Developmental differences in children's use of visual and phonological representations in working memory

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18th Advanced Course

Archives Jean Piaget

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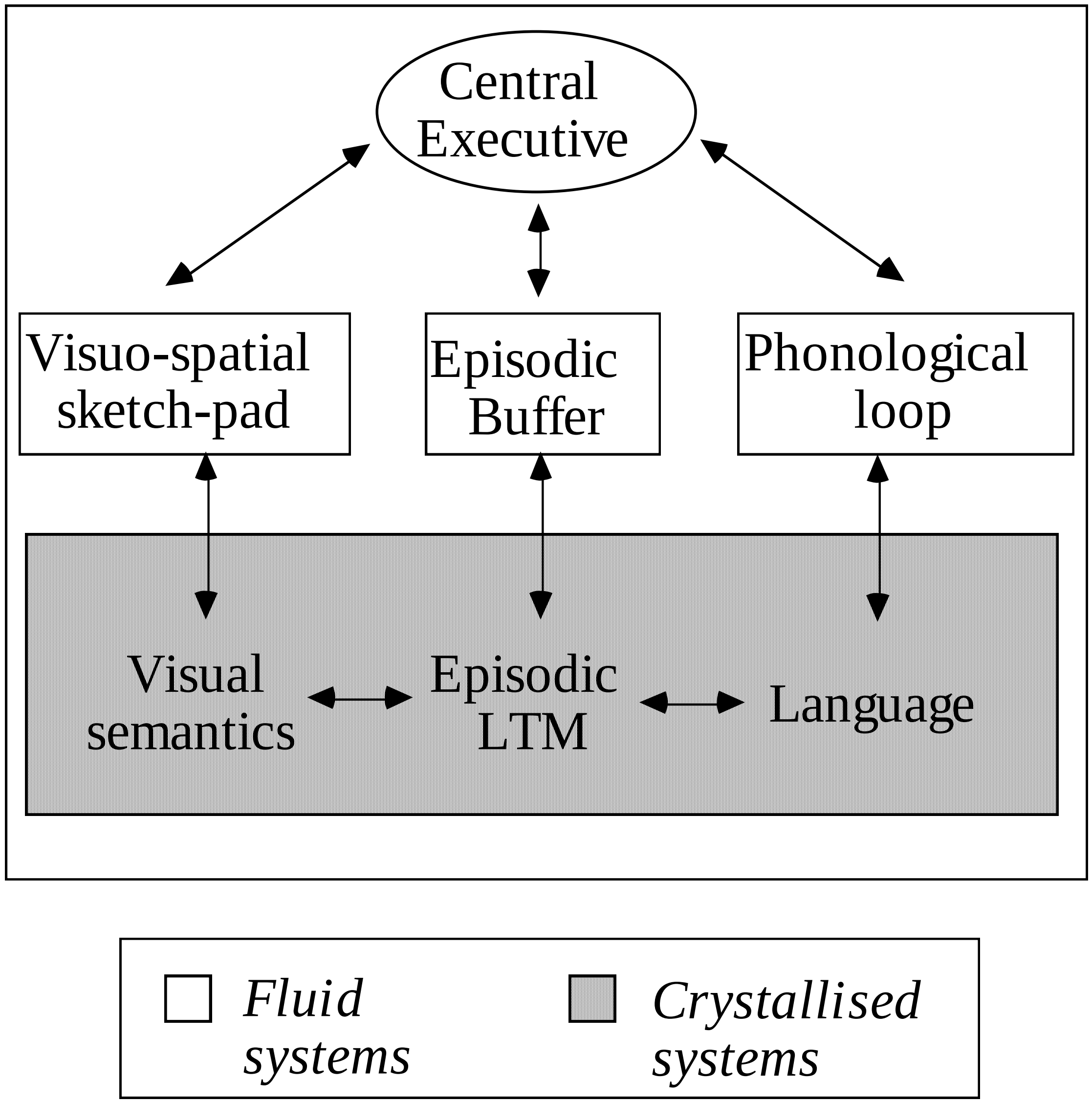
Revised model of working memory *(Baddeley, 2000)*



WM model complementary to neo-Piagetian approaches?

Kemps, De Rammlelaere & Desmet (2000)

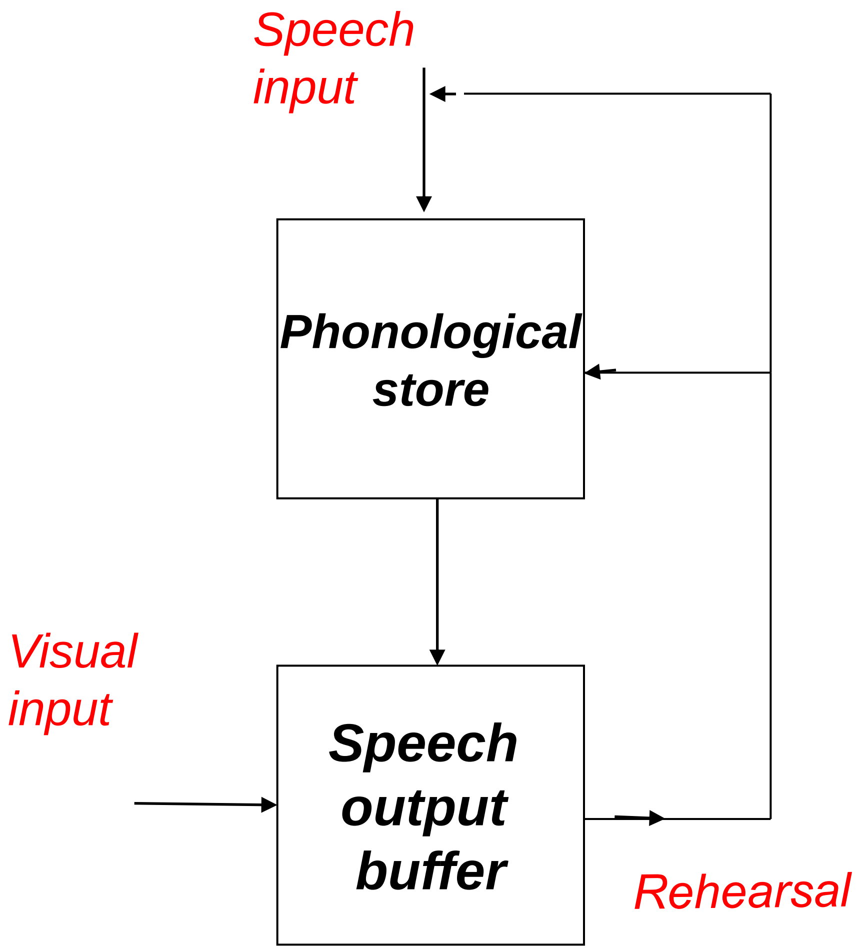
Pascual-Leone's notion of 'schemes'

- multiple, differ in modality and content
- include executive schemes
- broadly analogous to components of WM model
- more complex and ambitious than WM model
- less close to experimental manipulations and data

Case's application of M-space

- simpler, closer to WM model and experimental data
- fails to distinguish phonological and visuo-spatial subsystems

Phonological loop in more detail



Vallar & Papagno (2002)

- Accounts for auditory-verbal STM (effects of word length, phonemic similarity, articulatory suppression)
Baddeley & Hitch (1974)

- Also explains selective neuropsychological impairment, neuroimaging data, aspects of normal and abnormal development
Baddeley (2008)

Development of subvocal rehearsal

General progression

labelling

→single word rehearsal

→cumulative rehearsal

→elaborative-associative rehearsal

Lehmann & Hasselhorn (2007)

Pre-school children

little awareness of ‘inner speech’

Flavell,Green, Flavell & Grossman (1997)

