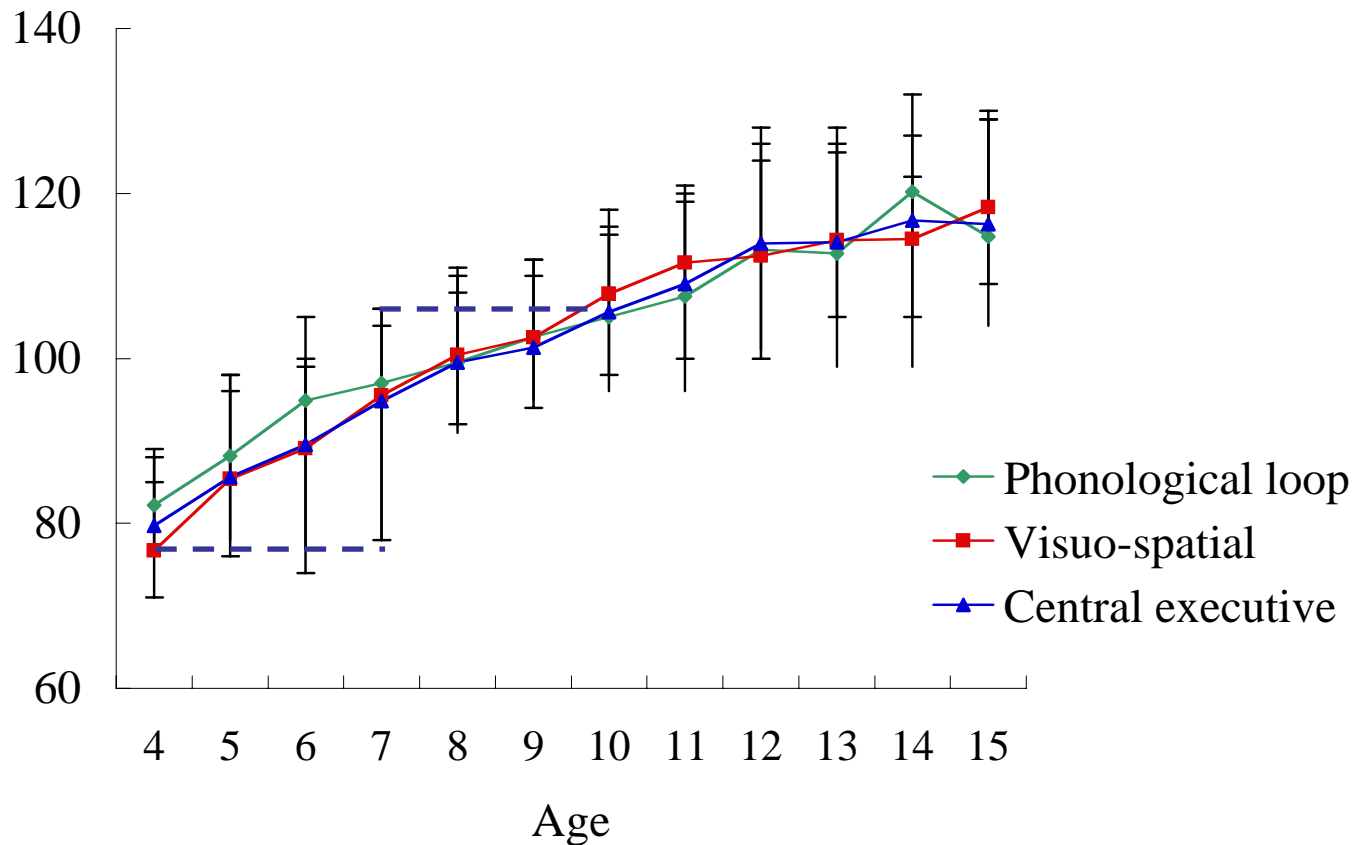
Recall: legs, yellow

Working Memory Test Battery for Children

Automated Working Memory Assessment (AWMA)



Age-related increase in working memory scores, with 10th and 90th centile points



CRPDN, Sydney, March 2006



WORKING MEMORY and LEARNING



Working memory and learning

WM skills closely associated with the academic attainments, particularly in literacy and mathematics.



