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COGNITIVE PERFORMANCE DURING MIDDLE CHILDHOOD IN RURAL GUATEMALA*[1]

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SUMMARY

Developmental changes in a variety of cognitive processes as a function of age and schooling were examined in 160 rural Guatemalan children aged 5, 7, 9, and 11 years. Larger differences in test performance were seen between ages 9 and 11 than during earlier age periods on most tasks. Regression analyses of years of schooling controlling for age, sex, and socioeconomic status indicated that the effects of school were limited to memory tasks and to response time on the Matching Familiar Figures Test (MFF). Evidence for cumulative effects of additional years in school on test performance was weak. Good school performance was also most related to two memory measures. Previous studies indicating that schooling has a substantial effect on abstract cognitive processes were questioned; the suggestion that school performance is related to various memory processes was raised.

A. INTRODUCTION

Two contemporary concerns in studies of cognitive development are the nature of the changes in cognitive competencies that occur in middle to late childhood, and the effect of schooling on these competencies. Since public education begins at about 6 years of age in the United States, and this event is

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correlated with the emergence of executive processes between 5 and 7 years of age, in American children, it is not possible to unconfound the effect of schooling on the emergence of new cognitive abilities. However, research in less modern settings, where a large number of children do not attend school or, enter school later, can be useful in clarifying the relationship between the growth of these cognitive competences and educational experience.

It is fairly clear that the changes in cognitive performance during the preadolescent years involve different patterns for different kinds of tasks. In general, it has been hypothesized that while factual knowledge tends to increase linearly with age (for example, growth of vocabulary), growth of more process-oriented skills, such as use of strategies in short-term memory, operations or transformations in memory, and Piaget's concrete operational structure improve more between 5 and 7 years of age in American children than between the four year span before or after this period.

The purpose of this research report is to inquire into developmental changes on three kinds of cognitive tasks over the period 5 through 11 years of age in a randomly selected group of rural, isolated children, some of whom are attending school. The tasks vary in the kinds of skills required: three are memory tasks (Memory for Sentences, Digit Memory, and Auditory Integration), two measure figural analysis (Embedded Figures Test and Matching Familiar Figures Test), and one assesses pictorial vocabulary knowledge. Energence of different competencies was not measured; rather, we assumed that relatively large differences in test performance with age would be related to use of more sophisticated strategies.

It is generally believed that schooling contributes significantly to superior performance on tests of basic cognitive skills (4, 5, 12), because experiences in school teach the child to adopt the proper problem-solving set, to pay attention to the examiners' instructions, and to learn useful strategies of processing and organizing information. Cole, Gay, Glick, and Sharp (1, pp. 26-27) stated that in sub-Saharan Africa "schooling represents the single most powerful institution for producing non-traditional, acculturated people." Scribner and Cole (11) suggest further that schooling assists children in generalizing a solution rule from one problem to another, and increases their disposition to use language in describing ongoing mental processes and to aid task solution. On the other hand, it is possible that these effects can be attributed to other differences between schooled and unschooled populations, such as degree of modernism, wealth, or level of socioeconomic development. In the present study, the schooled and unschooled populations were compared on a rough measure of socioeconomic level (SES), and attempts were made to control for the effects of SES in examining the effect of schooling on test performances.

Ideally one would also want to know whether schooled children were initially smarter than nonschooled children on tests of mental development; if a difference of this sort were found, then effects attributed to schooling might be simply a function of initial differences. Although the data were not available to answer that question here, the question is being examined in a concurrent study (6).

If groups can be equated initially, a second question concerning the effects of schooling on mental development can be asked: does the experience of being in school improve the student's mental performance? Again, to answer this appropriately requires a longitudinal analysis. However, with a cross-sectional analysis we can ascertain whether children who have had more exposure to school score relatively higher than their age-mates on our tests of mental development, controlling for initial differences in SES.

Rather than selecting a fixed number of schooled and nonschooled children, the strategy used here was to include almost all children in the village between the ages of 5 to 11 regardless of their schooling history. Then statistical methods rather than *S* selection are used to control for possible confounding variables. The method permits the description of the population and avoids the risk of unknown biases in selection of *S*s, a particular problem in cross-cultural research. The main limitation is the weakness of a statistical control for confounding variables, since variables generally cannot capture all the variance which one would want to control for.

