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Gender Differences on Planning, Attention, Simultaneous, and Successive Cognitive Processing Tasks

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The study examined gender differences on the Das–Naglieri planning, attention, simultaneous and successive processing tasks developed following the Planning, Attention, Simultaneous and Successive model of cognitive processing. The study's two samples of 434 (Grades 2, 6, and 10) and 110 (combined Grades 4 and 5) children included pupils from several schools in a large midwestern suburban school district. The results indicated that boys and girls performed similarly on simultaneous, successive, and attention measures but girls outperformed boys on measures of planning processes. These differences were significant for the sixth graders in the first sample and for the combined sample of fourth and fifth graders. These results suggest that a broader definition of intelligence, one that includes measures of planning and attention in addition to simultaneous and successive processes, might provide useful information when cognitive differences and similarities of the genders are examined. Implications of these findings are discussed.

Das, Kirby, and Jarman (1975) and recently Naglieri and Das (1990) have operationalized measures of planning, attention, simultaneous, and successive (PASS) cognitive processes following from Luria (1966, 1973, 1980). In their early research, Das (1973) and his colleagues (Das, Kirby & Jarman, 1975, 1979) operationalized Luria's second functional unit, which is responsible for the acquisition, storage, and retrieval of knowledge through simultaneous and successive processes. Following development of tasks intended to measure the second functional unit, Luria's third functional unit (planning) was operationalized (Das, 1980, 1984; Das & Dash, 1983; Das & Heemsbergen, 1983; Naglieri and Das, 1988; Naglieri, Das, Stevens, & Ledbetter, 1990; Naglieri, Prewett, & Bardos, 1989). Measurement of Luria's first functional unit, which

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is involved in maintaining attention and a proper state of arousal, has only recently been included with planning, simultaneous, and successive tasks (Hurt & Naglieri, 1992; Naglieri, Das, Stevens, & Ledbetter, 1990; Naglieri, Prewett, & Bardos, 1989).

In the PASS model, planning processes provide the individual with a mechanism for regulation and verification of activity, impulse control, generation of plans of action, inspection of actions so that the aims of the plans may be attained, and the development of new plans. This component entails the aptitude for asking new questions, solving problems, and self-monitoring, which Das (1984) suggests represent the most complex form of human behavior. Attentional processes maintain an appropriate level of arousal and focus of attention vital for effective performance. Luria's information coding processes (simultaneous and successive) are responsible for the acquisition, storage, and retrieval of knowledge. Simultaneous processing involves the integration of stimuli into groups (where each element of the task is related to every other) and successive processing involves the integration of stimuli into a specific linear series (where each element is related only to the next). Figure 1 provides a graphic representation of the planning, attention, simultaneous and successive (PASS) model of cognitive processes. For a more complete description of these processes see Das, Kirby & Jarman (1979), Naglieri (1989), Naglieri and Das (1990), and Naglieri, Das, and Jarman (1990).

Research investigations of the PASS processes have shown that these processes have been identified at several ages, have been found in different cultures, are measurable for various kinds of exceptional children, and are significantly related to achievement (Naglieri, 1989; Naglieri & Das, 1990; Naglieri et al., 1990). Importantly, planning processing tasks have been found to correlate significantly with achievement (Bardos, 1990; Das, 1980; Ashman & Das, 1980; Das, 1984; Das & Dash, 1983; Das & Heemsbergen, 1983; Garofalo, 1982; Naglieri & Das, 1987; Schofield & Ashman, 1986; Stutzman, 1986; Warrick, 1989). This is a crucial finding, because planning processes are not assessed by current intelligence tests such as the Wechsler, Stanford-Binet, or the K-ABC (Naglieri & Das, 1990; Naglieri et al., 1990).

