Effect of Low Attentional Control on Working Memory & Intelligence

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INTRODUCTION

Studies examining the mechanisms of complex memory processing have led to a greater understanding of working memory capacity and its relation to other cognitive processes. Such studies have found that working memory capacity (WMC) is strongly related to general fluid (Gf) intelligence.[2,3,4]

Methods for measuring WMC include complex span tasks, such as operation span (O-SPAN) and symmetry span (S-SPAN) tasks.[1,2,4] Other methods of measuring WM include verbal working memory (VWM) and symbolic working memory (SWM) tasks, from the Wide Range Assessment of Memory and Learning 2nd edition (WRAML2).

Typical methods of measuring Gf include verbal (e.g., Inferences and Letter Sets) and nonverbal (e.g., Ravens) tasks. [2,3,4]

The current study utilized each of these tasks to examine the relationship between WM capacity and Gf intelligence among the undergraduate student population at CSUSB. Interestingly the typically strong association between WMC and Gf intelligence was not found in the current sample.

Specifically O-SPAN did not predict Gf intelligence. We suggest that certain characteristics of the O-SPAN including the length and difficulty of the task, increase the demands placed on attentional control. While other working memory tasks like S-SPAN and VWM require less attentional control.

We argue that tasks with high requirements of attentional control , like O-SPAN, may show a weaker relationship with Gf intelligence than other less demanding tasks, when the sample of interest has low attentional control.

METHODS

Participants consisted of 138 college students recruited from CSUSB (129 females, 9 males, M_{age} = 24 years, age range: 18-50 years). Participant class rank ranged from freshman to senior standing. Participants were compensated with extra course credits after completion of both sessions.

The following are descriptions of the tasks administered to each participant:

Gf Intelligence tasks

Letter Sets: find the set of letters that does not fit the rule shared by the other sets

Inferences: find the only inference that can be true based on a set of given statements

Ravens Advanced Matrices: find the missing piece that completes an abstract visual pattern

WM Capacity tasks

OSPAN: hold a set of letters in memory while simultaneously performing math problems (computerized task).

SSPAN: hold a set of spatial locations in memory while simultaneously deciding if presented images are symmetrical or not (computerized task).

VWM (WRAML2): maintain in memory and reorder verbally presented sets of animal and non-animal items

SWM (WRAML2): maintain in memory and reorder verbally presented sets of number and letter items

Simple Span tasks

Finger Windows (WRAML2): replicate a visual pattern of holes presented on a plastic card

Number Letter (WRAML2): repeat sets of verbally presented number and letter items

PROCEDURES

Participants completed two 60 minute sessions in which they were assessed using measures of WMC and Gf intelligence. Participants were assessed individually and tasks during a given sessions were administered by a single researcher.

In the first session, each participant completed a brief demographic questionnaire (approximately 5 min), the O-SPAN task (approximately 25 min), the WRAML finger windows test (approximately 10 min), the WRAML Verbal Working Memory task (approximately 10 min), and the Letter sets test (approximately 10min).

During the second session each participant completed the S-SPAN task (approximately 15 min), the WRAML2 Number Letter task (approximately 10 min), the WRAML2 Symbolic Working Memory task (approximately 10 min), the Inferences test (approximately 10 min), and the Raven's Advanced Progressive Matrices Test (approximately 12 min).

RESULTS

Regression analysis indicated that O-SPAN was not a significant predictor of the Gf composite created from the three Gf measures, R = .157, R^2 = .025, $F(1,136) = 3.45$, b = .024, β = .157, $p > .05$. S-SPAN on the other hand was a significant predictor, R = .324, R^2 = .105, $F(1, 136) = 15.987$, b = .081, β = .324, $p < .001$. A simultaneous regression including all of the WRAML tasks indicated that the model significantly predicted the Gf composite, R = .569, R^2 = .324, $F(4,132)$ = 15.81, $p < .001$.

