fNIM
Functional neuroimaging of memory laboratory

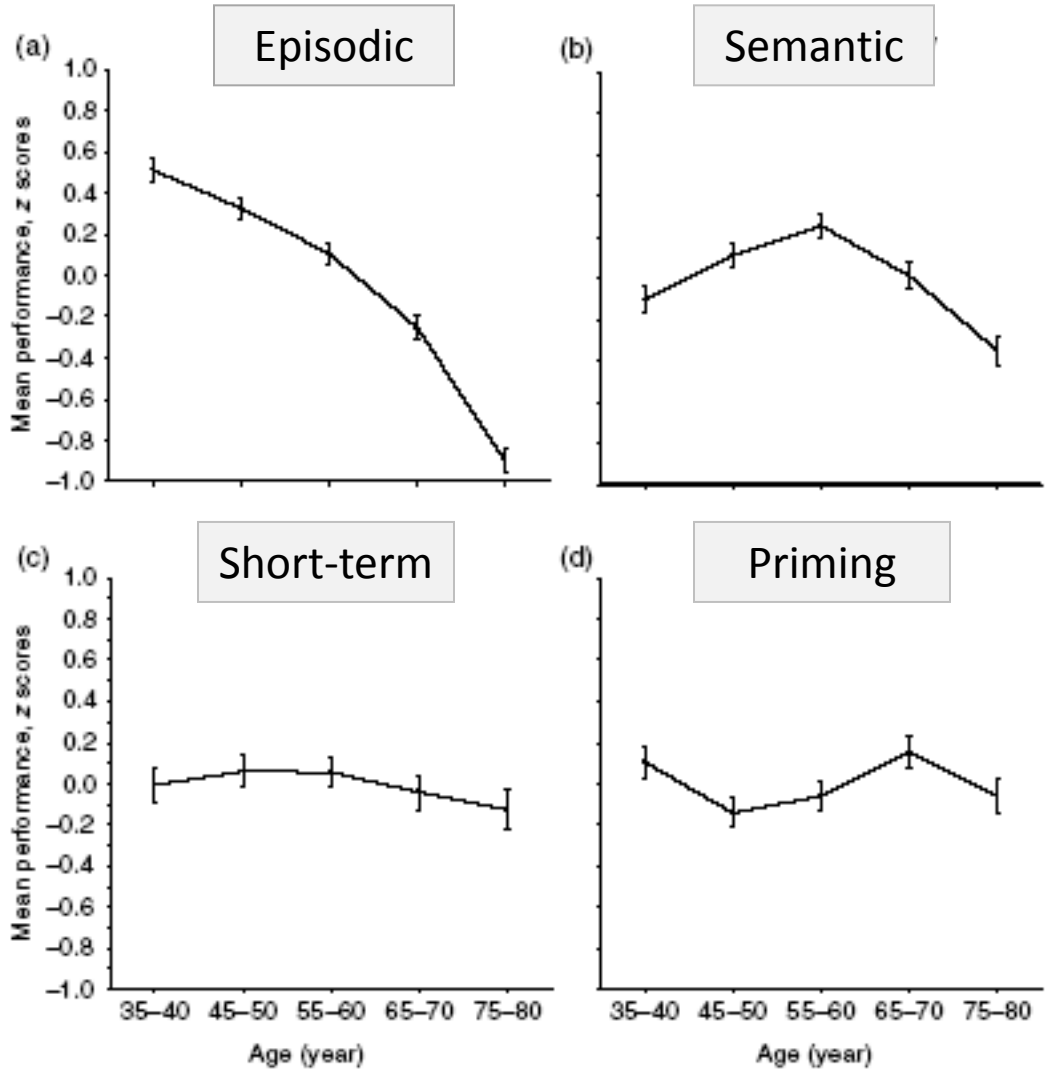
CENTER FOR VITAL LONGEVITY
THE SCIENCE OF THE AGING MIND

The Effects Of Age On Episodic Memory - What Stays Up And What Goes Down?

Michael Rugg

UT DALLAS
The University of Texas at Dallas

Aging and memory



Nilsson, 2003

Subject characteristics

	Young Adults (n=36)			Middle Adults (n=36)			Older Adults (n=56)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Age	22.2	3.0	18-29	49.4	3.4	43-55	68.4	3.6	63-76
Years of education*	15.5	2.4	11-22	16.3	2.6	10-22	16.8	2.3	12-22
Mini Mental State Exam	29.6	0.6	28-30	29.3	0.8	28-30	29.3	0.8	27-30
CVLT imm free recall ***	12.8	2.1	9-16	11.6	2.3	8-16	11.0	3.0	3-16
CVLT imm cued recall **	13.6	1.9	10-16	13.0	2.0	9-16	12.5	2.2	7-16
CVLT delay free recall **	13.3	2.2	8-16	12.2	2.5	8-16	11.6	2.8	4-16
CVLT delay cued recall **	13.7	1.9	9-16	12.9	1.9	9-16	12.4	2.4	8-16
FAS Letter Fluency	43.6	11.8	23-65	47.5	12.0	28-69	45.9	13.3	21-81
WMS Log Mem I	30.4	6.8	16-44	29.0	6.5	16-45	28.6	5.1	20-40
WMS Log Mem II	27.6	6.7	15-40	25.2	6.2	12-44	25.6	5.6	15-39
SDMT Digit symbol ***	61.4	10.1	39-83	55.2	7.8	41-70	49.4	8.7	31-74
Trail A ***	20.9	7.3	11-47	24.1	6.7	14-39	33.1	11.7	15-88
Trail B ***	46.7	17.3	23-108	51.7	16.9	27-95	76.1	49.4	31-360
W3 Digit Span	18.0	3.9	11-26	18.2	3.5	13-26	18.6	4.5	12-27
CCF Category fluency	24.8	5.9	16-42	24.0	5.9	13-36	21.9	5.6	12-40
Wtar FSIQ 3	43.2	4.2	35-50	43.6	4.6	35-50	43.9	5.1	34-50
RAVEN'S ***	11.2	1.0	8-12	10.4	1.5	7-12	9.6	2.1	3-12