Despite the large body of research on simultaneous and successive processing and the emerging research on planning and attention, few researchers have examined gender similarities and differences on the PASS tasks. Although investigations and position papers regarding gender differences in cognitive ability continue to appear in the recent literature (Feingold, 1988; Hyde & Linn, 1988; Scarr, 1988), assumptions about gender differences (Maccoby & Jacklin, 1974) have recently been questioned by researchers using meta-analytic techniques (Hyde & Linn, 1988). Regarding the processes related to the PASS model, Merritt and McCallum (1983) examined male and female performance on measures of simultaneous and successive processing and found similar mean scores and factor structure. Their sample was composed of 53 males and 104 female undergraduate students who were administered three

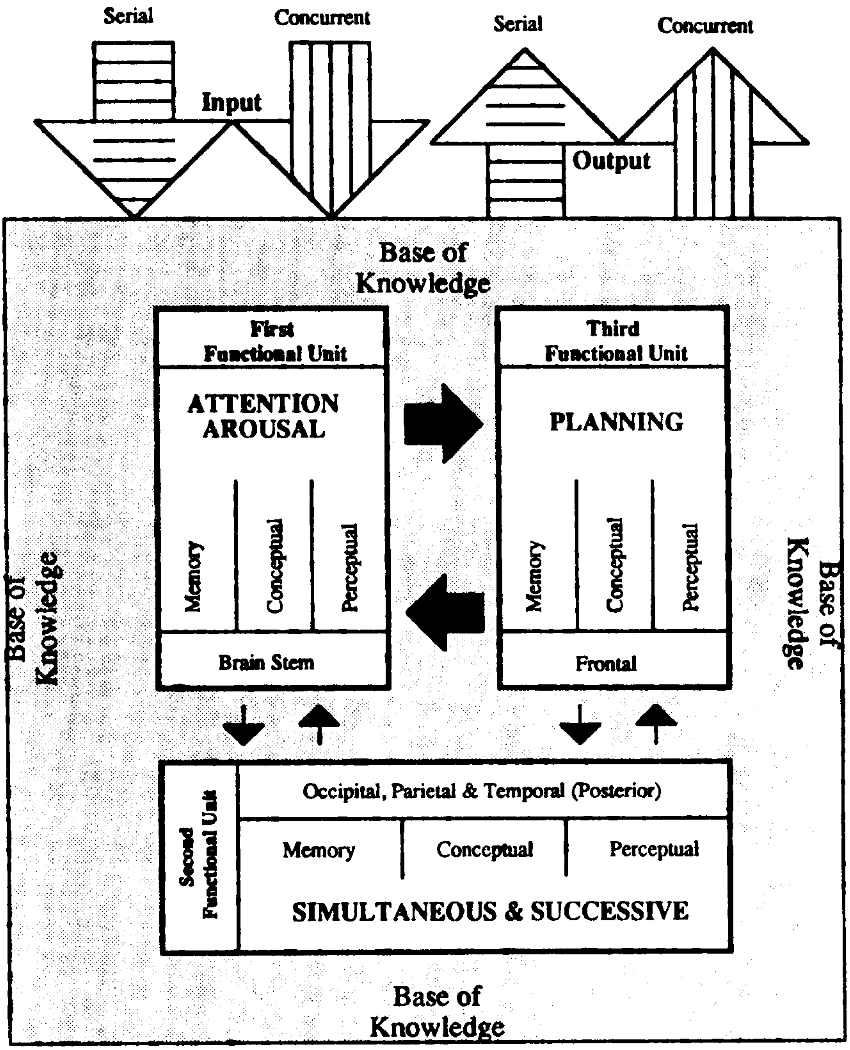

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Figure 1. The Planning, Attention, Simultaneous, Successive (PASS) cognitive processes model.

successive (Digit Span, Free Recall, Serial Recall) and three simultaneous (Raven Matrices, Memory for Designs, and Figure Copying) tasks. It is the only investigation of gender differences on simultaneous and successive processing tasks, and given that measures of planning and attention (Luria's third and first functional units) were not included, that the sample examined only adults (mean age was 22 years), and that no analysis of developmental changes was included, further investigation into gender differences is needed.