Development of subvocal rehearsal: Individual differences

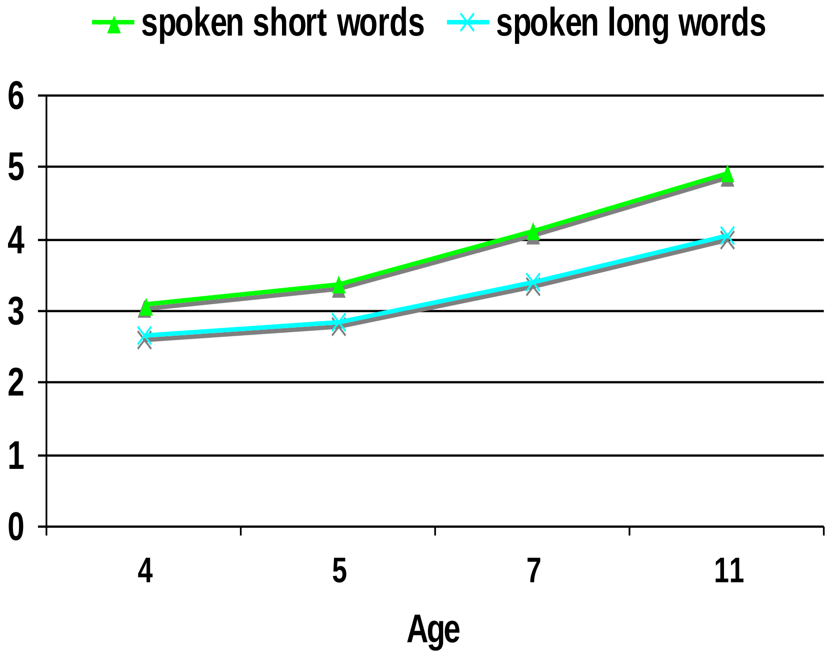
	4-5 year olds		
	Digit span	**Digit art rate**	**Word span**
Digit art rate	.04		
Word span	**.57***	-.11	
Word art rate	.05	**.66***	-.09

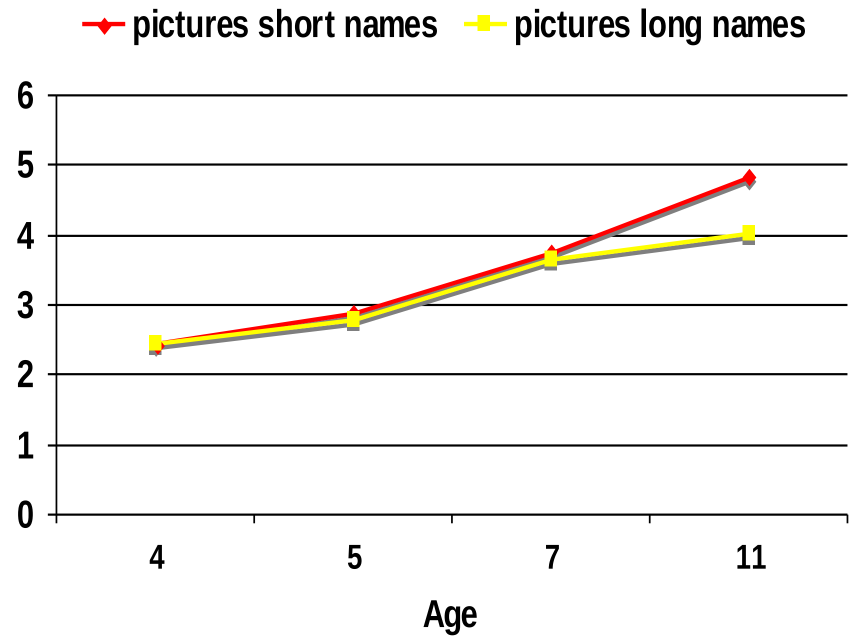
	Adults		
	Digit span	**Digit art rate**	**Word span**
Digit art rate	**.43***		
Word span	**.52***	**.54***	
Word art rate	**.44***	**.79***	**.45***

Gathercole, Adams & Hitch (1994)

Pattern of development of phonological coding depends on stimuli

e.g. word length effect





Hitch, Halliday, Dodd & Littler (1989)

Procedure for identifying memory representations used in recall of pictured items

Show items from left to right in a row

Child observes and remains silent

E points to locations left to right in turn

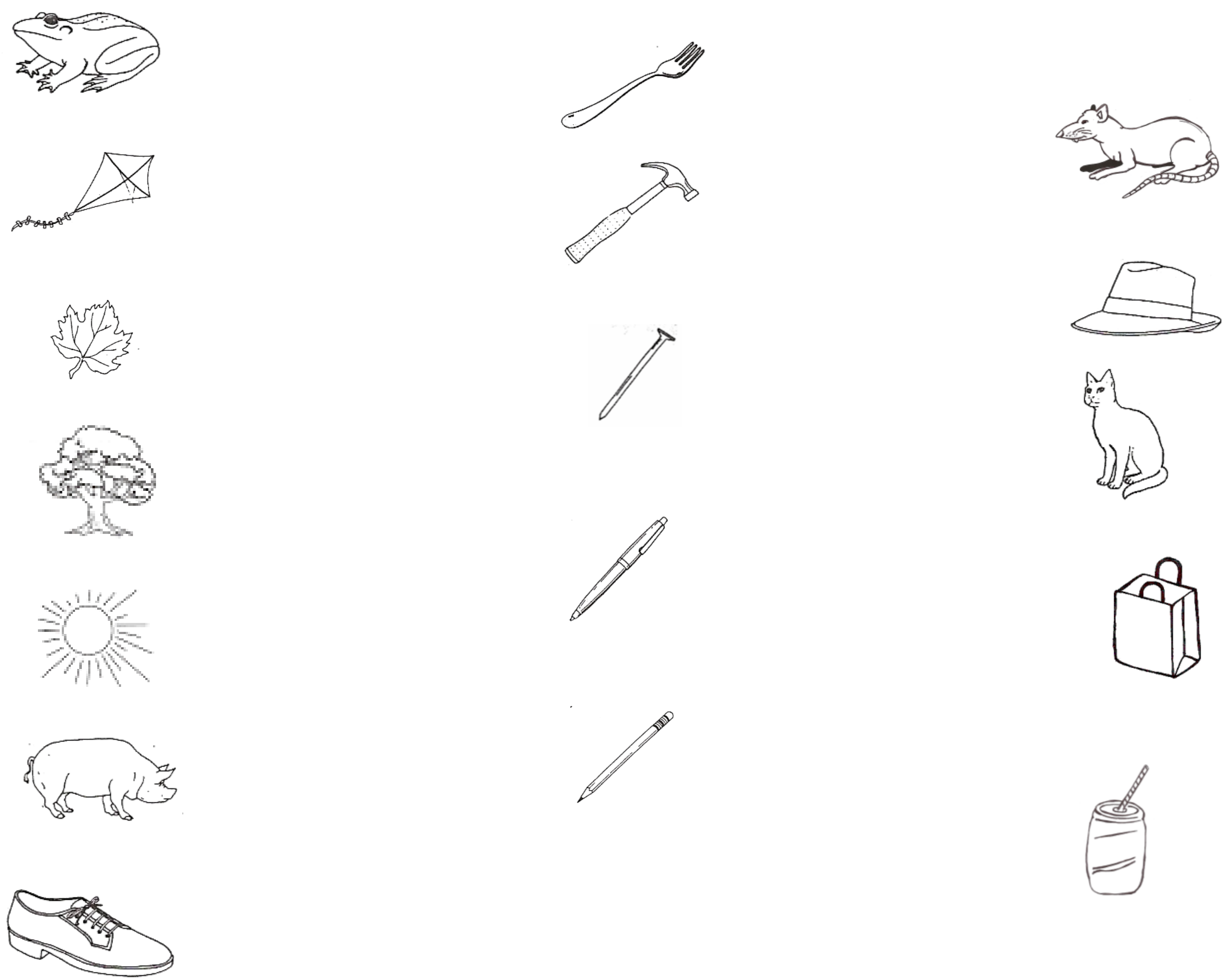
Child recalls name of picture at each location