*p < .05, **p <.01, *** p < .001, 2-tailed t-tests.

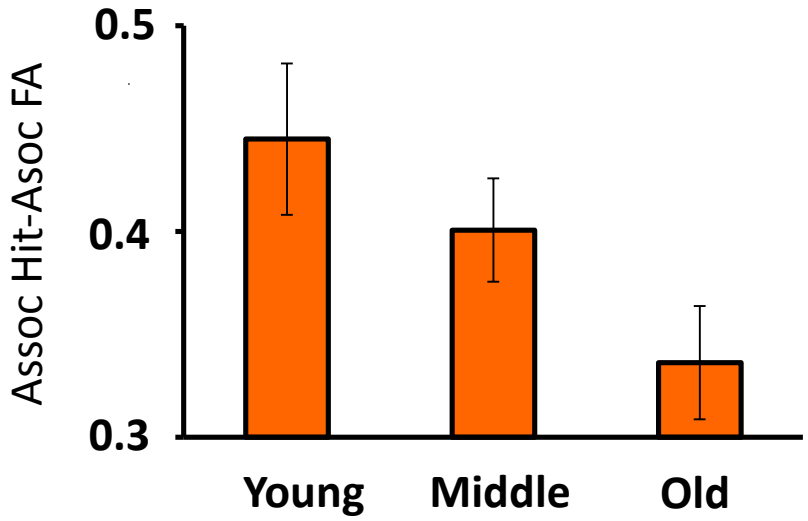
Associative recognition

Study	Test	
PICTURE - STREAM	PICTURE - STREAM	***Intact***
CHURCH - PRINCE	EDGE - PRINCE	***Rearranged***
EDGE - SINK	BUCKET - BOOK	***New***

Which fits in which?

Intact/Rearranged/New?

Associative recognition - performance



Associative recognition

ENCODING

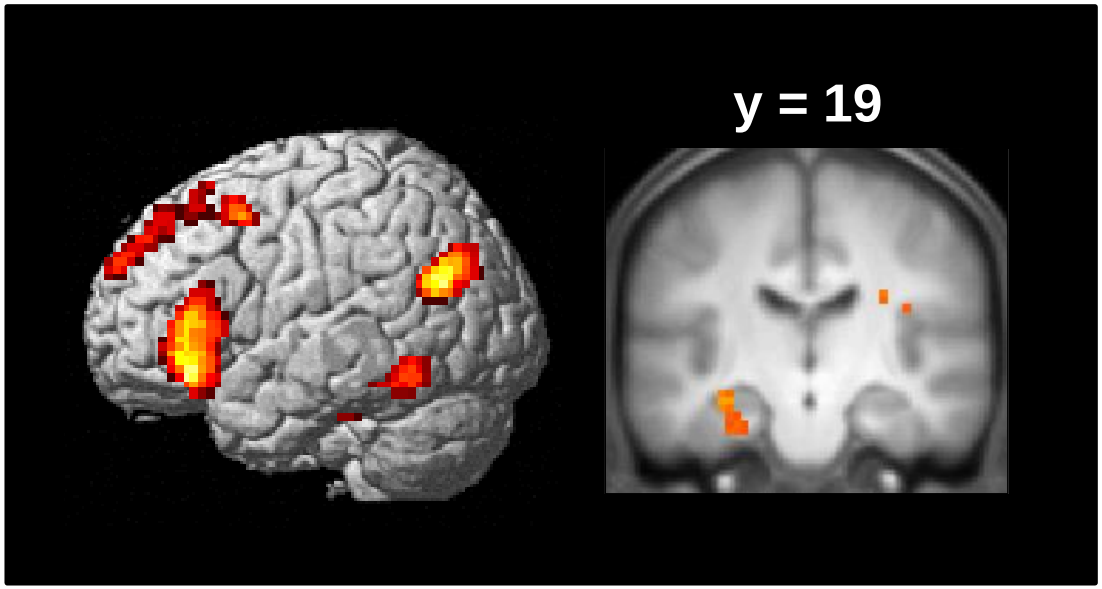
Study	**Test**	
PICTURE - STREAM	PICTURE - STREAM	***Intact***
CHURCH - PRINCE	EDGE - PRINCE	***Rearranged***
EDGE - SINK	BUCKET - BOOK	***New***
Which fits in which?	**Intact/Rearranged/New?**	