The purpose of this investigation was to meet the need to examine gender differences on measures of planning, attention, simultaneous, and successive cognitive processing. The importance of this examination rests on the fact that although for measures of intelligence such as the Wechsler Intelligence Scale for Children–Revised (WISC-R; Wechsler, 1974) gender differences have not been found (Sattler, 1988), males and females have performed differently on academic tasks such as reading and math. Furthermore, demographic data suggest that higher percentages of males are referred, selected for, and receive special education services (D'Amato, Dean, Rattan, & Nickell, 1988; Sutaria, 1985). Because the planning and attention processes are not measured in existing tests of intelligence, a viable hypothesis for explaining gender differences may be that males and females perform differentially on these processes. The tests' limited view of intelligence (Naglieri, 1989) may make tests like the WISC-R and others insensitive to gender differences. In order to address these questions two experiments were conducted into gender differences in PASS cognitive processes. Experiment 1 tested gender differences for planning, simultaneous, and successive tasks. Experiment 2 included attention tasks so that all four processes could be compared.

EXPERIMENT 1

Method

Subjects. A sample of 434 subjects in three grades was included in experiment 1. There were 149 subjects (mean age = 7 years 8 months) at Grade 2 (48% males, 52% females; 89% white, 10% black, 2% other) who attended four elementary schools; 160 (mean age = 11 years 7 months) from two middle schools in Grade 6 (49% males, 51% females; 92% white, 7% black, 1% other); and 125 (mean age = 15 years 7 months) at Grade 10 from one high school (48% males, 52% females; 89% white, 10% black, 2% other).

Procedures and Data Analysis. Nine experimental tasks were administered to all subjects by one of nine trained examiners, who also group-administered the Matrix Analogies Test–Short Form (MAT-SF; Naglieri, 1985). All examiners were advanced graduate students in some area of psychology (e.g., clinical, developmental, school). Cognitive processing composite scores (planning, simultaneous, successive) were obtained by first converting each test score to a standard score (mean of 100 and *SD* = 15) derived from the means and standard deviations for each grade separately and then summing the standard score each subject earned on each task.

Principal factor analyses (R^2 in the diagonal) with oblique rotation were conducted first for each gender in order to determine if the correlational relationships among the variables were similar for males and females and to test the support of organizing processing tasks into processing composites. Examination of the performance of each of the two groups on the resulting processing composites was performed next for each grade by means of profile analyses (SPSS-X, 1986; p. 587). Groff (1983) offered a decision model to aid in the decision on the proper order of testing in the examination of two-sample profile analyses. The first step in this decision model is the test of parallelism, which determines whether differences in means are the same for each group. If the parallelism test does not reject the hypothesis of parallel profiles, a profile levels test and flatness test are conducted. If the null hypothesis of parallel profiles is rejected, then Bonferroni *t* tests are recommended for group contrasts.

INSTRUMENTS

Planning Tasks

Trails. This paper-and-pencil task is similar to the Trail Making task that was originally part of the Army Individual Test of General Ability (1944) and was used by Reitan (1955) and Spreen & Gaddes (1969). This kind of task loads on a planning factor (Ashman & Das, 1980; Naglieri & Das, 1987; Naglieri et al., 1989). The task is considered a measure of planning because the subject has to organize the tasks, prevent perseveration, and plan to shift between rules. The first two items of the task required the connection in their proper sequence of a series of numbers (1 to 2 to 3, etc.) that were arbitrarily arranged on a page. The last two items required alternate connection of numbers and letters in their proper sequence (1 to A, A to 2, 2 to B, B to 3, and so on). The score was the time needed to complete each of the four items.

Visual Search. This task is similar to that developed by Teuber, Battersby, and Bender (1949) and reported by Das (1984) and Naglieri et al. (1989) to load on a planning factor. The student was instructed to point to a picture, number, or letter in a field around a reference picture, number, or letter located in a stimulus box. Each item included two searches per page, one located at the top and the other at the bottom of an 8 1/2″-by-11″ page. The items were timed from the point of exposure to the moment the second target was found. If the subject made an error, he or she was instructed to keep looking for the correct object until the time limit was consumed.

Matching Numbers. This planning task requires the subject to find and circle two numbers that are the same. In our study the numbers ranged from one to six digits in length and were arranged on one page. The total score was the number of correct matches found in 3 minutes. This task has loaded on a planning factor (Naglieri & Das, 1988) owing to the need for an efficient system of determining which of the two numbers match.

