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Working memory capacity and attentional networks: relationships between processing, storage and executive control components

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OBJECTIVES

- to present normative data of Working Memory Capacity (WMC) and Attentional Networks (AN).
- to understand the relationships between the processing/time, storage/recall and executive attention components of the cognitive system.

THEORETICAL BACKGROUND

Working memory capacity (WMC) has been shown to be a critical cognitive system which in interaction with attentional mechanisms participates in the production of complex higher order processes.

Working memory capacity (Unsworth & Engle, 2007; Shipstead, Lindsey, Marshall & Engle, 2014): "A system comprising encoding, maintaining, and retrieving from long-term memory the information, goals, and strategies necessary to perform a task".

Attentional Networks (Posner & Petersen ,1990):

- Orienting: is responsible for the selection of information from stimulus entering the system.
- Alerting: facilitates achieving and sustaining an alert state.
- Executive attention: refers to a system that controls interference and solves conflicts between possible responses.

METHODOLOGY

- 1218 university students:
  Female: 56.6%
  Mean of age= 20.18; *SD*= 3.129,
  enrolled in their first academic year.
- Data was collected using a computer-delivered battery:

1) A sociodemographic questionnaire.

2) AOSPAN to measure WMC (Unsworth, Heitz, Schrock, & Engle, 2005). An 85% of arithmetic accuracy criterion was used to control the interference in the span test.

3) ANT to measure attentional networks: alerting, orienting and executive attention (Fan, McCandliss, Summer, Raz, & Posner, 2002)

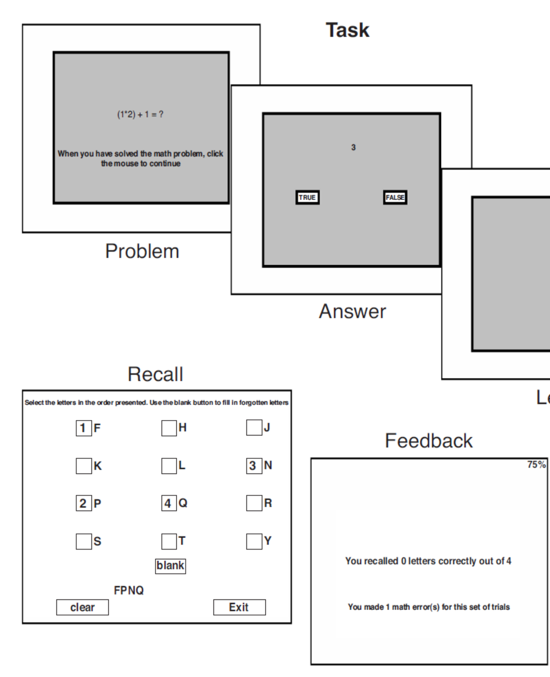


Figura extraida de Unsworth, N., Heitz, R.P., Schrock, J.C., & Engle, R.W. (2005). An automated version of the operation span task. *Behavior Research Methods, 37*(3), 498-505.

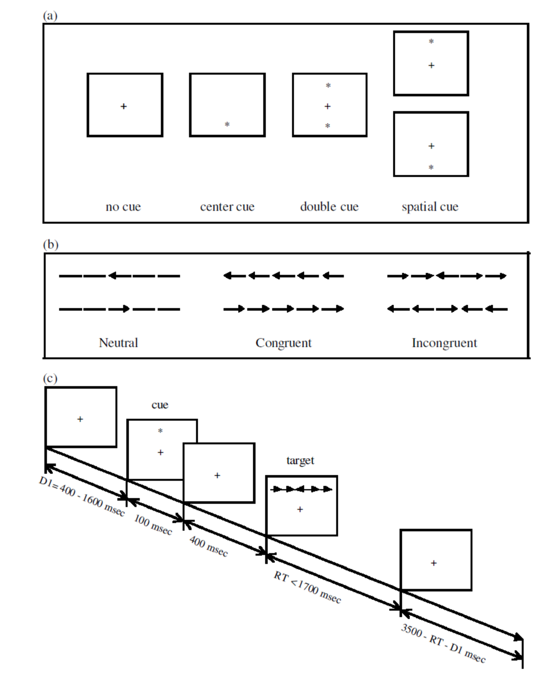


Figura extraida de Fan, J., McCandliss, B. D., Sommer, T., Raz, A. & Posner, M. I. (2002). Testing the efficiency and independence of attentional networks. *Journal of Cognitive Neuroscience, 14*, 340-347.