Critical contrast

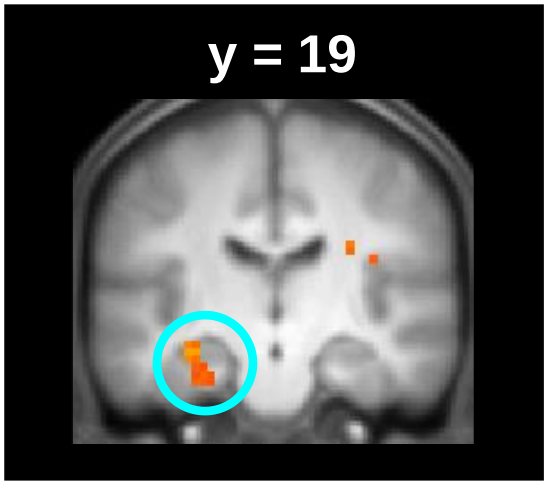
Study activity elicited by pairs correctly judged intact vs. pairs incorrectly judged rearranged

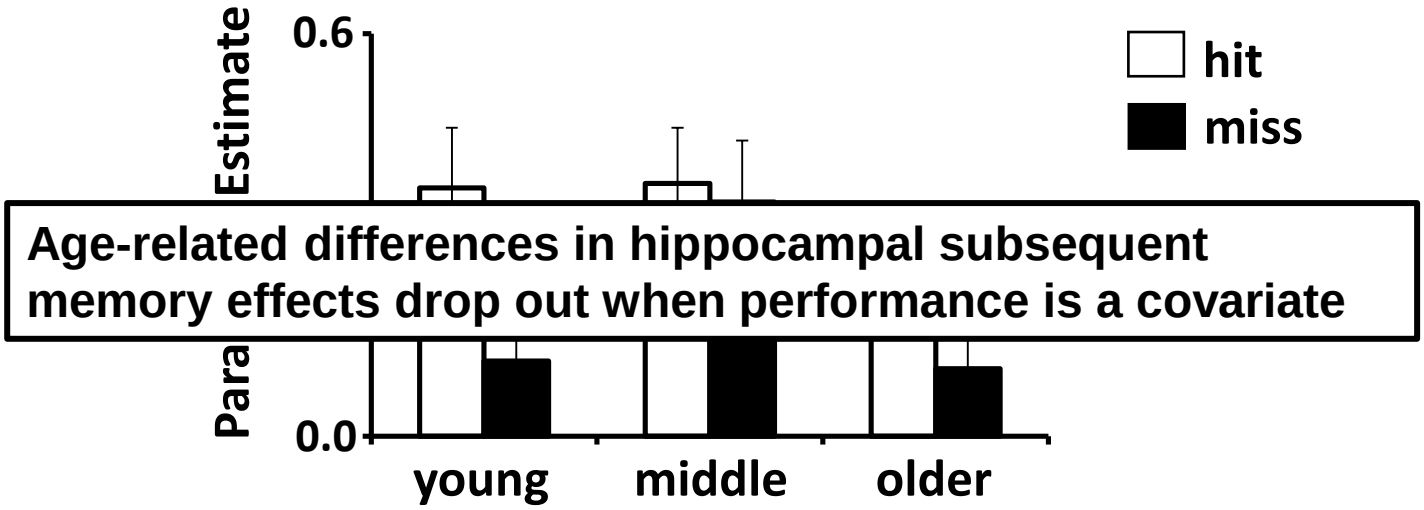
Main effect of subsequent memory

Associative hits > associative misses

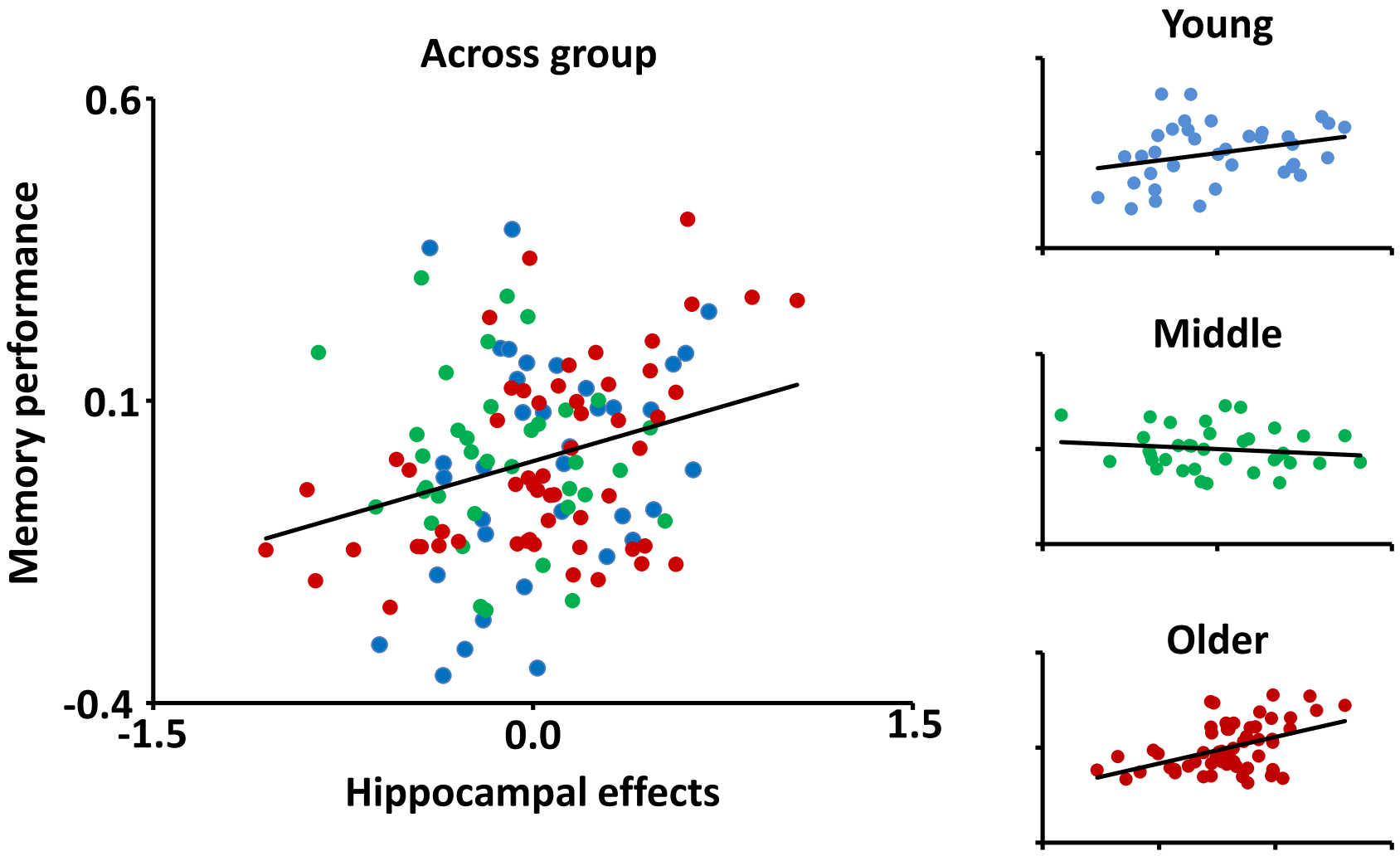