Working memory and attainments in English and mathematics

Gathercole, Pickering, Knight, & Stegmann (2004)

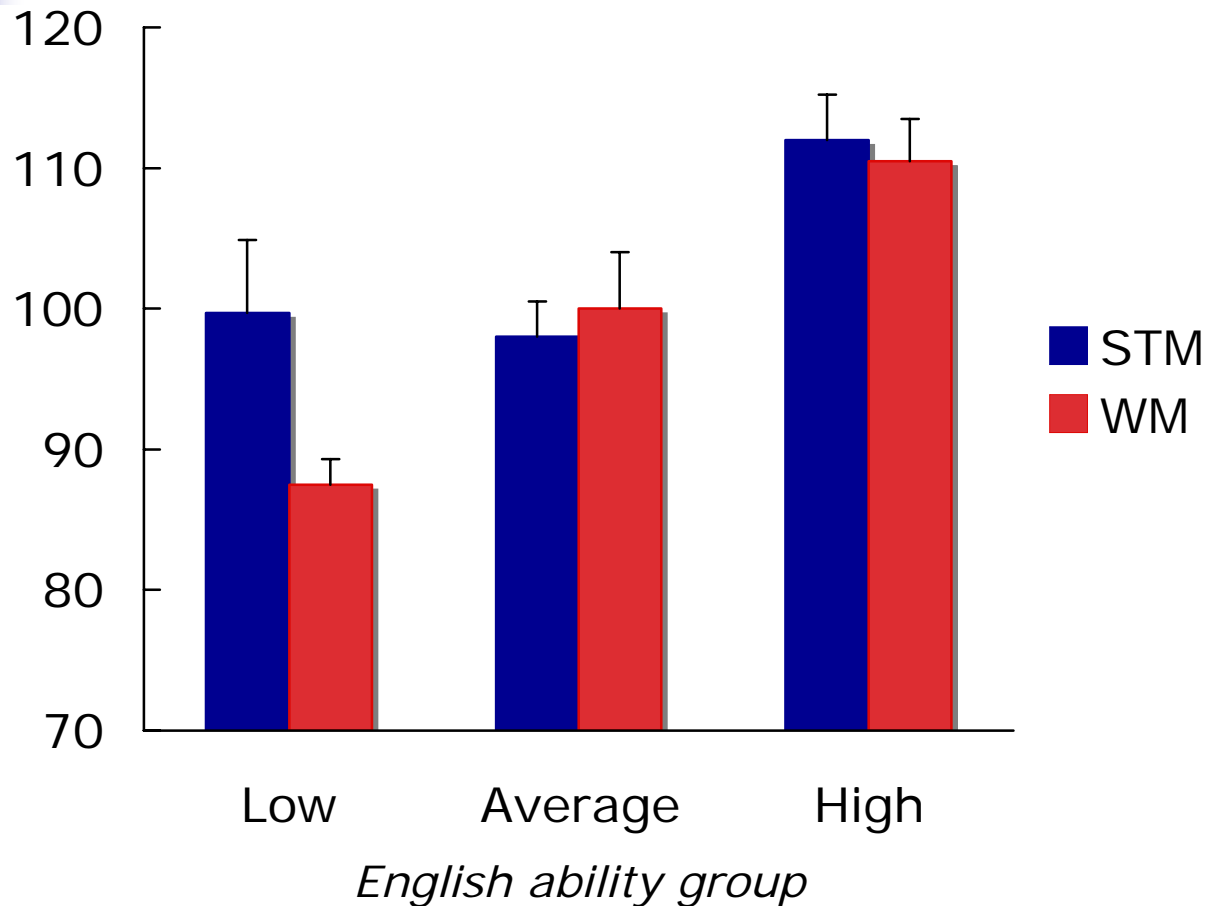
Assessed working memory in children with varying levels of attainments on National Curriculum Tests @ 7 & 14:

- Below national average
- Average
- Above national average



Gathercole, Pickering, Knight & Stegmann(2004)

Mean standard short-term and working memory scores by English attainment groups: Data from 7-year olds