RESULTS

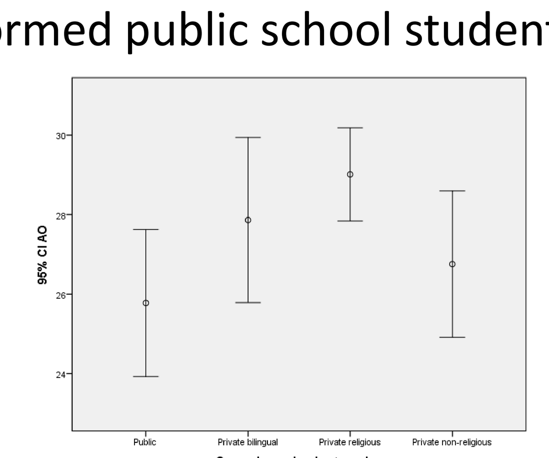
Descriptive measures AOSPAN (Working Memory Capacity) (N= 1560)

		Precision Errors	Math Errors	Recall measure		Speed Errors
Mean		6.54	8.32	27.66	47.77	1.78
SD		3.287	3.958	14.809	13.391	1.984
Skewness		.363	.497	.295	-.672	2.101
Skewness error		.062	.062	.062	.062	.062
Kurtosis		-.582	-.020	-.394	.193	6.612
Kurtosis error		.124	.124	.124	.124	.124
Percentiles	5	**2**	**3**	**4**	**22**	**.00**
	25	**4**	**5**	**17**	**40**	**.00**
	33.3	5	6	20	44	1
	50	6	8	27	49	1
	66.6	8	10	33	55	2
	75	**9**	**11**	**37.75**	**58**	**2**
	95	**13**	**15**	**54.95**	**67**	**6**

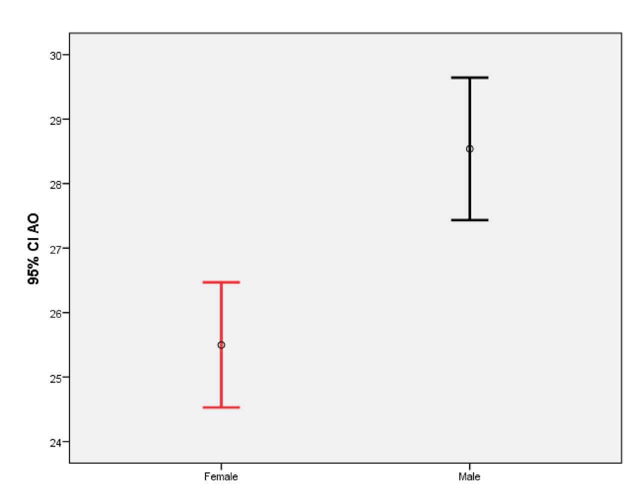
Descriptive measures Attentional Networks Test (N= 1770)

		Alerting	Orienting	Executive control	Total Reaction Time
Mean		35.3693	43.5622	103.6627	502.3294
SD		23.59845	23.40168	42.65829	64.25149
Skewness		.204	-.005	2.230	1.319
Skewness error		.058	.058	.058	.058
Kurtosis		3.182	2.852	13.937	3.905
Kurtosis error		.116	.116	.116	.116
Minimun		-101.83	-81.50	-72.38	350.46
Maximun		167.67	213.83	558.00	997.58
Percentiles	5	**-.1167**	**7.4167**	**53.2500**	**417.0833**
	25	**21.3750**	**29.0000**	**77.5000**	**458.8750**
	33.3	26.0000	34.6667	84.6764	470.1453
	50	34.7500	43.8333	98.3750	492.4583
	66.6	43.5000	52.5000	112.2500	516.1657
	75	**48.9583**	**58.4167**	**120.1562**	**533.4583**
	95	**71.8917**	**80.9167**	**175.8688**	**621.0833**

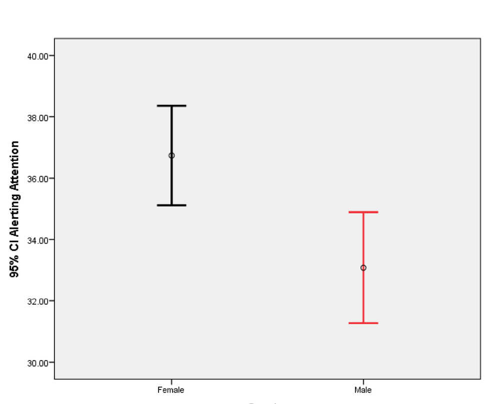
Secondary school background effects were found on recall:
students coming from private religious schools outperformed public school students ($p<.05$; $\eta^2=.009$).