Hippocampal subsequent memory effects

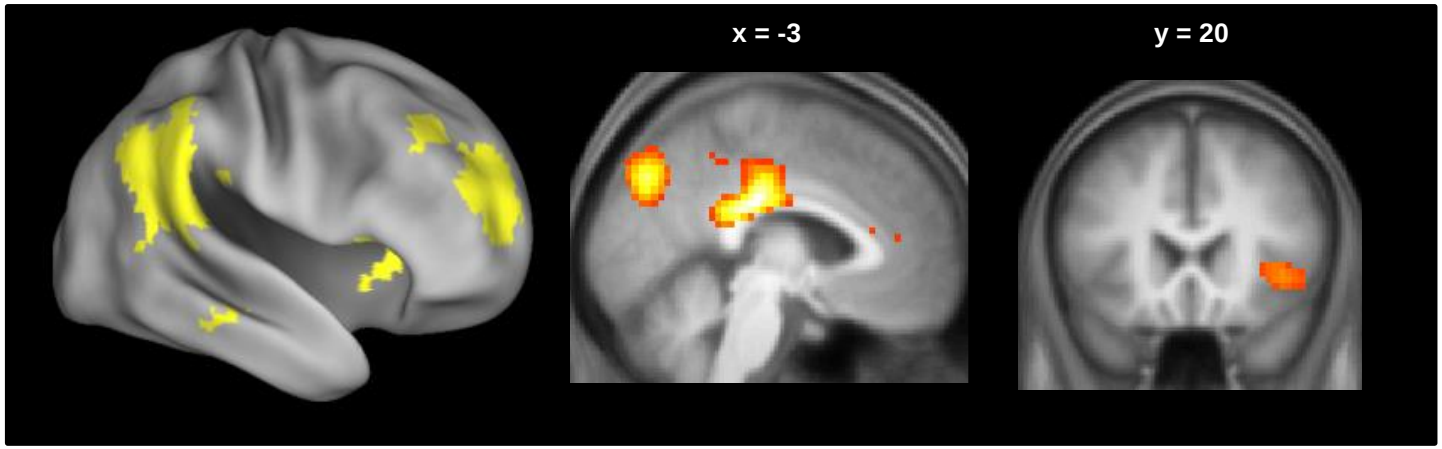


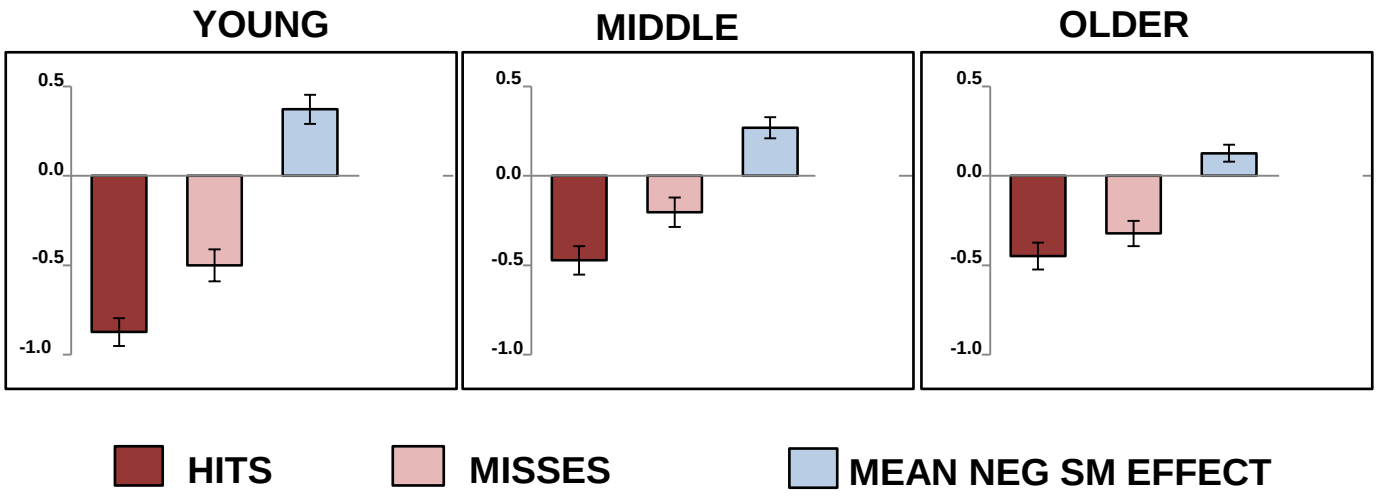


Hippocampal subsequent memory effects and performance: partial plots



Negative subsequent memory effects





Age-related differences in negative subsequent