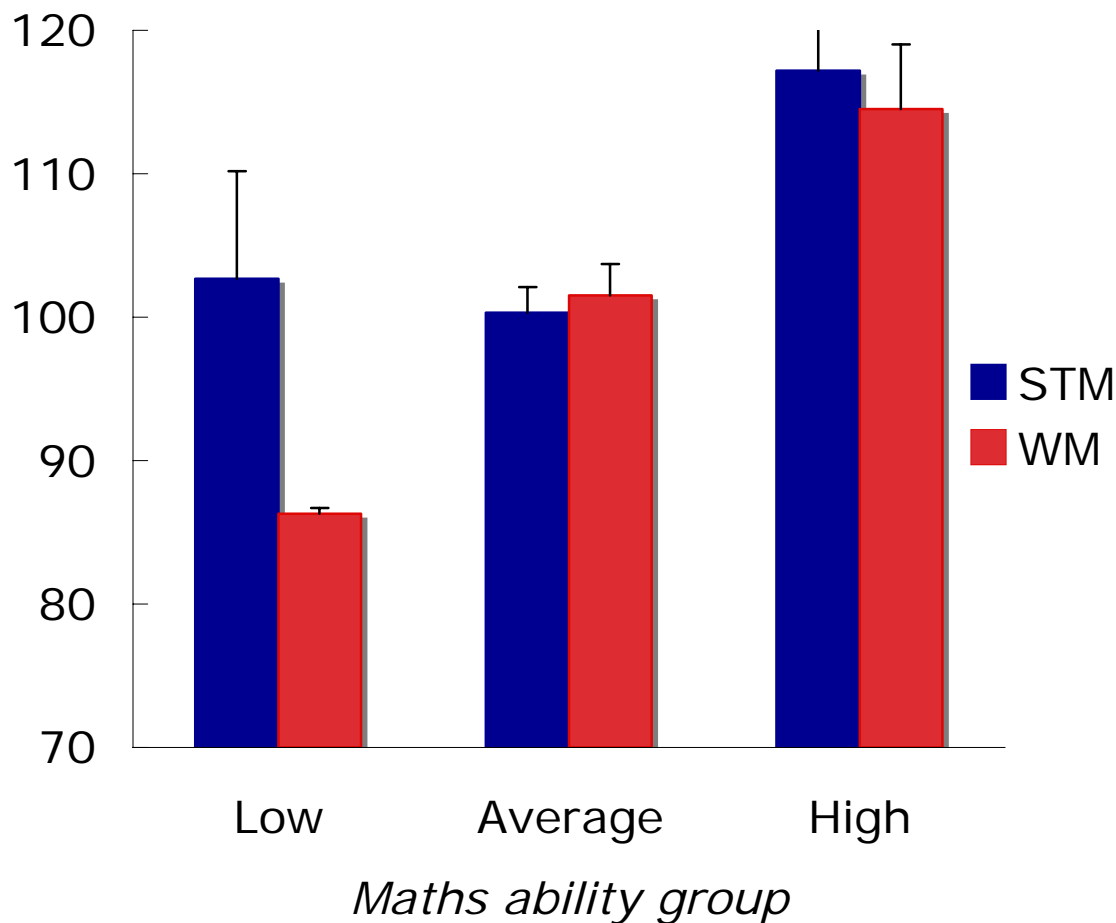
CRPDN, Sydney, March 2006



WORKING MEMORY and LEARNING

Gathercole, Pickering, Knight & Stegmann(2004)

Mean standard short-term and working memory scores by maths attainment groups: Data from 7-year olds



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WORKING MEMORY and LEARNING

Working memory and learning difficulties (1)

Pickering & Gathercole (2004)

- 98 children in standardisation sample of *WMTB-C†* with special educational needs
- WM profiles classified by area of need identified by school

†Working Memory Test Battery for Children

Pickering & Gathercole, 2001





Pickering & Gathercole (2004)

Mean standard working memory scores by area of learning difficulty:

Language	77
Literacy & maths	80
Literacy only	93
Behaviour	99



Working memory and learning difficulties (2)

Gathercole, Alloway, Adams & Willis (2006)