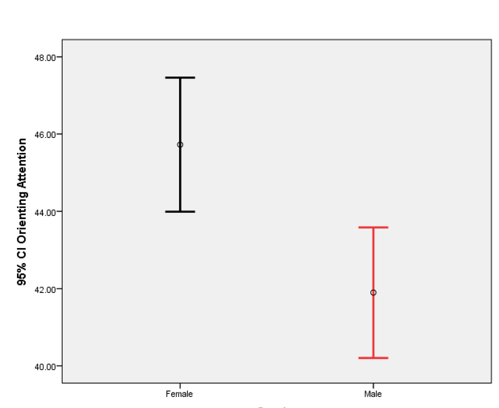


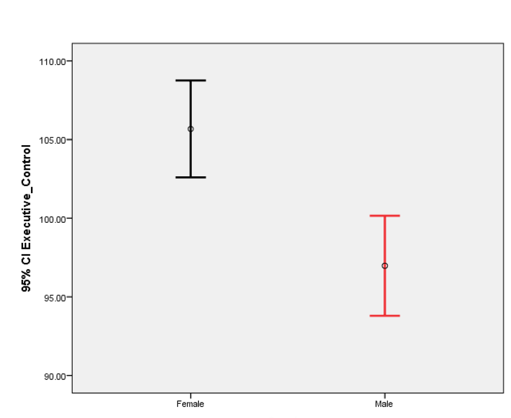
Gender effects on the recall measure of WMC ($F_{(1,1386)} = 15.770$; $p < .001$; $\eta^2 = .011$).



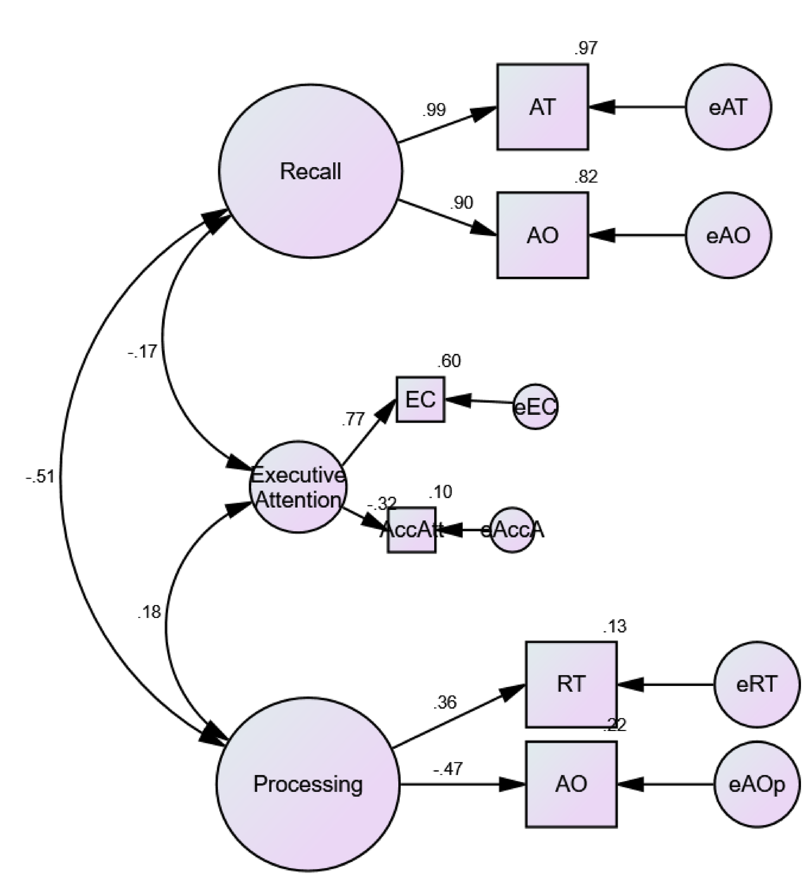
Gender effects on:
alerting ($F_{(1,1370)} = 8.711$; $p = .003$; $\eta^2 = .006$),
orienting ($F_{(1,370)} = 9.250$; $p = .002$; $\eta^2 = .007$),
executive attention ($F_{(1,1367)} = 14.478$; $p < .001$; $\eta^2 = .01$),







Males outperformed females on these measures but the magnitude of these effects were small



χ^2=24.838; χ^2/gl=4.14; p=.001;
NFI=.990; CFI=.992; RMSEA= .047

A three-factor model (SEM) achieved a very good fit involving:

1- Processing/reaction time (Reaction Time and Accuracy).

2- Storage/recall (total and absolute number of letters recalled).

3- Executive attention (Accuracy and Reaction Time).

DISCUSSION

- The effect of gender on AN is consistent with those found in previous studies in adults during visuospatial tasks (Bradshaw & Nettleton, 1983; Kolb & Whishaw, 1985).
- The gender differences in WMC are consistent with previous neuroimaging studies which also found a different functional brain organization for this type of task between men and women, perhaps because of problem solving strategies used or neurodevelopment (Speck et al., 2000).
- Relative independence between WMC and Executive Attention.
- Negative correlation between reaction time and recall: slow RT/less recall

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