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ABSTRACT

A 1978 study (Torgesen, Bowen and Ivey) of the structure and modality variables of the Visual-Aural Digit Span (VADS) test was replicated to determine: (1) if the effects generalized across age; (2) if differences between simultaneous and sequential visually presented items were due to mode of presentation or the amount of study time; (3) the effects of mode of output; and (4) the relationship between performance on the various tests and performance on standard achievement tests in mathematics and reading for second and fourth graders. The major consistent finding was that all groups performed significantly better on simultaneous digit span tests than on sequentially presented digit span tests. However, there was no significant difference in overall performance between second and fourth graders. Unlike Torgesen et al., the consistent positive and significant correlations among performance on all conditions argued for a consistent memory for order across different conditions. Finally, the failure to find significant correlations between the memory for order measures and achievement scores fails to replicate earlier studies. Possible explanations for the failure to replicate revolves around differences in age of subjects and measures used. (Author/PN)

The Visual-Aural Digit Span: Is the Type of Response a Factor in Performance?

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Running Head: Digit Span

In a recent study conducted by Torgesen, Bowen and Ivey (1978), the structure and modality variables of the Visual-Aural Digit Span Test (VADS) were investigated as they relate to reading performance. The VADS is a test developed by Koppitz (1970) as a measure of sequential memory skills and was designed to diagnose problems in information processing in learning disabled children. The test consists of digit span subtests presented visually and orally while the response is required in oral or written form. Originally Koppitz had hypothesized that the reason there were significant differences between L.D. and non L.D. fourth graders on the Visual Presentation Oral response subtest was due to the similarity between this subtest and the reading task itself. Torgesen et al. on the other hand pointed out that in the VADS the modality was confounded with presentation mode. More specifically, in the visual mode all items were presented at the same time while in the oral mode they were necessarily presented sequentially. Consistent with his earlier theorizing Torgesen hypothesized the menemonic strategies can be used more efficiently when all items are seen simultaneously and normal children would be more apt to spontaneously use such strategies than L.D. children. Torgesen then acquired his own sample of normal and L.D. children (at about fourth grade level) and verified his hypothesis in two ways. First, the only significant differences between normal and L.D. children were on the visual simultaneously presented tasks (written and oral responses). While the normal readers had higher mean scores on the other tasks

(auditory-oral, auditory-written, visual sequential-oral, visual sequential-written), the differences were not significant. It should also be mentioned that both groups performed considerably better on the simultaneously presented tasks. In addition, the relationship among tasks that had some structure but different modalities were more likely to be significantly correlated than tasks which had same modality but different structure. He did not relate performance on these tasks to reading achievement for the normal students.

There were several major goals of the present study. First, we were interested in replicating the Torgesen, Bowen and Ivey findings using normal children at fourth and two other grade levels to determine if the effects generalized across age. In this case we would predict that the difference between simultaneous and sequential presentation would increase with age because more older subjects would be more likely to spontaneously adopt rehearsal strategies. Second, we were interested in determining if differences between simultaneous and sequential visually presented items were due to the mode of presentation or the amount of study time presentation. In the Torgesen study the simultaneous presentation modes all provided the same amount of study time. In the present study we added a condition in which study time depended on number of items presented. Third, we were interested in the effects of mode of output. It is possible that several strategies (e.g., write down all numbers in short term memory and then order them) could be adopted in the written response mode. Finally, we were interested in

determining the relationship between performance on the various tests and performance on standardized achievement tests in mathematics and reading for the second and fourth graders. Typically it has been found that measures of memory for order including the Digit Span Forward are significantly correlated with other measures of cognitive ability (e.g., Cohen & Sandberg, 1977; Hall & Kaye, 1980).

Method

Subjects. Subjects were 20 subjects (counter balanced by sex) each in second grade, fourth grade, and college. The grade school students were randomly selected from a pool of subjects whose parents had signed permission slips which allowed them to participate and the college subjects from a subject pool of introductory psychology subjects.

Tasks. The eight tasks listed below were presented to each subject in a random order. Each task consisted of a list of digits which the subjects were required to recite in order of presentation.

Tasks

Test	Presentation	Response
1-2	Visual/Simultaneous (9 seconds for all)	written and oral
3-4	Visual/Simultaneous, T (times according to number of items e.g., 2 items = 2 seconds)	written and oral
5-6	Visual/Sequential	written and oral
7-8	Oral/Sequential	written and oral

The aural presentation was via tape recorder with a one second per item rate. The visual presentations were via a CRT attached to a microcomputer. The sequential subtests were presented at the rate of one digit per second across a horizontal plane of the CRT. The simultaneous presentations were also displayed horizontally. As indicated above one condition displayed all digits for 10 seconds the other displayed the items by utilizing the formula of each digit multiplied by one second.

The scoring system utilized for the digit spans was similar to that used on the Wechsler Intelligence Scale for Children - Revised (Wechsler, 1974). The subjects received each span length twice, starting with three, and continuing until subjects missed the same length twice or correctly recited all digits. The score for each subject was calculated at one point per each order correctly recalled.

Results

Table 1 includes means and standard deviations for each condition in each grade along with means and standard deviations reported by Torgesen. Subsequent analyses revealed that for all three ages performance on simultaneous conditions was superior to performance on sequential presentation ($p < .01$). It is also possible to ascertain that this superiority was greater for fourth and college subjects. For second graders only the visual sequential oral group was clearly inferior to the simultaneous groups. There were no significant effects due to the time variable on visual simultaneous presentation or mode of output.