B. Method

1. *The Village*

The village in which the study was conducted is a poor rural Spanish-speaking, ladino farming community of about 1000 inhabitants located in the eastern hills of Guatemala. Families raise corn, beans, and squash primarily for subsistence. Roads are of dirt, houses are of adobe or thatch, and people are generally without radios, books, and newspapers. Despite the general poverty, there is variability in economic and social status, since the village is a municipal center of the district.

The village school has six grades, although the 5th and 6th grades are taught by the same teacher in the same room. In all grades, the curriculum is determined by a national program that describes the material every teacher must follow. At the end of the year, all children still attending are given national tests (a multiple-choice objective exam), and their graduation to the next grade depends in large part on the results of those examinations. About 85% of the children in this area of the country who take the examination pass to the next grade. In this village, the passing rate has fluctuated from a low of 31% to a high of 83% over the past five years. As in most of the villages in this area, the majority of children do not continue in school after one year; of those who attend during first grade, about ⅓ go on to second grade, and about one half of those in third grade continue in the upper grades. Therefore, the number of students in the first grades is large compared to the number in later grades.

Legally children cannot enter school before 7. However, many enter at older ages. There are first graders as old as 10, 11, and 12. In this sample, 45% of those examined entered at age 7; 40% entered at age 8; 9% at 9 years; 2% at 10 years; and 4% entered before the age of 7. The proportion of children living in the village who ever attend school is difficult to obtain, since accurate census figures of the school-age population in villages are rarely collected.

Schooling data (years of school attended and end-of-school-year examinations) were obtained from school records for all children in the sample who had ever been to school, and were checked with children's statements about their schooling.

Teachers in three neighboring villages were questioned as to reasons for lack of attendance or dropping out of school. Reasons from village to village were similar: children had to take lunch to their fathers in the fields, work in the home, or were taken to other towns. In a very few cases, teachers attributed the nonattendance to lack of interest or ability on the part of the child. The reasons for not continuing are apparently primarily economic necessity rather than capacity for schooling.

2. *Subjects*

One hundred and sixty children aged 5 to 11 years from a single village were included in the sample. All children born in a village must be registered in the village records. All children listed in the official registry still living in the village were used, as well as some children who had emigrated after birth. Although complete census figures were not available, we estimated from both records and local informants that this was approximately 90% of the children in the village. Children were grouped by two-year age intervals—5, 7, 9, and 11—with 40 children at each age level, half boys and half girls. Schooling was not a criterion for admission to the sample. Means and standard deviations of chronological age were similar for boys and girls.

3. *Socioeconomic Status*

Information on socioeconomic status (SES) was collected on the families of all children in the sample. Two measures of SES were used: an objective assessment of the quality of the house (quality of walls, roof, and number of rooms), called *House,* and the mother's report of the extent of parental teaching of her children, called *Teach*. These measures have been validated in similar communities in a longitudinal study of the effects of malnutrition on mental development (10). There were no significant sex or age differences in the socioeconomic status variables.

4. *Tests*

The tests had been carefully adapted to the culture of the village as part of a longitudinal study of the effects of malnutrition on mental development. The process is described in Klein (9).

(*a*) *Auditory Integration* was a sound blending test similar to that subtest of the Illinois Test of Psycholinguistic Abilities. The child listened to a tape recording of syllabized words with a three-second delay between each syllable, and was asked to identify the word. Twenty Spanish nouns ranging from two to six syllables in length were used. The words were selected to be familiar to the children by asking nine adults (teachers and psychometrists) to select from a random list of words those words which would be known to 5-year-olds in the villages. The words judged as most familiar within each category of syllable length were selected. However, the longer words were generally rated as less familiar than the shorter words. The score is the number of words correctly identified out of 20 possible words.

(*b*) *Memory for Digits* was similar to the digit memory span test in the Illinois Test of Psycholinguistic Abilities. The child was asked to repeat series of digits of increasing length until he failed three successive series. His score consisted of the total number of digits correctly recalled with an additional point awarded for each complete sequence recalled correctly.

(*c*) *Memory for Sentences* consisted of sentences of two-syllable words which increased progressively in length from 2 to 10 words. The sentence was read to the child once at a normal rate, and the child repeated the sentence. The child received points for each word correctly recalled and an additional point if the entire sentence was correct.