Simultaneous Tasks

Matrices. The Matrices task that was used consisted of items from the Pattern Completion and Reasoning by Analogy groups of the Matrix Analogies Test–Short Form (Naglieri, 1985) that have loaded on a simultaneous factor in other research (Naglieri et al., 1989).

Tokens. The Tokens task is one similar to that described by Lezak (1980) and has been used to measure simultaneous verbal functions (Luria, 1966) and shown to load on a simultaneous factor. In the present task 16 tokens that varied by size (large and small), shape (square and circle), and color (blue, yellow, white, green) were put before each student. The 18 items included directions such as "Give me all the small yellow circles" and "Put, under the small white square, all the circles that are not large."

Figure Recognition. This task requires the subject to trace a geometric design (such as a square or triangle) that has been previously shown for 5 sec when it was embedded in a more complex figure. In the present design, for a response to be scored correct, all lines of the design had to be indicated without any additions or omissions. The subject's score was the total number correct. This task is similar to those used by Das et al. (1979) and Naglieri & Das (1988) as a simultaneous marker task.

Successive Tasks

Hand Movements. This task, which has loaded on a successive factor (Naglieri & Das, 1988), requires the repetition of a series of simple hand movements in a manner described by Luria (1980). Because six hand movements, rather than three, are used, this task differs from the Hand Movements subtest of the Kaufman Assessment Battery for Children (Kaufman & Kaufman, 1983), which has shown only marginal effectiveness as a successive task.

Successive Ordering. This task, which was shown to load on a successive factor by Das & Naglieri (1988), requires the subject to reproduce the specific order of a serial event. In this study the task required the student to touch circular shapes (approximately one inch in diameter) arranged linearly on a small board in the same order as that demonstrated by the examiner.

Word Recall. The recall of words has been shown to load on a successive factor in numerous studies (Das et al., 1979; Naglieri & Das, 1988; Naglieri et al., 1989) and therefore was considered a marker for successive processing. This task consisted on nine single-syllable words that were presented orally by the examiner in a series of 24 items ranging in length from two to nine words. The student's score was the total number of words correctly recalled.

Experiment 1 Results

Factor analyses were conducted for boys and girls separately using all grade groups because of the similarity among the factors by grade reported by Naglieri and Das (1988) for these data. Three factors of eigenvalues > 1 emerged for boys (2.9, 1.2, 1.1) and for girls (2.5, 1.3, 1.0), which suggested a three-factor solution was appropriate. Table 1 presents the three-factor promax solutions for the two groups. A coefficient of congruence (Gorsuch, 1983) of .93 was obtained for the factor loadings across the two groups, which indicates that the results are similar for males and females. These results also support the organization of tasks into groups that are labeled Planning (Trails, Visual Search, and Matching Numbers), Simultaneous Processing (Tokens, Figure Recognition, and Matrices) and Successive Processing (Word Recall, Hand Movements, and Successive Ordering). Furthermore, the factorial results supported the development of composite scores and comparisons of performance levels between males and females across planning, simultaneous and successive cognitive processes.

The means and standard deviations of scores for the three composites earned by the boys and the girls are presented in Table 2 for each grade level. The significant test of parallelism in profile analysis rejected the hypothesis of parallel profiles, which suggests a gender-by-variable interaction for Grade 6 [$F(2, 153) = 5.43, p < .005$] and Grade 10 [$F(2, 118) = 3.14, p < .04$]. In order to determine which of the composite scores contributed to the overall multivariate significance, t tests were performed with the Bonferroni correction to keep the overall Type I error rate at .05. The girls performed significantly better than the boys on the Planning Composite at Grade 6 ($t = 2.9$). Similarly, although the test of parallelism was rejected at Grade 10, subsequent Bonferroni t tests revealed that the somewhat higher performance of the girls on the Planning Composite score did not reach statistical significance ($t =$

Table 1
Promax Factor Loadings of Cognitive Tasks for Male and Female Students (Experiment 1)