memory effects *remain* when age is a covariate

Associative recognition

RETRIEVAL SUCCESS

Study	Test	
PICTURE - STREAM	PICTURE - STREAM	***Intact***
CHURCH - PRINCE	EDGE - PRINCE	***Rearranged***
EDGE - SINK	BUCKET - BOOK	***New***

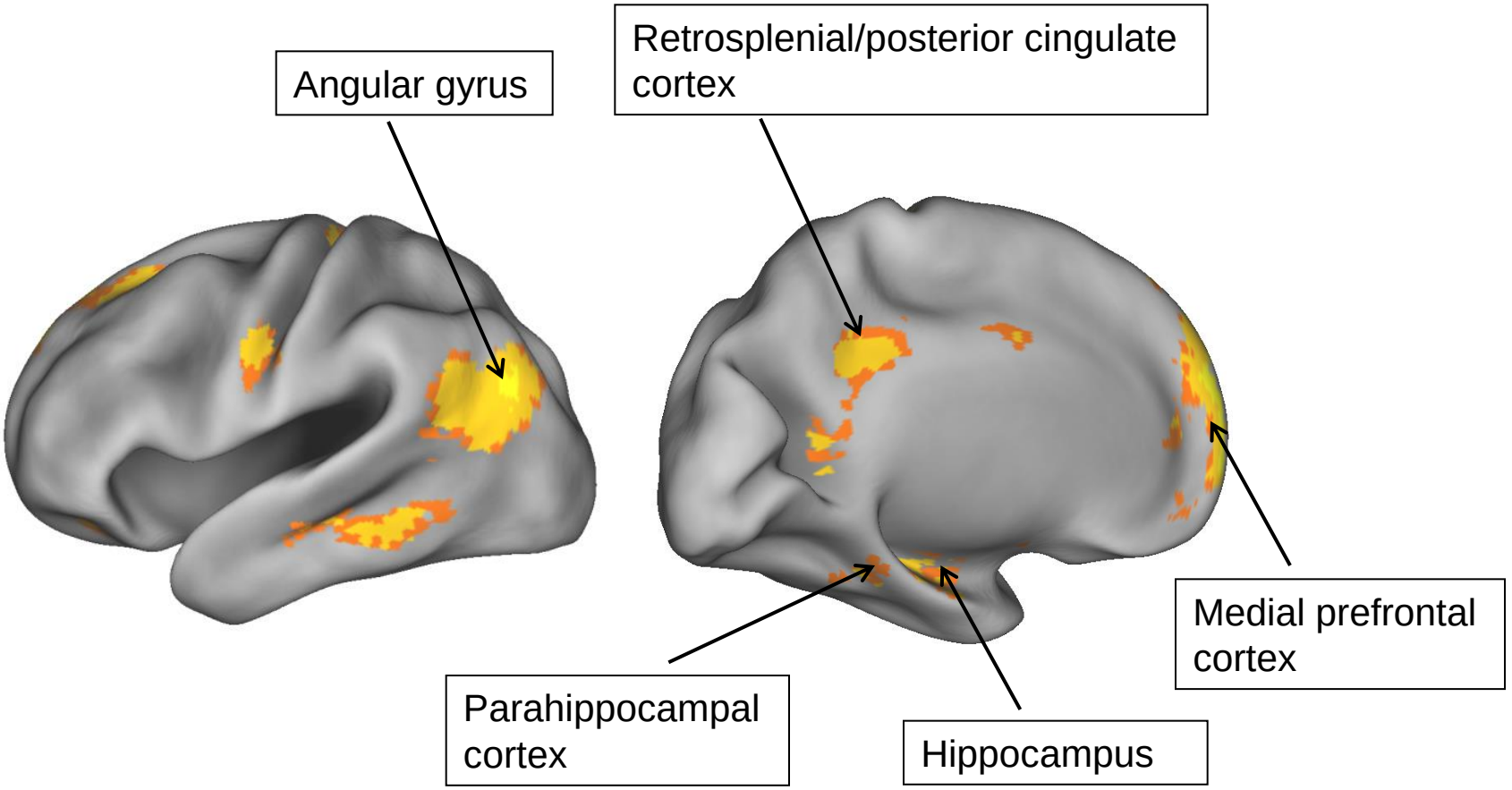
Which fits in which?