Table 1

Correlations among tasks

	1	2	3	4	5	6	7	8	9
1) WRAML2 FW SS	1								
2) WRAML2 NL SS	.121	1							
3) WRAML2 VWM SS	.133	.579 *	1						
4) WRAML2 SWM SS	.257 *	.479 *	.548 *	1					
5) OSPAN partial	.243 *	.258 *	.200 *	.251 *	1				
6) SSPAN Partial	.499 *	.172 *	.121	.208 *	.369 *	1			
7) Raven	.288 *	.208 *	.308 *	.310 *	.143	.350 *	1		
8) Letter Sets Total	.385 *	.283 *	.424 *	.336 *	.158	.257 *	.530 *	1	
9) Inferences Total	.110	.140	.324 *	.306 *	.055	.162	.296 *	.282 *	1

Note. Significant correlations are indicated by * ; $p < .05$

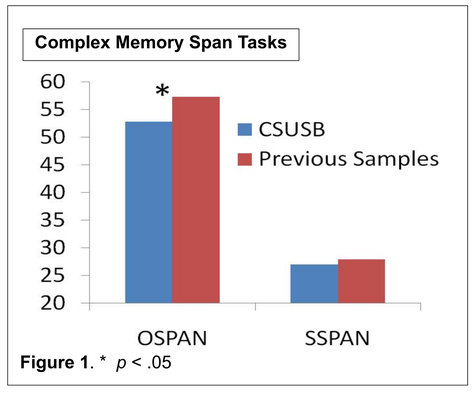

Figure 1. * $p < .05$

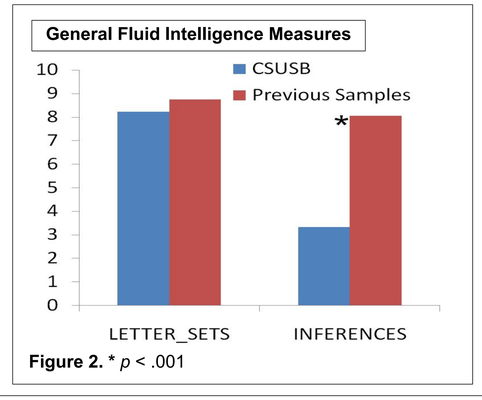

Figure 2. * $p < .001$

DISCUSSION

Previous research has found a strong relationship between WMC and Gf, with O-SPAN being one of the most commonly used measures of WMC.[2,3,4] As shown in the results, O-SPAN was not a significant predictor of Gf. Table 1 indicates that O-SPAN did not significantly correlate with any of the Gf measures used. S-SPAN predicted Gf and as shown in Table 1 correlated significantly with two of the three Gf measures used. However, as indicated in Figure 1, the CSUSB population's mean O-SPAN score was significantly lower than the mean scores from previous samples.

We suggest that O-SPAN's longer duration and more complex distracting component (math problems), may require higher attentional control. Recent research [5] (see Figure 4) has suggested that attentional control has a strong and complex relationship with working memory and the mechanisms that underlie retrieval of task relevant information.

Previous models [4] have shown a clear relationship between WMC and Gf, but it has recently been suggested that attentional control may be a common component of both constructs. We suggest that for populations with lower attentional control, O-SPAN may not measure WMC as well as less demanding tasks. This would explain why O-SPAN did not predict Gf in the current sample. Future research should include a variety of attentional measures in order to further understand attention's relationship with WMC and Gf.

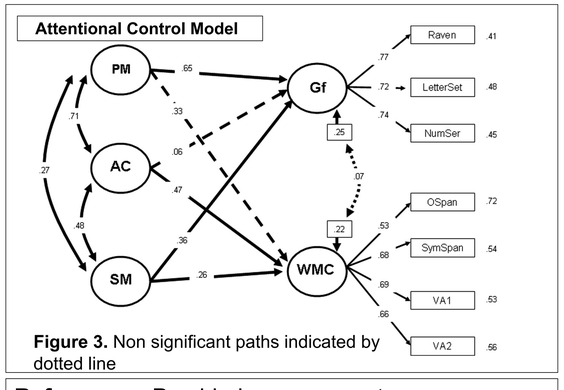

Figure 3. Non significant paths indicated by dotted line

References: Provided upon request