	Males (n = 243)			Females (n = 224)		
Tasks Factors[a]	I	II	III	I	II	III
Matching Numbers	**59**	−11	22	**37**	25	01
Trail Making	**59**	−08	03	**43**	10	08
Visual Search	**58**	04	−11	**74**	−11	−06
Matrix Analogies	−08	**84**	−05	−04	**74**	−08
Tokens	11	**32**	17	01	**48**	−08
Figure Recognition	13	**30**	10	10	**30**	12
Hand Movements	−09	00	**61**	00	08	**49**
Successive Ordering	06	01	**49**	18	08	**39**
Word Recall	07	07	**38**	−07	−06	**53**

Note: Decimal points are omitted.
[a]I, Planning; II, Simultaneous; III, Successive.

Table 2
Means and Standard Deviations for Male and Female Students Across Three Grades (Experiment 1)

	Planning		Simultaneous		Successive	
	Mean	*SD*	Mean	*SD*	Mean	*SD*
Grade 2						
Males	99.5	11.5	100.8	10.2	100.5	10.8
Females	100.5	10.7	99.0	10.9	99.6	10.8
t test	0.58		1.1		0.6	
Diff/s[a]	−0.12		0.18		0.08	
Grade 6						
Males	97.6	11.0	100.8	11.9	100.3	7.5
Females	102.5	10.8	99.6	9.7	99.7	8.3
t test	2.9		0.7		0.5	
Diff/s[a]	−0.42		0.14		−0.11	
Grade 10						
Males	98.6	12.0	100.6	9.7	100.6	11.7
Females	102.0	9.9	99.4	13.1	99.1	10.3
t test	1.7		0.5		0.7	
Diff/s[a]	−0.39		0.10		0.01	

[a]Diff/s is the difference between male and female means divided by the weighted average *SD* of the two groups.

1.7). The test of parallelism for Grade 2 [$F(2, 153) = 1.05$, $p < .373$] was nonsignificant, suggesting that the profiles were similar for this group. Further univariate tests indicated that the two profiles for the boys and the girls in Grade 2 were coincident and that the small deviations observed could be due to sampling error.

EXPERIMENT 2

Method

Subjects. The sample was composed of 110 elementary school students in Grades 4 and 5 (mean age = 10 years 5 months, *SD* = 7.7 months) who attended a large suburban district in central Ohio. There were 56 boys (mean age = 10 years 5 months, *SD* = 7.6 months) and 54 girls (mean age = 10 years 5 months, *SD* = 7.95 months) from eight regular classrooms and two schools. All students were selected from returned parental permission slips and tested on the basis of availability.

Procedures and Data Analysis. Two advanced-level graduate students in school psychology individually administered all of the processing tasks with the exception of the Matrix Analogies Test–Short Form (Naglieri, 1985), which was group-administered. The results of factor analyses of this same data set (Naglieri et al., 1989) were used to substantiate the organization of tasks into

Planning, Attention, Simultaneous, and Successive Composite scores. The four composites were the averaged scores each subject earned on the following tasks: (1) Planning Composite (Trails, Visual Search, and Planned Codes); (2) Attention (Selective Attention–Expressive); (3) Simultaneous Processing (Matrix Analogies Test–Short Form and Figure Recognition); and (4) Successive Processing (Word Recall and Sentence Repetition and Questions). Raw scores for each of the tasks were transformed to standard scores, with a mean of 100 and a standard deviation of 15, based on values obtained from dividing the sample into three age groups. Profile analyses were performed as in Experiment 1.

Instruments

Three new tasks were introduced in this experiment, for the planning (Planned Codes), the attention (Selective Attention–Expressive), and the successive (Sentence Repetition and Questions) areas. All other tasks used in this experiment have already been described under the instruments section of Experiment 1. A description of the new tasks follows.

Planned Codes. This subtest presented, at the top of the stimulus page, four letters (A, B, C, and D) with a different three-letter code (e.g., OOX) under each one. The rest of the page contained rows containing the four letters in the same sequence but this time with three empty boxes beneath them. The student's task was to fill in as many boxes as possible with the correct codes within a 2-minute period. The task contained two parts, and the student's score was the total completed on both pages. This task was found by Naglieri and Das (1988) to load on a Planning factor.