Intact/Rearranged/New?

Critical contrast

Intact pairs judged intact > intact pairs judged rearranged

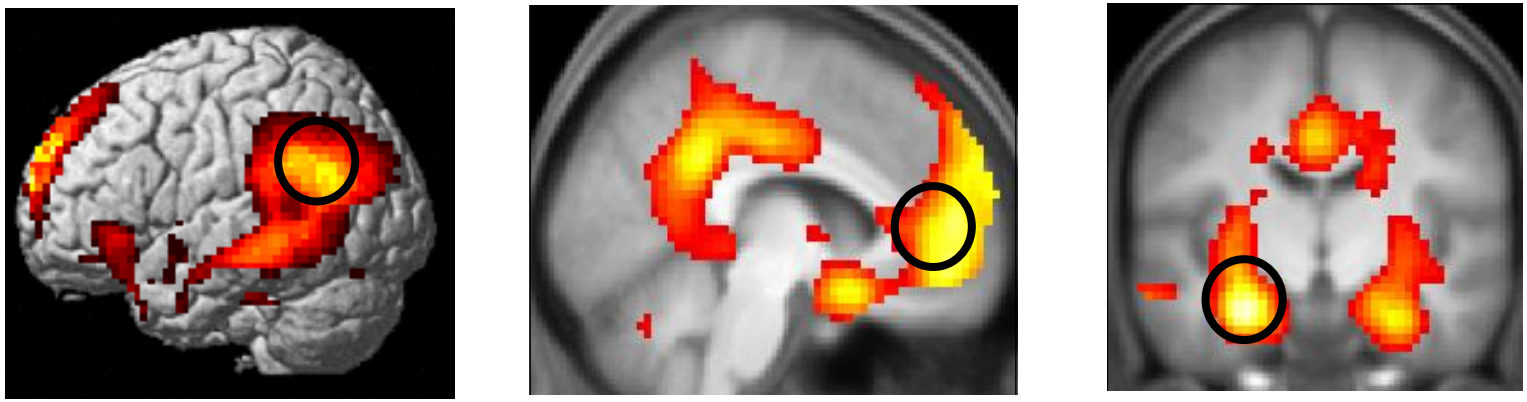
‘Core’ recollection network

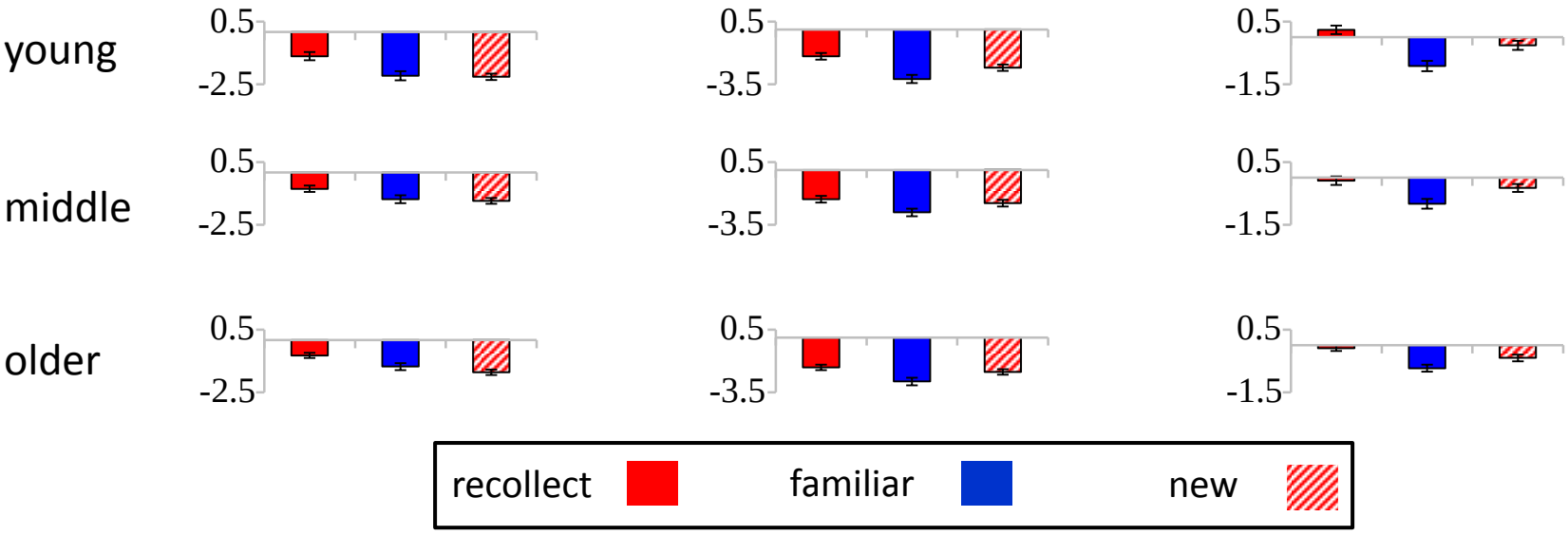


Rugg & Vilberg, 2013.

