Do the *g* Loadings on Forward and Backward Visual Tasks Match Those of Auditory Tasks?

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ABSTRACT

Previous research has shown that the Backward Digit Span task on the Wechsler Intelligence Scales has a higher *g* loading than the Forward version of the same task (Jensen & Figueroa, 1975), which is likely due to the increased information-processing resources required for the Backward Digit Span task. The Wechsler Memory Scale utilizes a nonverbal version of the Digit Span task that uses visually-presented stimuli (Spatial Span). No research to date has been done on the *g* loadings of the Spatial Span tasks. The purpose of this study is to assess the pattern of *g* loadings on the Forward and Backward Spatial Span tasks.

INTRODUCTION

In the Wechsler Intelligence Scales, one of the subtests (Digit Span) requires the recall of orally presented integers (digits). The subtest is split into two forms of this task. In the first form, Forward Digit Span, the respondent repeats verbatim the string of digits heard. The second form of the task, Backward Digit Span, is more difficult for most, as it requires the respondent to repeat the digits heard in reverse order. Jensen and Figueroa (1975) were the first to look at the difference in *g* loadings between Forward and Backward Digit Span tasks.[1] They found that while neither task had a particularly high *g* loading, the Backward Digit Span had almost twice the *g* loading of the Forward Digit Span. Jensen (1981) explains:

> *The main difference is that backward digit span requires more mental work and manipulation than forward digit span, which requires only reproductive memory. In the backward digit span task, the subject must transform the input . . . This extra mental manipulation or active transformation of the input is the source of backward digit span's greater* g *loadings* (p. 61).

The Wechsler Memory Scale uses Spatial Span, a task similar to the Digit Span task, except the stimuli are presented visually instead of orally. In this subtest, the respondent is required to tap a sequence of blocks in the same order the examiner taps them. Like its Digit Span counterpart, the Spatial Span task has both Forward and Backward components, with the Backward component requiring the respondent to tap the blocks in the reverse order of the demonstrated sequence. To date, there has been no systematic examination as to whether the *g* loadings on the Spatial Span Forward and Backward tasks are similar to those of the Digit Span tasks. Consequently, the purpose of this project is to assess the pattern of *g* loadings on the Forward and Backward Spatial Span tasks, comparing the results to those found on the Forward and Backward Digit Span tasks.

[1]In this context, *g* refers to general intelligence, as first derived by Spearman (1904).

METHOD

Forty-five subjects were gathered as part of a larger study on mathematics disabilities. They were given the Wechsler Adult Intelligence Scale-III (WAIS), the Wechsler Memory Scale-III (WMS), and the Woodcock-Johnson III Tests of Achievement (WJ). All the subtests of the WAIS (except for WAIS Digit Span, which was split into Forward and Backward Digit Span), six subtests of the WJ and the WMS Forward and Backward Spatial Span were correlated, yielding 22 manifest variables. As 45 is a very small *n* from which to extract factors from a $\mathbf{R}_{(22)}$ matrix, the correlations were bootstrapped using 1000 iterations, and the mean value was used as input to model the factorial relationship. The bootstrapped $\mathbf{R}_{(22)}$ was factor analyzed, and three factors fit the data best. The three factors were rotated obliquely (see Johnson & Wichern, 2002) and the pattern matrix and the factor correlation matrix were used to extract second-order factors via the method described by (Schmid & Leiman, 1957) (see **TABLE 1** for factor loadings).

TABLE 1: ***EFA Factor Loadings*** (some subtest *g* loadings omitted for space)

	g	f1	f2	f3	h^2
WAISInformation	0.766	0.420	0.064	-0.019	0.767
WAISVocabulary	0.657	0.410	-0.052	-0.002	0.603
WAISDigitSpanForwardRawScore	**0.412**	**0.309**	**-0.135**	**-0.007**	**0.283**
WAISSimilarities	0.463	0.302	0.006	-0.163	0.333
WAISComprehension	0.558	0.261	0.202	-0.169	0.449
WAISDigitSpanBackwardRawScore	**0.436**	**0.255**	**-0.036**	**0.085**	**0.264**
WAISLetterNumberSequencing	0.494	0.175	0.167	0.145	0.323
WJIIIAppliedProblems	0.503	-0.008	0.641	-0.080	0.671
WJIIICalculation	0.347	-0.089	0.632	-0.109	0.540
WAISArithmetic	0.585	0.048	0.573	0.042	0.675
WAISPictureCompletion	0.325	0.064	0.217	0.083	0.164
WAISSymbolSearch	0.174	-0.050	-0.038	0.807	0.686
WAISCoding	0.147	0.003	-0.088	0.601	0.391
WMSSpatialSpanForwardRawScore	**0.064**	**-0.108**	**0.087**	**0.481**	**0.255**
WAISPictureArrangement	0.125	0.033	-0.111	0.448	0.230
WMSSpatialSpanBackwardRawScore	**0.271**	**-0.019**	**0.166**	**0.447**	**0.301**
WAISMatrixReasoning	0.362	0.095	0.100	0.312	0.247
WAISBlockDesign	0.312	0.033	0.183	0.277	0.208
SUMSQ	4.321	0.993	1.502	2.102	8.917
%CCV	48.45	11.13	16.84	23.57	

WAIS: Wechsler Adult Intelligence Scale-III; **WMS:** Wechsler Memory Scale-III
WJ-III: Woodcock-Johnson III Tests of Achievement
SUMSQ: Sum of Squares; **%CCV:** Percent Covariance

RESULTS

From **TABLE 1**, the Spatial Span tasks follow the same pattern as that of the Digit Span tasks, although the magnitude of the *g* loadings for the Spatial Span tasks are much lower. More specifically, although the Backward Digit Span task has a higher *g* loading than its Forward counterpart **(.436** and **.412**, respectively) the *g* loadings are very similar. For the Spatial Span tasks, the pattern is the same, but the *g* loadings are very different, with the Backward Spatial Span task having almost a 2.5 times larger loading than the Forward version of the task **(.271** and **.064**, respectively).

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