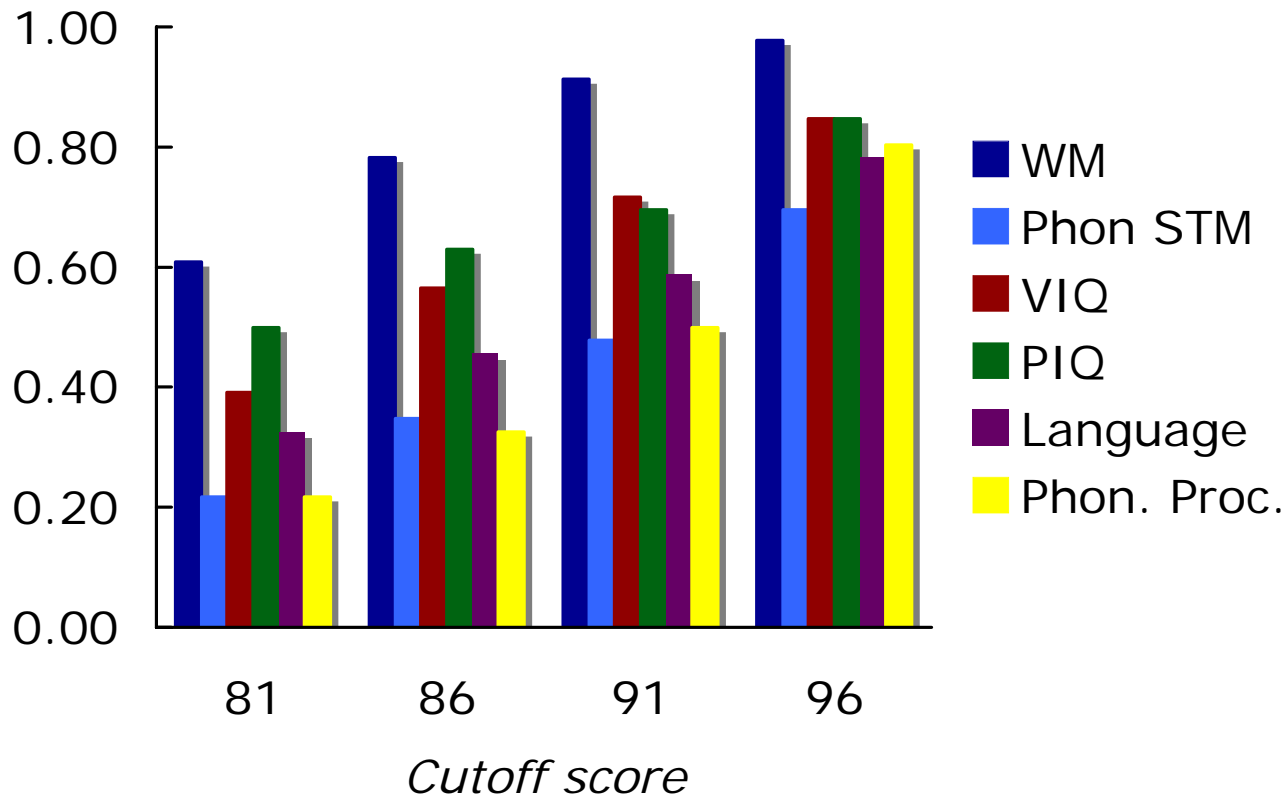
46 children identified as having reading difficulties

Assessed: IQ, maths, language, working memory, verbal STM, phonological awareness

- *Are working memory deficits characteristic of these children?*
- *Are working memory deficits predictive of severity of learning difficulties, or are they a proxy for general verbal impairments?*



Proportions of children failing to reach cutoff scores



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WORKING MEMORY and LEARNING

Multiple regression: dependent variable reading score

<i>Predictor</i>	<i>stand. β</i>
Working memory	.347*
Verbal IQ	-.159
Performance IQ	.026
Phon. awareness	.206
Language	.427*

* $p < .05$



Multiple regression: dependent variable maths score

<i>Predictor</i>	<i>stand. β</i>
Working memory	.339*
Verbal IQ	.280
Performance IQ	.024
Phon. awareness	.181
Language	.072

* $p < .05$



Why is working memory crucial to learning?



Do the children struggle to learn because they are unable to meet the working memory demands of learning activities?



Observing working memory in the classroom*

- Children identified as having very poor working memory capacities but average IQ and verbal STM at school entry
- Observed for one week in their classrooms a year later, at 5/6 years.
- Focus on identifying learning situations in which the children's failures could be due to working memory overload.