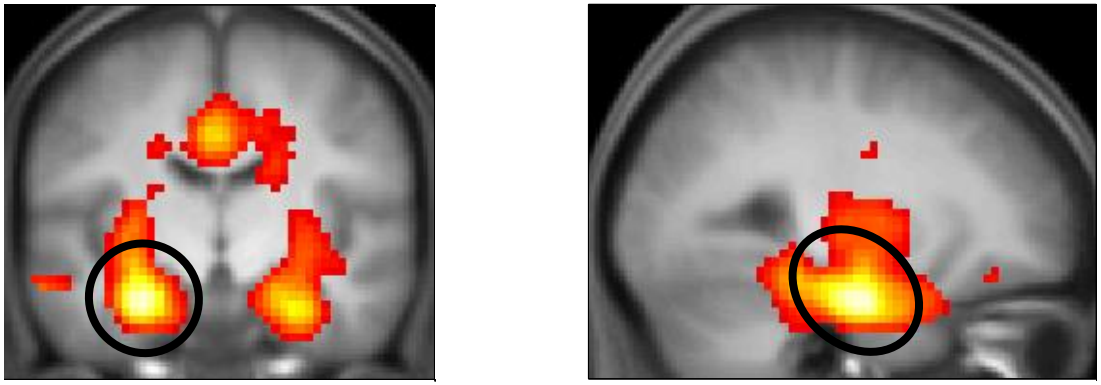
Recollection effects across all age groups

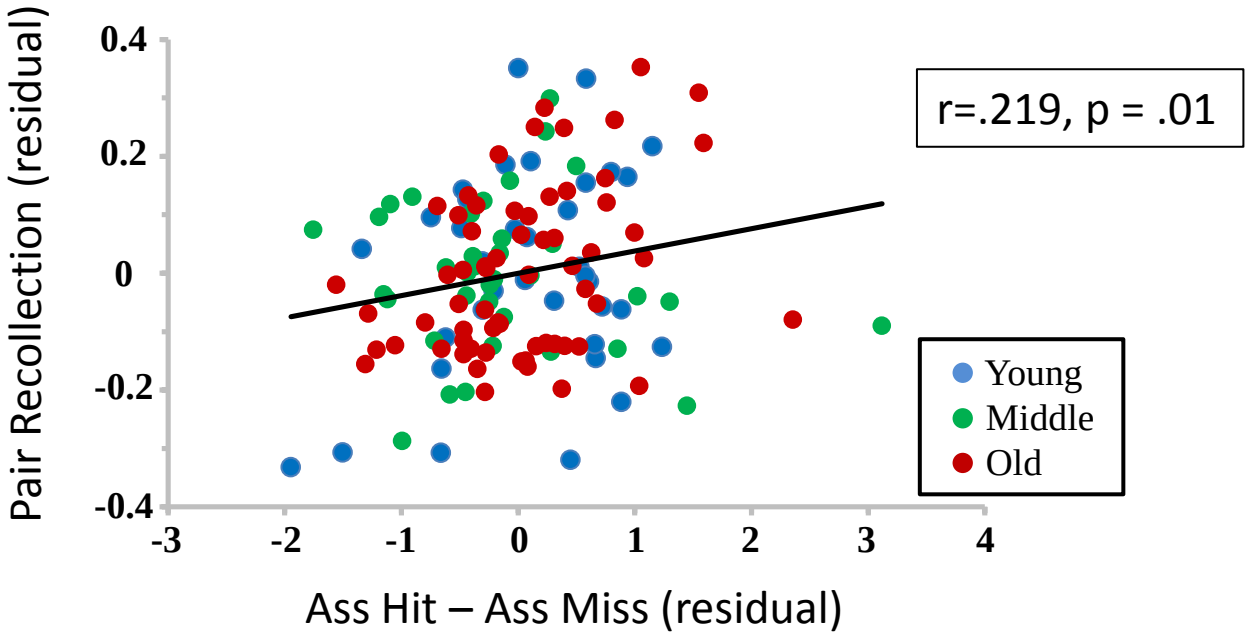
Intact - rearranged main effect (FWE p < .05)