Small set of pictures sampled repeatedly

Vary similarity of picture shapes and picture names:

Control; Visually similar; Visually dissimilar

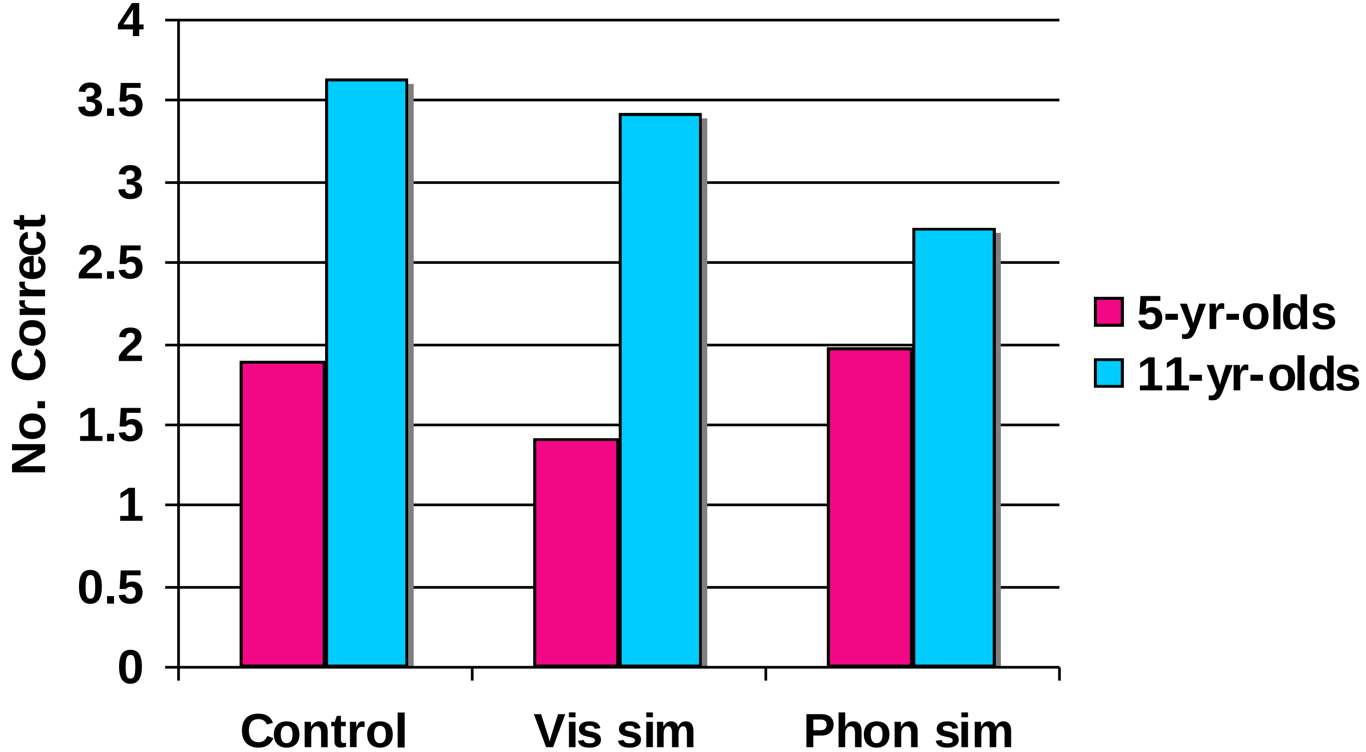
Dissimilar | Visually similar | Phonemically similar



Examples of typical materials

5-yr-olds: list length = 3 items

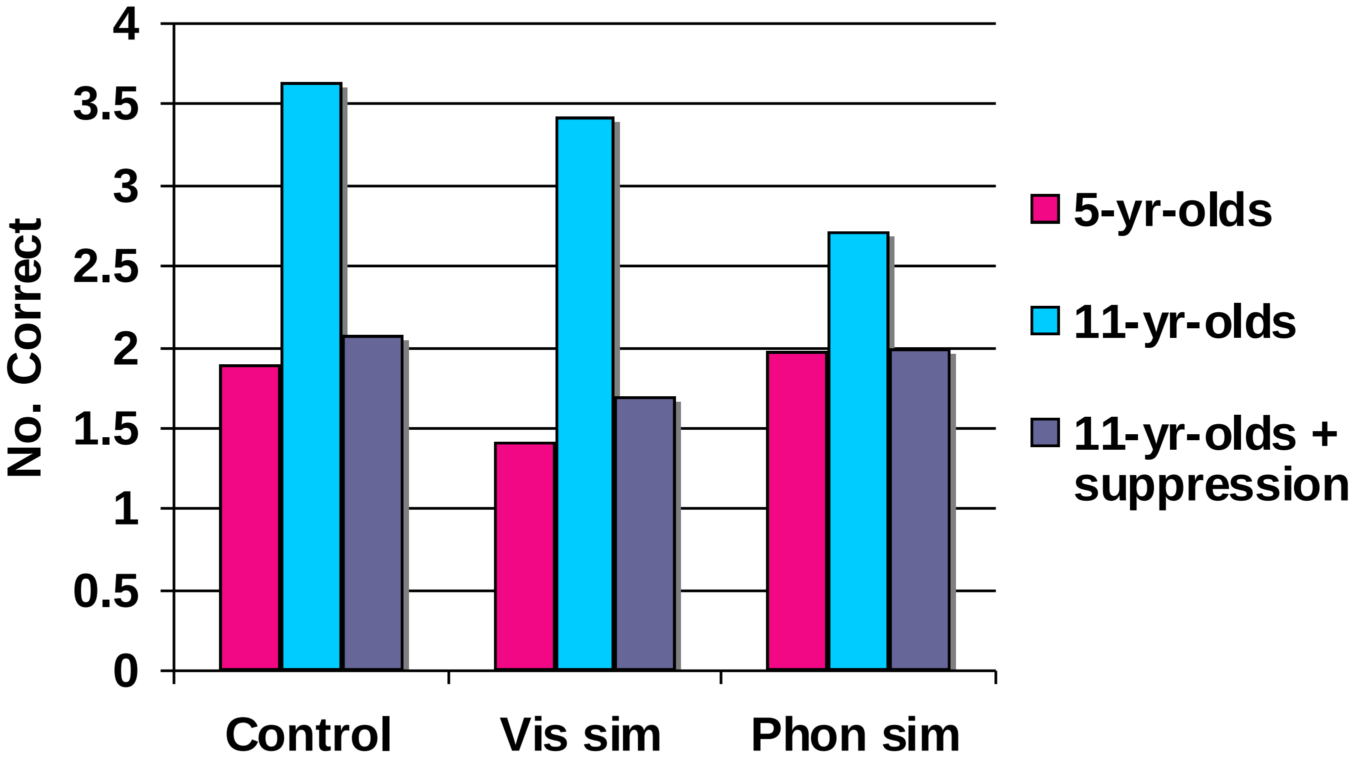
11-yr-olds: list length = 5 items



Hitch, Woodin & Baker (1989)

5-yr-olds: list length = 3 items

11-yr-olds: list length = 5 items



Hitch, Woodin & Baker (1989)

Further evidence for 5 yr olds' use of visual representations for pictures:

No primacy effect in forwards order recall

Recall in backwards temporal order better than forwards order

Recall disrupted more by visual than auditory-verbal post-list interference

(Opposite is true in all cases for 11 year olds)

Hitch, Halliday, Schaafstal & Schraagen (1988)

'End points' generally confirmed

visual coding in younger children

phonological coding/subvocal rehearsal dominant in older children and adults e.g. *Longoni & Scalesi (1994); Palmer (2000)*

Dual coding in older children and adults

6 and 7 yr olds can show both visual and phonological similarity effects in spoken recall of pictures (Palmer, 2000)

Adults can show visual and phonological similarity effects in serial order reconstruction memory for nameable pictures (Poirier, Saint-Aubin, Musselwhite, Moranadas & Mahammed, 2007)

Verbal overshadowing

e.g. Articulatory suppression can improve adults' performance on mental image manipulation tasks.