(*d*) *Embedded Figures Test* was adapted from a version for older children (8). The stimuli were 12 pictures with a triangle hidden in each illustration. The child had to locate the triangle in each picture. Both number of correct responses (Sum) and mean response time on the 12 items (Time) were scored.

(*e*) *Matching Familiar Figures Test* was a version of the original Kagan measure (7). In this version the child had to match a standard stimulus with one of four comparison stimuli. The eight items of the test were all objects familiar to the child. The variables scored were the total number of correct responses (Sum) and the mean response time to the child's first solution (Time).

(*f*) *Vocabulary Test* was a picture naming task. The child was shown a series of pictures and was asked to supply the name of each one. The pictures were selected to represent objects in every child's environment. The score was the number of correct responses.

5. *Psychometric Properties of the Tests*

Reliability estimates of all tests except the Auditory integration Test have been collected both on the longitudinal sample and in various other parallel groups of *S*s. Most have acceptable levels of reliability. Reliability of scoring was between .99 and 1.00 on all tests. Internal consistency varied from test to test. For Memory for Digits and Memory for Sentences, the odd-even reliabilities were between .95 and .98 for samples of about 180 *S*s (separated by age and sex). For Auditory Integration, the odd-even reliabilities ranged from $r = .94$ to $r = .97$; for Vocabulary, from $r = .75$ to $r = .90$; for the EFT Sum and Time, from $r = .40$ to $r = .73$, and for the MFF Sum and Time, from $r = .02$ to $r = .41$. These MFF reliabilities, which are for children 5 through 7 years, may indicate that the test is too difficult at younger ages.

Test-retest reliability was assessed over an eight-day interval on a similar sample of children aged 3, 5, and 7, with 20 children in each age group. Pooled-within-group test-retest correlations were adequate for Memory for Digits ($r = .65, p < .01$), Memory for Sentences ($r = .60, p < .01$), Vocabulary ($r = .86, p < .01$), MFF Sum of correct responses ($r = .57, p < .01$), MFF Time ($r = .71, p < .01$), and EFT Time ($r = .48, p < .01$). For the EFT Sum of Correct Responses, the reliability was quite low ($r = .22$, N.S.). However, in the longitudinal sample, test-retest correlations for this variable over a one-year time span ranged from $r = .38, p < .01$ to $r = .55, p < .01$ with the exception of 3-year to 4-year females ($r = .15$). Therefore, the test seems to be less reliable at younger ages, but adequate for the ages in this study.

6. *Procedure*

All children were tested individually, in Spanish, by a trained Guatemalan psychometrist. The testing site was a familiar location in the village. Each child was seen for two sessions, with a warm-up period before the first session. Tests were evenly divided between sessions.

C. Results

1. *Sex Differences*

Before testing the major hypotheses, the data were examined for sex differences in means and intercorrelations at all four age levels.

Sex differences in performance as assessed by a 4(age) × 2(sex) ANOVA were not significant for any test. Moreover, there were no sex differences in the number of significant correlations among tests or in the relation between test scores and socioeconomic status. Finally, school attendance and the number of years in school did not differ by sex of child. As a result, sex was not considered a major determinant of test performance although it was controlled for statistically in subsequent analyses.

2. *Interrelationship Among Tests with Age*

The intercorrelations among the eight measures, by age, appear in Table 1. The relationship among the three kinds of tests (memory, perceptual analysis, and vocabulary) varied by age. The three memory scores were positively and significantly correlated at all four ages. However, number of correct responses on the EFT and on the MFF were significantly correlated only at age 7. At other ages, the correlations were positive but low. On the MFF, response time was unrelated to correct responses at 5, significantly related at ages 7 and 9, and positively (but not significantly) related to performance at 11. By contrast, on the EFT, time and correct responses were significantly related at 5 and 7, showed a low positive relation at 9, and a negative relation at 11. There appears to be a ceiling effect by age 11 on the EFT. The two response time measures were significantly related at 5, 7, and 11 years.