Table 2 includes the correlations among the different treatments for each age group. For second graders and college students the correlations were uniformly significant and positive. The correlations for fourth graders were considerably lower and no clear pattern of correlations were found. It was true, however, that in contrast to the Torgesen et al. findings modality was more important than structure (one of four possible same structure different modality correlations were significant while five of eight possible different structure same modality correlations were significant).

Table 3 includes correlations between performance on the different conditions and total reading and mathematics achievement scores. It is clear that there were no consistent patterns of correlations between performance on the total reading and mathematics achievement test scores and the measures of digit span. We did include correlations between performance on the memory for order subtests and the application subtest on the achievement test because it was significant for the second graders.

Discussion

The major consistent finding was that all groups performed significantly better on simultaneous than sequentially presented digit span tests. This is consistent with the findings of Torgesen et al.

The other results were rather puzzling. In the first place we believe that our second and fourth grade sample was not typical and results acquired from this group must be viewed with caution. Numerous

studies (including norming studies on the WISC-R and Stanford Binet as well as large scale longitudinal studies such as Hall & Kaye, 1980) have found Digit Span to increase with age over these same age spans. In our sample however, there was no significant difference in overall performance between our second and fourth graders. Of particular interest was the lack of significant relationships among performance on the different treatments for fourth graders.

Second, the consistent positive and significant correlations among performance on all of the conditions for the second graders and college students did not replicate Torgesen et al. Instead it argued for a consistent memory for order across different conditions. This would replicate findings by Merkel & Hall (1982), and Martin (1978).

Finally, the failure to find significant correlations between the memory for order measures and achievement scores fails to replicate earlier studies by Cohen & Sandberg (1977), Hall & Kaye (1980) and Merkel & Hall (1982). Possible explanations for the failure to replicate revolves around differences in age of subjects and measures used.

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Table 1

Means and Standard Deviations for all Subjects in all Conditions (Including Torgesen et al.)

Grade		Vis/Sim Oral	Vis/Sim Written	Vis/Sim Oral(T)	Vis/Sim Written(T)	Vis/Seq Oral	Vis/Seq Written	Aud/Seq Oral	Aud/Seq Written
2	$\bar{X}$	5.95	5.40	6.05	5.30	4.10	5.25	5.30	5.50
	SD	1.19	.99	1.32	1.17	1.37	1.21	1.17	1.14
4	$\bar{X}$	5.85	5.90	5.80	6.05	5.65	4.85	4.75	4.35
	SD	.99	1.07	.89	1.10*	1.27	.87	.97	.99
C	$\bar{X}$	8.10	8.15	8.40	8.45	7.25	7.40	6.70	7.25
	SD	.92	.99	.82	.83	1.21	1.14	1.22	1.02
*	$\bar{X}$	6.7	6.5			4.5	4.6	4.9	5.1
T	SD	.47	.51			1.20	.79	.93	1.06

*Torgesen's good readers

Table 2

Correlations Among Conditions

in the Present Study

	Grade	Vis/Sim Oral	Vis/Sim Written	Vis/Sim Oral(T)	Vis/Sim Written(T)	Vis/Seq Oral	Vis/Seq Written	Aud/Seq Oral	Aud/Seq Written
Vis/Sim	2								
	4								
Oral	C								
Vis/Sim	2	.72							
	4	.28							
Written	C	.74							
Vis/Sim	2	.71	.58						
	4	.44	.36						
Oral(T)	C	.58	.58						
Vis/Sim	2	.69	.75	.67					
	4	.35	.36	.44					
Written(T)	C	.50	.43	.65					
Vis/Seq	2	.78	.62	.67	.60				
	4	.63	.36	.58	.32				
Oral	C	.50	.27	.64	.67				
Vis/Seq	2	.78	.74	.59	.80	.40			
	4	.70	.54	.50	.23	.42			
Written	C	.47	.60	.66	.69	.61			
Aud/Seq	2	.80	.74	.57	.69	.60	.80		
	4	.23	.23	.36	.26	.53	-.05		
Oral	C	.41	.43	.49	.45	.52	.58		
Aud/Seq	2	.75	.74	.57	.66	.54	.82	.82	
	4	.22	.48	.50	.22	.19	.37	.15	
Written	C	.59	.48	.57	.55	.50	.45	.66	

*.45 sign at .05

Table 3

Correlations Between Performance on Memory and Achievement Tasks*

	Grade	Vis/Sim Oral	Vis/Sim Written	Vis/Sim Oral(T)	Vis/Sim Written(T)	Vis/Seq Oral	Vis/Seq Written	Aud/Seq Au	Aud/Seq
Total	2	.26	.21	.34	.02	.15	.18	.19	.15
Reading	4	.06	-.24.	-.04	-.16	.18	.37	-.14	-.03
Total	2	.28	.45*	.39	.12	.28	.28	.27	.28
Math	44	.27	.39	.25	.48*	.39	.44*	.12	.30
Math	2	.51*	.60*	.58*	.42	.44*	.52*	.47*	.40
App	4	.34	.30	.30	.36	.42	.53*	.17	.38

*Achievement Test is the Stanford Achievement Test, scaled scores were used for analysis.