Happens when visual stimuli to be imagined are easily nameable, not when difficult to name (Brandimonte, Hitch & Bishop, 1992)

Interactions between subsystems:Do very young children recalling picture names remember only what they have seen?

Transfer of long-term learning

Modified ‘Hebb’ procedure

Immediate spoken serial recall

6 Training trials:

pictures (List **A**-ListB-List**A**-ListC-List**A**-ListD)

(**A** =‘Hebb list’; B,C,D,E = ‘Filler Lists)

2 Test trials:

(List**A**-ListE)

SAME MODALITY (pictures)

or

DIFFT MODALITY (spoken words)

N=20 5 year olds (3 items)

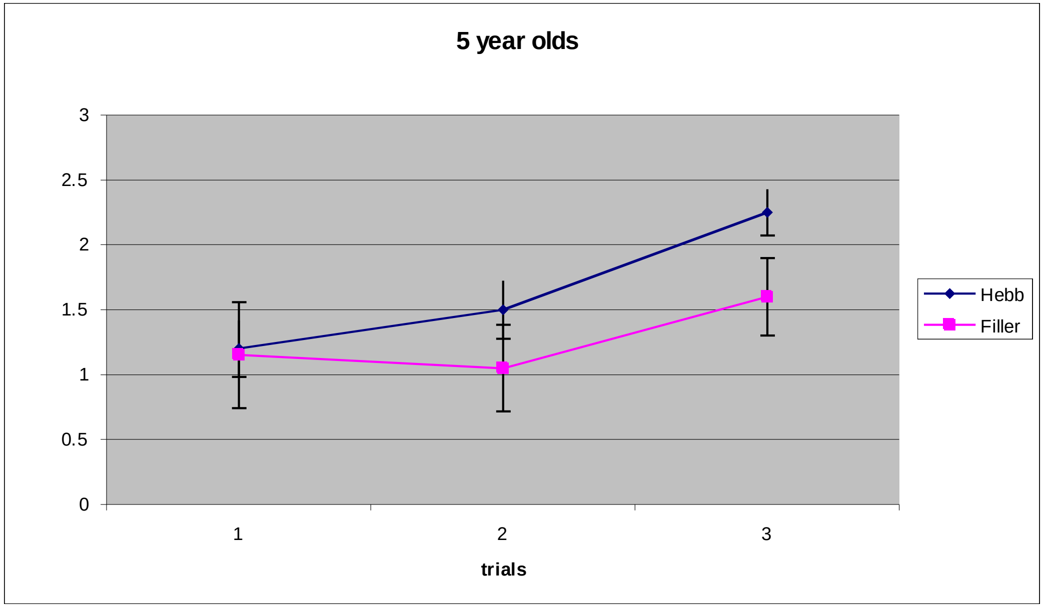
N=20 11 year olds (7 items)

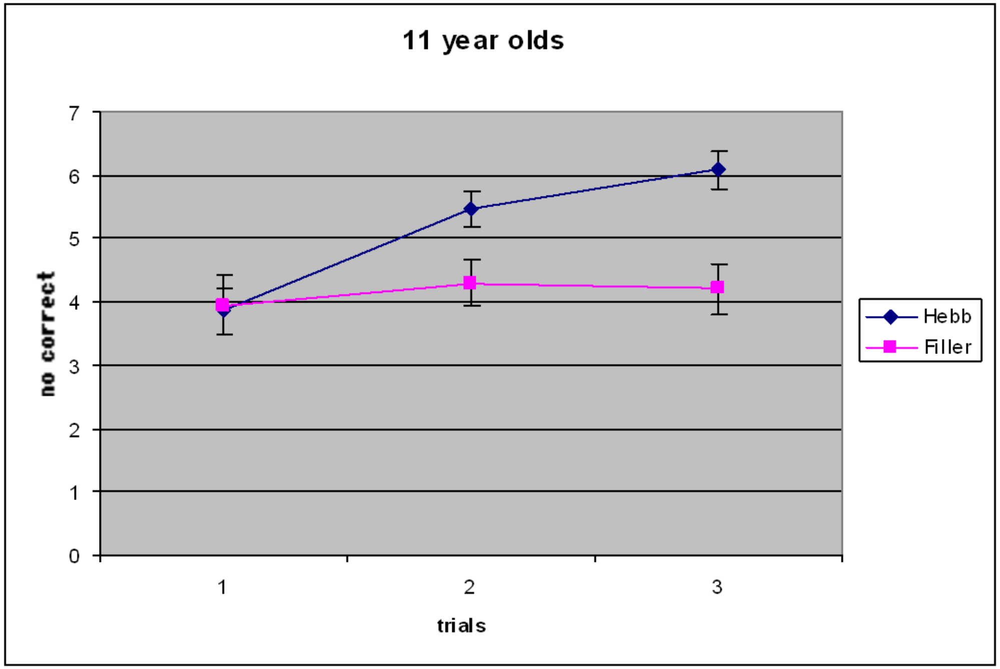
Hitch, Hambleton & Walker (in prep)