The three kinds of tests (Memory, Vocabulary and Perceptual analysis) were relatively independent at most ages. Scores were weakly interrelated at age 7. Vocabulary became more differentiated from the other scores with increasing age. The two perceptual analysis tests seemed to be more related to both memory and vocabulary at younger ages than older ages, and the relationship with the EFT was slightly higher than with the MFF. The tests appear to measure different factors, and these factors tend to diverge with age.

TABLE 1
INTERCORRELATIONS AMONG TESTS BY AGE

Variable	DM	MS	V	MFF Sum	MFF Response time	EFT Sum	EFT Response time
				Age = 5			
Auditory Integration	.67**	.60**	.42**	.11	.10	.52**	.41*
Digit Memory (DM)		.69**	.36*	.18	.18	.30	.42**
Memory for Sentences (MS)			.53**	.18	.02	.58**	.54**
Vocabulary (V)				.23	−.13	.42**	.23
MFF Sum					.01	.16	.10
MFF Time						.26	.48**
EFT Sum							.58**
				Age = 7			
Auditory Integration	.46**	.39*	.67**	.37*	.43**	.54**	.32
Digit Memory		.69**	.35*	.25	.22	.39*	.33*
Memory for Sentences			.33*	.40*	.36*	.27	.25
Vocabulary				.54**	.48**	.56**	.24
MFF Sum					.56**	.43**	.25
MFF Time						.63**	.50**
EFT Sum							.43**

				Age = 9			
Auditory Integration	.48**	.34*	.41*	.08	.25	.41*	−.03
Digit Memory		.52**	.30*	−.15	.18	.07	−.11
Memory for Sentences			.39*	.22	.21	.16	−.11
Vocabulary				.10	−.05	.29	−.20
MFF Sum					.40*	.17	−.11
MFF Time						.26	.25
EFT Sum							.20
				Age = 11			
Auditory Integration	.58**	.42**	.47**	.28	.32*	.35*	−.19
Digit Memory		.45**	.29	.15	.08	.37*	−.21
Memory for Sentences			.11	.37*	.12	.40*	.03
Vocabulary				.17	.24	.18	−.12
MFF Sum					.31	.28	−.05
MFF Time						.06	.36*
EFT Sum							−.31

Note: N = 40 per cell. MFF = Matching Familiar Figures Test; EFT = Embedded Figures Test.
* $p < .01$.
** $p < .05$.

3. *Age Changes*

To assess age differences in performance, a one-way analysis of variance with four age levels was performed on each of the six tests. Means, standard deviations, and significance levels of F appear in Table 2.

There were significant age effects for all measures. Since the question of primary interest involved differences in scores between age groups, adjacent ages were compared with the use of the Newman-Keuls procedure. Mean scores of 9- and 11-year-olds differed significantly on all measures except EFT Response Time (seven measures). Scores for 7- and 9-year-olds differed on five measures: Auditory Integration, Digit Memory, Vocabulary, EFT Sum, and MFF Time. Five- and 7-year-olds differed on three measures (Memory for Sentences, Vocabulary, and EFT Sum).

To determine when maximum changes occurred, differences between test scores in adjacent age groups were compared. For instance, we tested whether the difference in scores from 9 to 11 was greater than that from 5 to 7 or 7 to 9. On all tests except the two time measures and EFT Sum, which appears to have reached a ceiling at 11, the largest mean difference was between scores at

TABLE 2
MEANS, STANDARD DEVIATIONS, AND SIGNIFICANCE OF ONE-WAY ANOVA BY AGE ON TEST SCORES

Test		Group 5 years	7 years	9 years	11 years	Significance *F*
Auditory Integration	$\bar{x}$	6.38	7.95	11.63	16.45	52.73**
(Number of words)	SD	3.18	4.00	4.37	3.96	
Digit Memory	$\bar{x}$	37.38	45.63	55.75	71.68	30.89**
(Total points)	SD	12.29	12.53	16.28	23.58	
Memory for Sentences	$\bar{x}$	70.28	89.85	104.40	137.90	44.86**
(Total points)	SD	24.08	17.95	30.34	32.86	
Vocabulary	$\bar{x}$	18.48	21.80	25.13	29.18	40.32**
(Number of words)	SD	5.80	5.02	4.01	2.86	
EFT Response Time	$\bar{x}$	3.90	4.11	4.67	4.49	3.88*
(Seconds)	SD	1.28	1.27	.89	1.00	
EFT Sum	$\bar{x}$	3.88	6.20	8.15	9.40	52.80**
(Number of items)	SD	2.22	2.31	2.33	1.39	
MFF Response Time	$\bar{x}$	2.79	3.28	4.12	4.93	18.58**
(Seconds)	SD	1.10	1.48	1.55	1.37	
MFF Sum	$\bar{x}$	3.10	3.93	4.80	5.93	25.57**
(Number of items)	SD	1.06	1.51	2.02	1.31	