Hippocampal recollection effects and behavior





Associative recognition

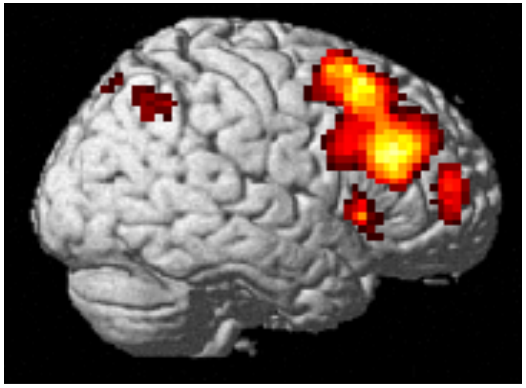
POST-RETRIEVAL MONITORING

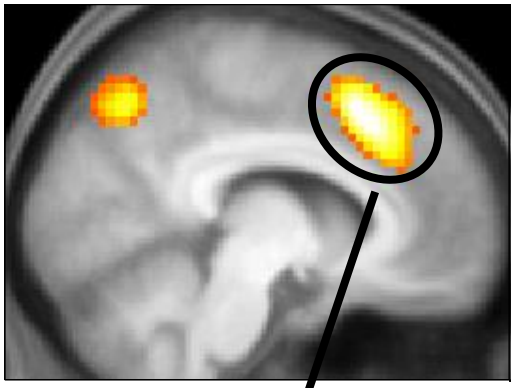
Study	Test	
PICTURE - STREAM	PICTURE - STREAM	***Intact***
CHURCH - PRINCE	EDGE - PRINCE	***Rearranged***
EDGE - SINK	BUCKET - BOOK	***New***
Which fits in which?	**Intact/Rearranged/New?**	

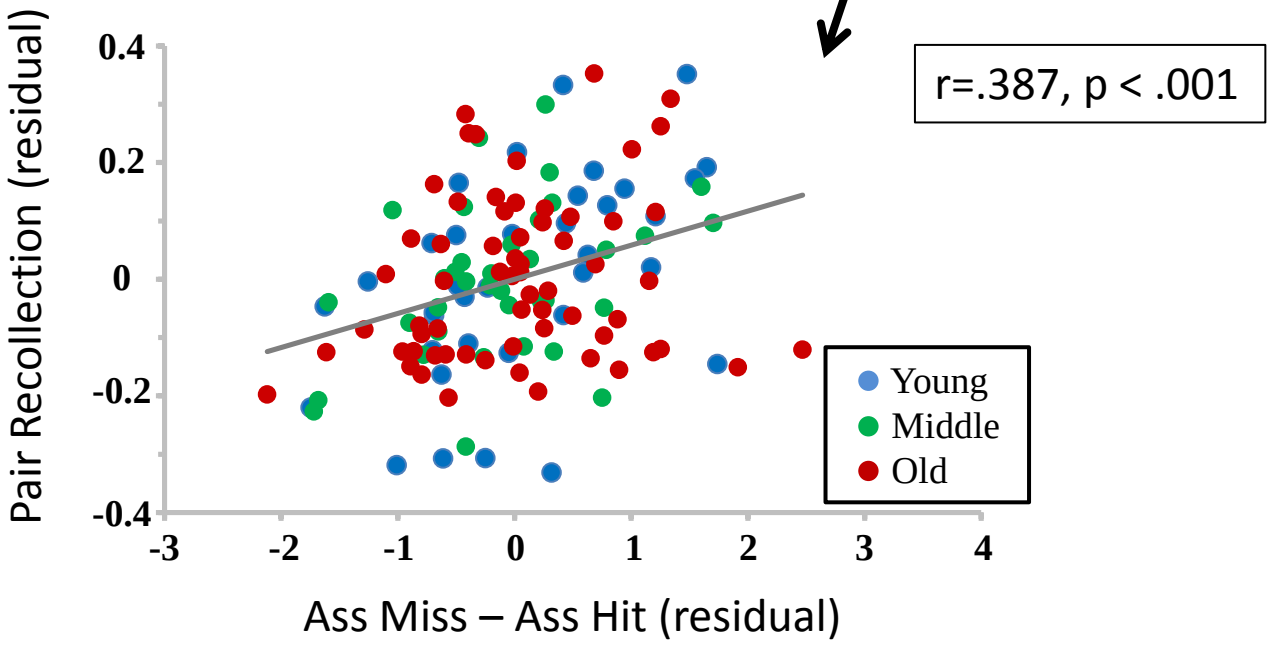
Critical contrast

Intact pairs judged rearranged > intact pairs judged intact

Anterior cingulate monitoring effects and behavior







Multiple regression model predicting memory performance

Model	*B*	*SEb*	*beta*	*p-value*
Age	-.002	.001	**-.266**	**.001**
Hipp encoding effect	.133	.032	**.235**	**.001**
Hipp retrieval effect	.05	.015	**.244**	**.001**
Retrieval monitoring effect	.07	.013	**.389**	**.001**

Adjusted R^2 = .389

Age = .160
N'image = .229

Conclusions

- Patterns of encoding- and recollection-related activity throughout the brain are remarkably stable across the healthy adult lifespan (up to age 75 or so…)

- At both encoding and retrieval, differential hippocampal activity is a predictor of recollection accuracy regardless of age. Apparent age-related differences in memory-related hippocampal activity are however performance confounds

- The most robust age-related differences are found in negative subsequent memory effects, implicating the encoding processes associated with these effects in age-related memory decline

- Together, the neural correlates of encoding, recollection, and post-retrieval monitoring explain more variance in memory performance than age

Acknowledgments

Marianne de Chastelaine

Erin Horne

Danielle King

Julia Mattson

Tracy Wang

National Institute on Aging

Hippocampal recollection effects and recollection accuracy