Selective Attention–Expressive. This is a shortened version of the Stroop test (Golden, 1978) and consists of three pages. Page 1 contains rows of the words red, blue, and green in varying order and the student's task is to read all of the words as fast as possible. Page 2 consists of rows of Xs grouped in units of four and printed in the colors red, blue, and green, the student names the color of each XXXX group as fast as possible. Page 3 is a selective attention task because it contains the words red, blue, and green printed in colors different from that denoted by the word. The student is requested to name the color each word was printed in, rather than read the word, as fast as possible. The student's score was the time needed to complete the third page.

Sentence Repetition and Questions. This task consisted of two parts, but in both cases the sentences that were orally presented used color words in place of nouns, verbs, and so forth (e.g., The blue is graying). The first part, Repetition, required the child to repeat the sentence exactly as presented (this included word endings as well as word reversals, omissions, etc.). The second part required the subject to answer a question about the sentence (e.g., "The blue is graying. Who is graying?"). The child's score was the sum of the number of sentences repeated or answered correctly in both parts.

Experiment 2 Results

The means and standard deviations of scores for the four composites earned by the boys and the girls are presented in Table 3. In order to compare the performance of male and female students across the four composite dependent variables, a profile analysis was conducted. The test of parallelism suggested a gender-by-variable interaction [$F(3, 106) = 7.01$, $p < .001$]. To determine which of the composite scores were contributing to the overall multivariate significance, t tests were performed on each of the four variables with the Bonferroni correction to keep the overall Type I error rate at .05. The girls performed significantly better than the boys on the Planning Composite (t = 3.51). This difference equaled approximately two-thirds of a standard deviation, suggesting that the girls earned considerably higher scores in planning than the boys. The two sexes performed equally well in the Attention, Simultaneous Processing, and Successive processing scores.

DISCUSSION

The gender differences found in the present study indicated that the girls outperformed the boys in planning processes and that these differences were significant for the sixth graders in Experiment 1 and for the combined sample of fourth and fifth graders making up the sample of Experiment 2 (effect sizes of .42 and .69). Although these results need to be replicated with other samples at different grades and with other measures of PASS processes, they suggest that cognitive processing differences may exist between the genders at various age levels. Because planning is an executive function that influences the extent to which a person uses the attentional, simultaneous, and successive processes as well the base of knowledge at her or his disposal, the importance of good

Table 3
Means and Standard Deviations for Male (n = 58) and Female (n = 54) Students (Experiment 2)

	Males		Females			
	Mean	*SD*	Mean	*SD*	*t* test	Diff/s[a]
Planning	96.2	11.8	104.1	11.8	3.51	−0.69
Attention	101.5	12.4	98.4	17.2	1.06	0.21
Simultaneous	101.7	11.2	98.2	12.4	1.54	0.30
Successive	99.1	14.2	101.0	12.0	0.74	−0.14

[a]Diff/s is the difference between male and female means divided by the weighted average *SD* of the two groups.

planning processes for the academic performance, and for everyday activities, is obvious. The findings in these two experiments suggest that at some grade levels girls more efficiently utilized planning processes to solve the cognitive tasks. The female superiority we found in planning should be further explored in other investigations to determine how closely it is related to reading and math differences between the genders and the differential rate of identification of males and females in classes for the reading-disabled (Sutaria, 1985), particularly for Grades 4, 5, and 6, as was shown by D'Amato et al. (1988).

Finally, the present results also suggest that the failure to find gender differences in past IQ tests may have been the result of the narrow view of intellectual functioning these measures employ (Naglieri, 1989; Naglieri & Das, 1990). The planning differences found in the present study would not have been detected if current intelligence tests such as the WISC-R or the K-ABC had been used, because these measures do not measure planning (Naglieri & Das, 1987). The findings of this study support suggestions that an expanded view of cognitive functioning is needed that may yield greater understanding of cognitive functioning in general and gender differences and similarities in particular.

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