TRAINING

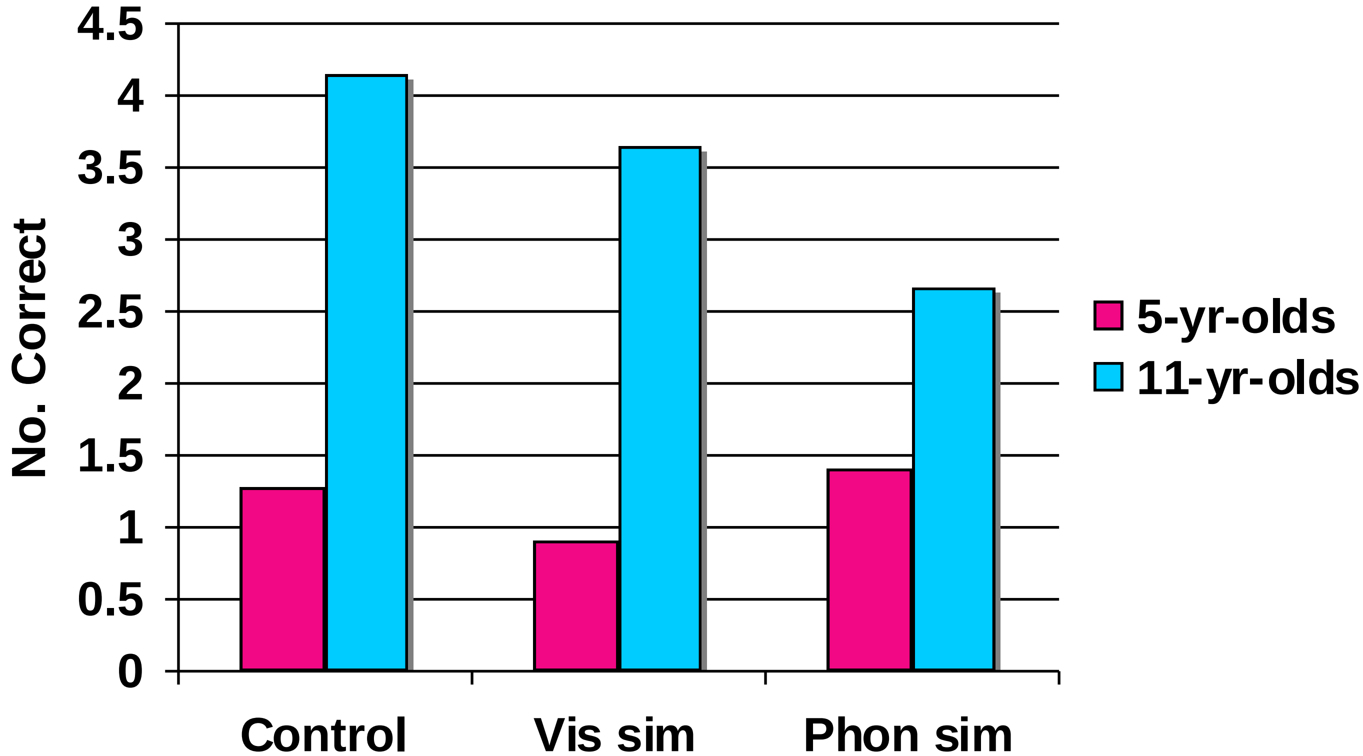
Present pictures

Speak recall of names



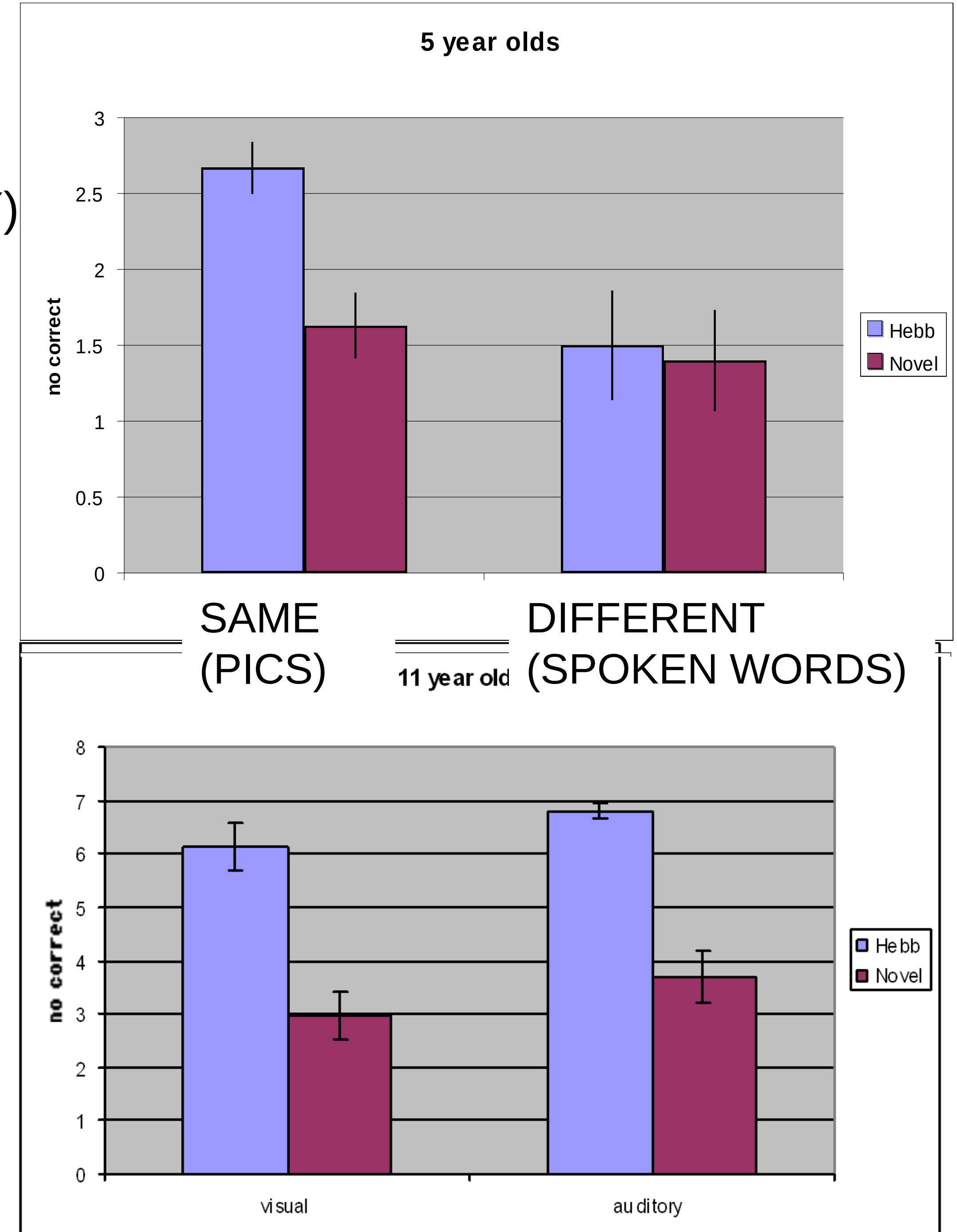


Check on age-related coding differences: Performance on filler lists in training trials as a function of item similarity



Hitch, Hambleton & Walker (in prep)

TRANSFER TEST AS F(MODALITY)



Do children really remember only what they see ?

Modified Hebb procedure

Immediate spoken serial recall

6 Training trials:

(all pictures or all spoken words)

Filler-Hebb-Filler-Hebb-Filler-Hebb

2 Test trials:

(always switch modality)

pictures $\rightarrow$words or words$\rightarrow$ pictures

Filler-Hebb

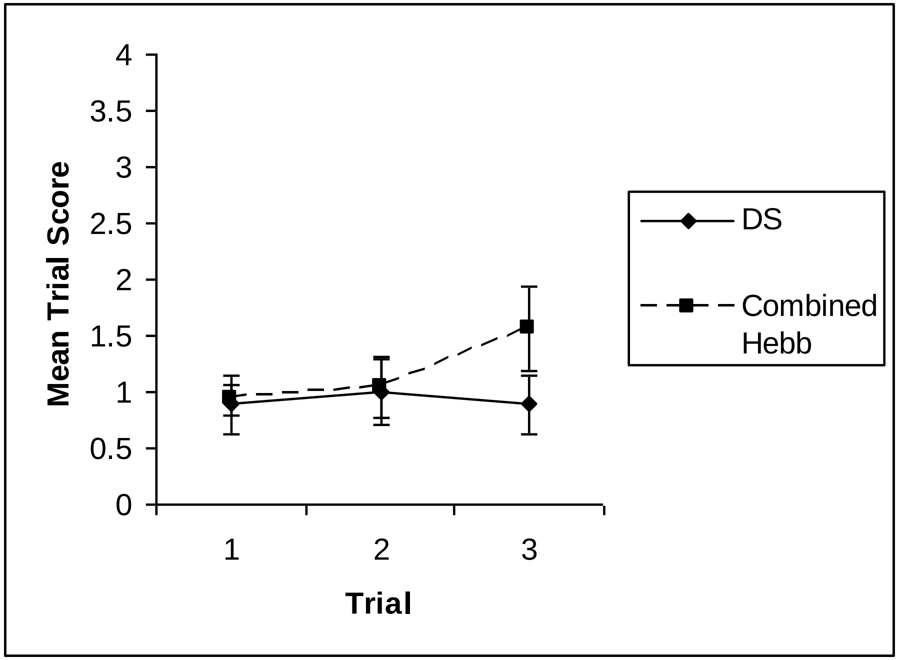
N=18 5 year olds (4 items)

N=21 11 year olds (7 items)