* *Gathercole, Lamont & Alloway (2006)*



Behavioural profiles of children with working memory impairments

- Typically in the low ability groups in both literacy and numeracy
- Normal social integration
- Reserved, rarely volunteer information
- Good insights into their own memory failures
- Often viewed by teachers as having poor attention
 - “He’s in a world of his own”
 - “He doesn’t listen to a word I say”



Situations in which children with working memory impairments often fail

- Forgetting instructions



Situations in which children with working memory impairments often fail

- Forgetting instructions

“Put your sheets on the green table, arrow cards in the packet, put your pencil away and come and sit on the carpet”



Situations in which children with working memory impairments often fail

- Forgetting instructions
- Keeping track in complex tasks



Situations in which children with working memory impairments often fail

- Forgetting instructions
- Keeping track in complex tasks
 - In writing, a child will often:
 - Lose his/her place
 - Repeat or omit letters
 - Abandon the task



Situations in which children with working memory impairments often fail

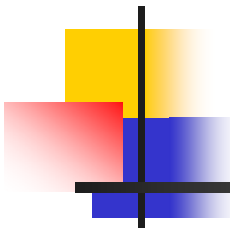
- Forgetting instructions
- Keeping track in complex tasks
- Unable to meet the demands of tasks that involve both storage and processing of information



Situations in which children with working memory impairments often fail

- Forgetting instructions
- Keeping track in complex tasks
- Unable to meet the demands of tasks that involve both storage and processing of information
 - Counting words in a sentence
 - Using number lines
 - Detecting missing numbers in a sequence





Working memory and following instructions

Gathercole, Evans, & Pratt (in prep.)

31 5/6 yr old children, assessed on digit recall (STM), backwards digit recall (WM), Raven's CPM, and *Conner's Teacher Rating Scale*

Measures of sentence processing

- abilities to follow simple instructions of varying length (e.g., *put the yellow ball on the blue ruler*)
- abilities to repeat instructions





Correlation coefficients

	STM	WM	Raven
Instruction repetition	.02	.19	.16
Instruction action	.21	.60**	.22
Oppos. behaviour	.04	-.38*	.01
Cog defic./ inattention	.08	-.53*	-.57**
Hyperactivity	-.12	-.43*	.02
ADHD index	.09	-.39*	-.18

Scores on the Conners' scales in blue



Attentional profiles: children achieving atypical Conners' scores

Scale	WM deficit n=9	No Wm deficit n=22
Oppositional behaviour	1 (.11)	0 (.00)
Cognitive deficits/ inatt.	7 (.78*)	6 (.27*)
Hyperactivity	2 (.22)	1 (.05)
ADHD index	4 (.44*)	2 (.09*)

WM deficit: BDR < 85

* $p < .01$, χ^2



A bottleneck for learning?

- Learning is an incremental process based on successes in individual learning episodes. Failures impede successful learning.
- Children with poor working memory capacities appear to fail often because they cannot meeting working memory demands of learning activities.



How can learning be enhanced in children with working memory deficits?

- No evidence that basic WM capacities can be trained
- An alternative approach:
Effective classroom management designed to avoid working memory overload
- Project team: Joe Elliott, Tracy Alloway, Hannah Kirkwood





Aims of the intervention

- Promote understanding of working memory and its constraints in teaching staff, via written guidance material (*Understanding working memory: A classroom guide*) and workshops

*Understanding Working
Memory:*

A Classroom Guide

Professor Susan E. Gathercole

&

Dr Tracy Packiam Alloway





Aims of the intervention

- Promote understanding of working memory and its constraints in teaching staff, via written guidance material (*Understanding working memory: A classroom guide*) and workshops
- Encourage teaching staff to structure learning activities for children with poor working memory function to avoid excessive working memory demands
- Develop effective strategies in children with low working memory skills





Principles of the intervention

- Recognise working memory failures in the classroom
- Monitor the child
- Reduce working memory loads if necessary
- Frequently repeat important information
- Encourage the child to use memory aids
- Develop the child's use of memory-relieving strategies





Summary

- Impairments of working memory closely associated with learning difficulties of a relatively general nature.
- Poor working memory function appears to prevent effective learning, possibly due to overload.
- Effective management of working memory loads during learning activities may be a valuable way of boosting learning achievements in low working memory children.





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