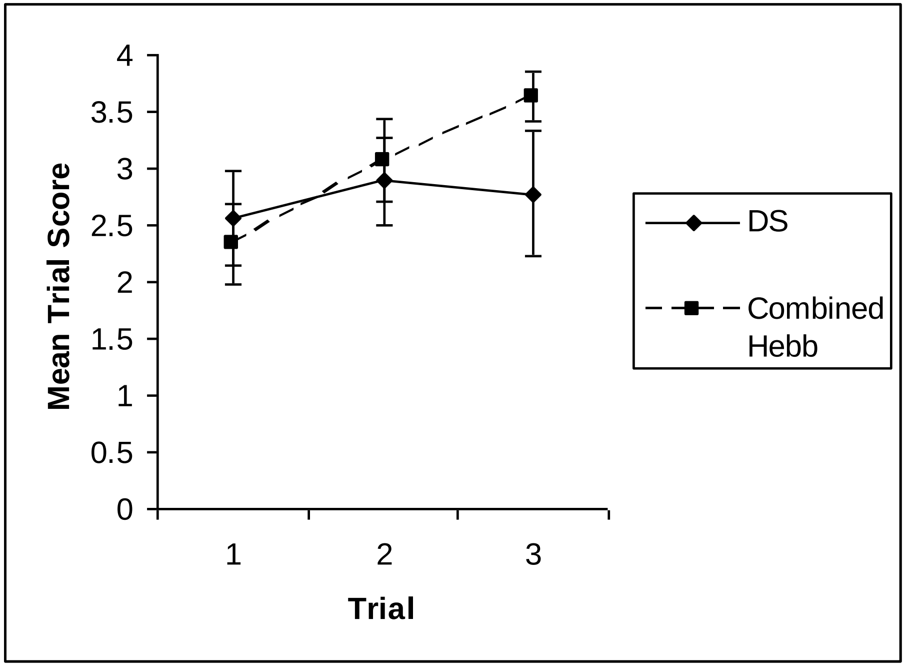
Hitch, Hambleton & Walker (in prep)

Training Phase:5-year-olds

Pictures

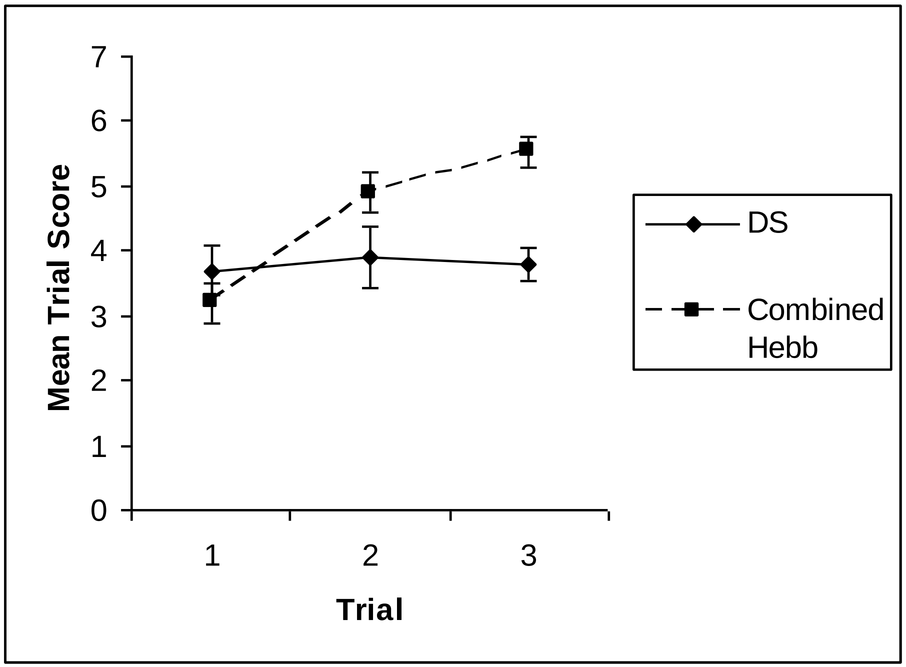


Auditory

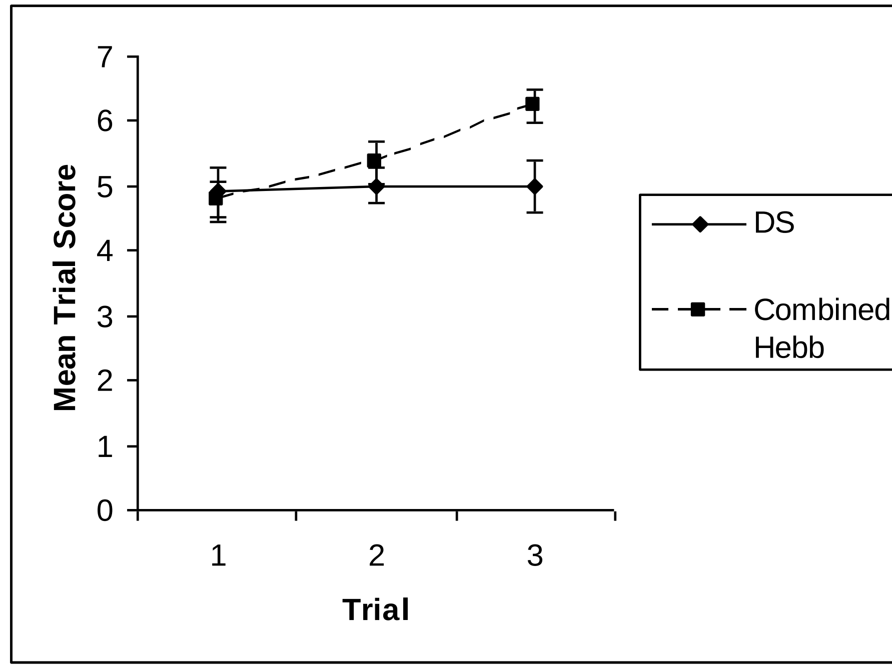


Training Phase:11-year-olds

Pictures



Auditory



Test Phase

Age	Group	Filler	Hebb	Transfer?
		M (SD)	M (SD)	
5	Picture →**Auditory**	2.22 (1.09)	1.74 (1.39)	*ns*
5	Auditory → **Picture**	2.11 (1.36)	3.04 (1.10)	*ns*
11	Picture →**Auditory**	4.10 (1.20)	5.90 (1.09)	$p<.05$
11	Auditory → **Picture**	4.64 (1.03)	6.00 (0.79)	$p<.05$

Hebb transfer experiments: summary and conclusions

5 year olds

Training on a list of pictures does not transfer to the same list of spoken words, nor does training on a list of spoken words transfer to the same list of pictures

This despite recall of pictures being spoken, so children had heard themselves repeat the sequence

STM and LTM representations follow perception not action

11 year olds

Training on a list of pictures transfers to the same list of spoken words and vice versa

STM and LTM representations include verbal component regardless of perceptual input

Can analysis of transition from modality-specific to verbal-phonological representations in working memory give useful information about abnormal development?

Dyslexia

Dyslexic adolescents show larger VSE and same or smaller PSE relative to RA and CA controls

(Palmer, 2000; McNeil & Johnston, 2004)

Autism spectrum disorder; **General learning/intellectual disability**

VSE and PSE generally consistent with mental age

(Henry, 2008; Rosenquist, Conners & Roskoss-Ewoldsen, 2003; Williams, Happé & Jarrold, 2008)

Phonological loop as a language learning device

(Baddeley, Gathercole & Papagno, 1998)

•Children

Nonword repetition ability: e.g. *skiticult, blonterstaping*
Correlates with digit span and predicts vocabulary scores

•Adults

Disrupting phonological loop experimentally *(eg phonemic similarity or articulatory suppression)* impairs learning of Word-*Nonword* paired-associates but not Word-*Word* pairs

•Neuropsychological patients

'PV' auditory digit span = 2, impaired phonological loop
Could learn Word-*Word* pairs but not Word-*Nonword* pairs

Is there a Hebb Effect for nonwords in young children?

Stimuli

- From Gathercole & Baddeley's CNRep Test
- e.g., *hampent, skiticult, woogalamic, pristoractional*

  sladding, bannifer, blonterstaping, contramponist etc
- Length from 2-5 syllables

Procedure

- Play NW, child immediately attempts repetition
- Score repetition accuracy, % syllables/phonemes correct

Subjects

- 24 children aged 4:10 - 5:8

Design: Learning within sessions and Session 1 $\rightarrow$ Session 2 retention

Session 1

Trials: A A A A B F_1 B F_2 B F_3 B F_4

Hebb (No Fillers) Hebb (1 Filler)

Session 2 (*4 weeks later*)

Repeat trials using same stimuli

Trials: A A A A B F_1 B F_2 B F_3 B F_4

Example of (good) learning

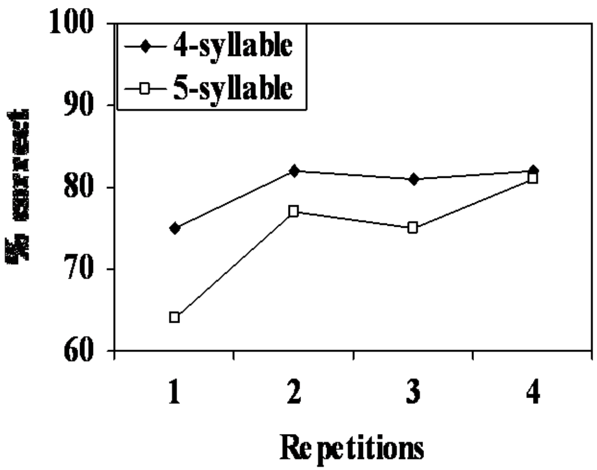
'Contramponist'

1st repetition	*contransid*
2nd repetition	*contranto-ois*
3rd repetition	*contramponis*
4th repetition	*contramponist*

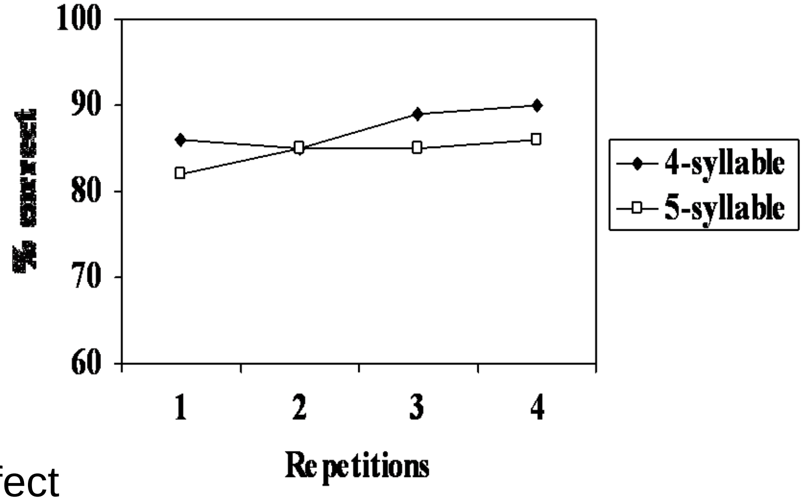
Learning within sessions
and Session 1 $\rightarrow$ Session 2 retention

Data pooled over spacings 1 and 0 fillers

Session 1

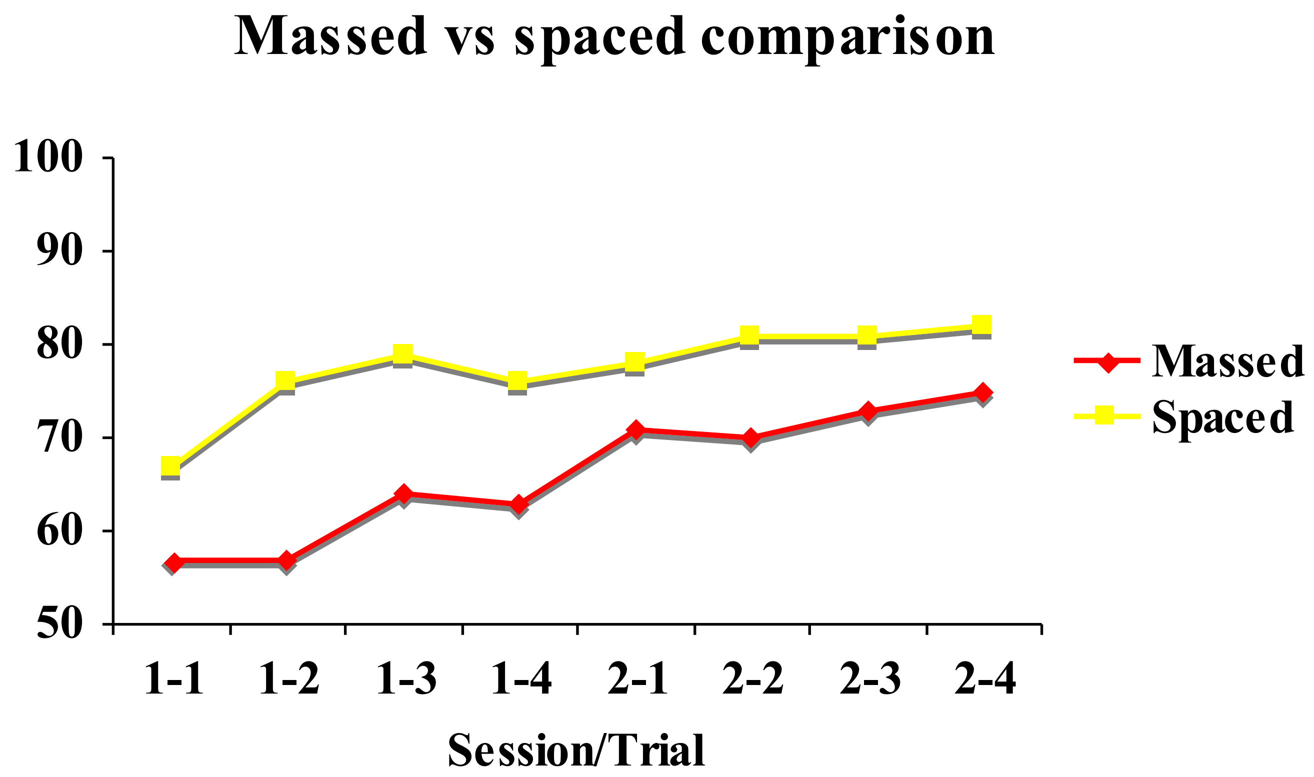


Session 2



- Word length effect
- Rapid learning
- Asymptote
- Long-term retention

Data pooled over 5 and 6 syllable



Is hearing or saying more important when young children learn new word forms?

Design:

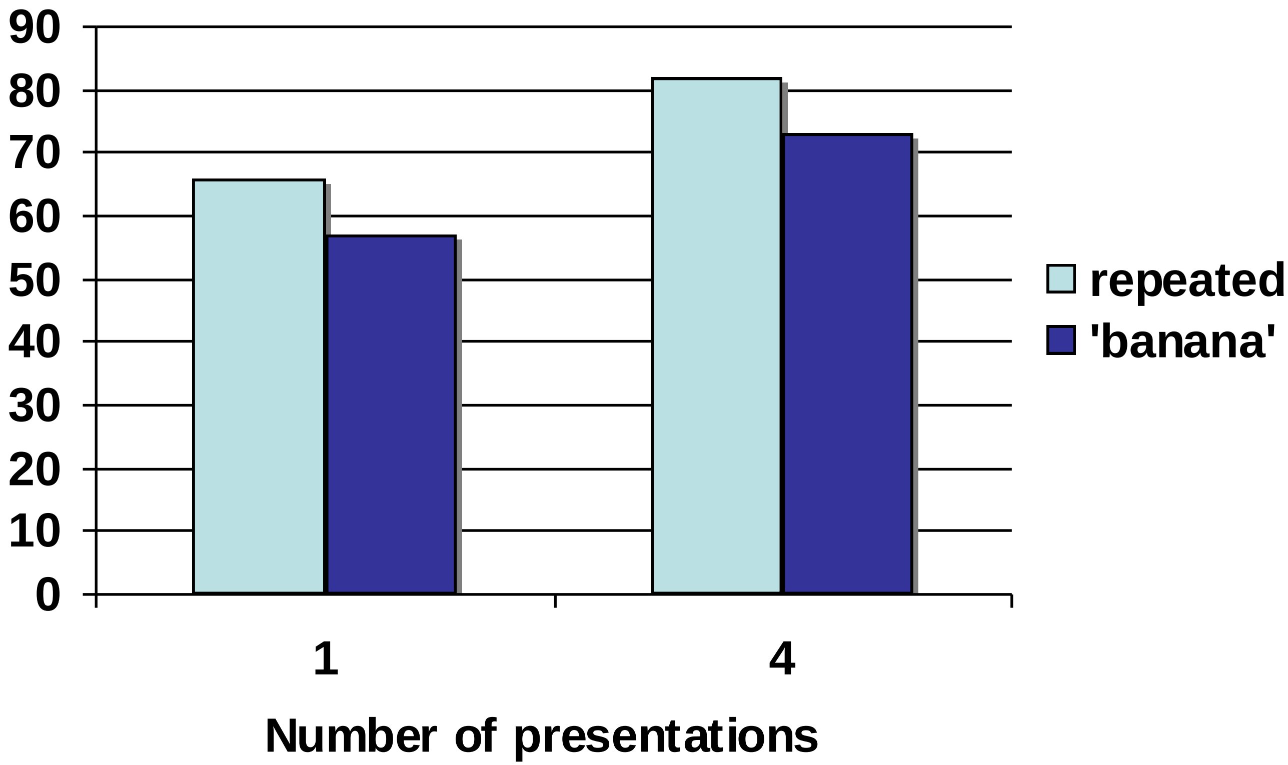
Two types of item heard either once or 4 times in training:

1. Hear and repeat nonword *colorasinoma* →*'colorasimomo'*
2. Hear nonword, say 'banana' *colorasinoma* →*'banana'*

Final test (all items)

Hear and repeat

Score repetition accuracy (no syllables correct)



90
80
70
60
50
40
30
20
10
0
1
4
Number of presentations
repeated
'banana'

Young children’s word-form learning

rapid, long-term

sensitive to word length

does not depend crucially on repeated articulation

affected by distribution of practice as other forms of learning

A function primarily of the phonological store

Development of phonological and visual representations: 1

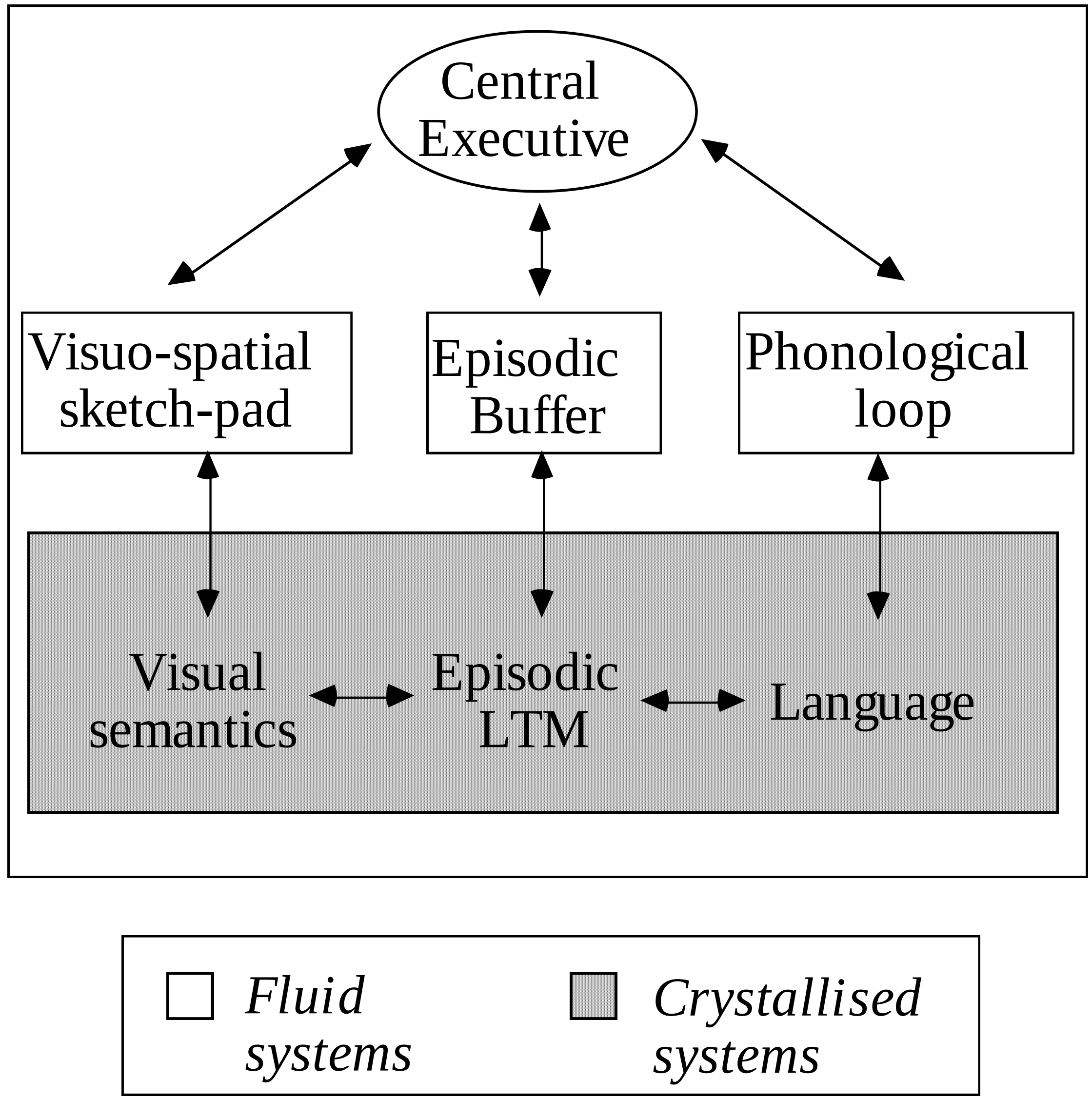
Separateness of systems more important in younger than older children

- use of each subsystem driven by its associated perceptual input stream
- the two subsystems do not appear to communicate with each other
- phonological loop - specialised for learning spoken word forms
- visuo-spatial sketchpad - specialised for what?
- (learning visual conjunctions? perception-action schemes?)

Development of phonological and visual representations: 2

Interaction between subsystems becomes important as children develop

- dual coding
- verbal/phonological can come to predominate/overshadow visuo-spatial
- inter-relationships almost certainly depend on task context and individual differences
    - much more needs to be known about these interactions
- dyslexia may be associated with abnormal interactions between visual and phonological subsystems in working memory
    - may simply be a consequence of the well-known phonological deficit`/
- in contrast, autism and in general intellectual impairment the pattern of using visuo-spatial and phonological components of working memory seems to follow mental age


Central Executive
Visuo-spatial sketch-pad
Episodic Buffer
Phonological loop
Visual semantics
Episodic LTM
Language
Fluid systems
Crystallised systems

Acknowledgements to:

Alan McNeil, Mike Page, Dennis Norris

Ed Hambleton, Hayley Walker, Alison Walker, Jessica Lambert

Performance on Filler lists in training phase: check on similarity effects

		Control	Vis sim	Phon sim
5 year olds	Pictures	0.93 (0.81)	0.40 (0.60)	1.04 (0.79)
	Auditory	2.74 (1.37)	2.70 (1.48)	1.67 (1.10)
11 year olds	Pictures	3.80 (1.19)	3.77 (1.26)	2.33 (0.87)
	Auditory	4.97 (1.19)	4.88 (1.30)	2.97 (1.55)

Performance on Filler lists in transfer phase: check on similarity effects

		Dissim	Vissim	Phonsim
5 year olds	Pictures	2.11 (1.36)	0.89 (0.78)	2.11 (0.93)
	Auditory	2.22 (1.09)	1.78 (0.97)	0.22 (0.44)
11 year olds	Pictures	4.64 (1.03)	4.55 (0.92)	2.36 (0.92)
	Auditory	4.10 (1.20)	3.90 (0.88)	2.60 (0.70)