Note: N = 40 per group. MFF = Matching Familiar Figures test; EFT = Embedded Figures test.
* $p < .05$.
** $p < .01$.

ages 9 and 11. For the Auditory Integration Test, the difference from 9 to 11 was significantly greater than the difference from 5 to 7 ($t = 2.63, p < .01$), although it did not differ from that for 7 to 9 ($t = .69$); Memory for Sentences differed slightly more from 9 to 11 than from both 7 to 9 ($t = 1.68, p < .10$) and 5 to 7 ($t = 1.73, p < .10$). For Vocabulary, Digit Memory, and MFF Sum, the differences from 9 to 11 were greater than earlier differences, but not significantly. It appears that differences from 9 to 11 are at least as great as those from 5 to 7 or 7 to 9. Only the two time measures showed greater change from 7 to 9, but the differences were not significantly different from those between other age intervals.

4. *Effects of Schooling*

Because children were selected regardless of schooling, the number of children with school experience was unequal at each age. None of the 5-year-olds were in school; 11 seven-year-olds, 28 nine-year-olds, and 35 11-year-olds were or had been in school, and the range of schooling was from one to five years. Because most of the 11-year-olds were in or had been in school at some point, a comparison of scores on the basis of a school/no school dichotomy could not be made here. Comparisons were made only for 7- and 9-year-olds.

Schooled 7-year-olds scored higher than nonschooled 7-year-olds on Auditory Integration ($t = 5.22, p < .01$), Vocabulary ($t = 4.32, p < .01$), EFT Sum ($t = 4.39, p < .01$), and MFF Sum ($t = 2.08, p < .05$). Schooled 9-year-olds also scored higher on Auditory Integration ($t = 7.00, p < .01$) and were higher on Digit Memory ($t = 2.73, p < .01$). The 7-year schooled *S*s were on the average six months older than the 7-year nonschooled *S*s ($t = 3.43, p < .01$). Therefore, the differences in this group could be attributed to age as well as to schooling. (For the 9- and 11-year-groups, the age difference by schooling was less than a month). For the 9-year-olds, schooling primarily affected digit memory and auditory integration. At 7, the effects appear in more measures, but may be attributed to age as well.

5. *SES and Schooling*

To determine whether the unschooled children were on the whole from a lower social and economic level than the schooled children, the SESs of schooled and unschooled children were compared. Schooled children tended to be slightly higher on *House* and *Teach* scores, but chi-square analyses of SES (high or low) by schooling (presence or absence) were not significant. To test whether SES affects number of years of school attended, rather than simply presence in school, years in school were correlated with SES. It was positively related, but at a low level, to both the housing and maternal teach measures ($r = .24, p < .01$ for *House*; $r = .18, p < .01$ for *Teach*). Apparently SES has a greater effect on number of years of school attended than whether or not the child ever attended school.

SES measures also had low positive correlations with mental test measures. Since SES was related to both schooling and test performance, it had to be controlled for or adjusted statistically in order to examine the independent relationship between years in school and test scores.

6. *Adjusted Effects of Schooling*

The effects of years of schooling on test performance was therefore analyzed through multiple regression. In this model, all *S*s were pooled, and the linear effects of age and SES were first partialled out of the relation between test performance and years of schooling. The age differences in the 7-year data and the confounding role of SES suggest the utility of this method. The dependent variable was the test score, and the independent variables were sex, socioeconomic status, age in months, and years in school (0 to 5). The relationship of years of schooling to test score was thus "adjusted" by the other three entries. A linear model seemed most appropriate for all corrections; i.e., linear effects of sex, age, and SES were removed from the test score. An effect of schooling on the *adjusted* score would be indicated (*a*) by a significant *b* value (or slope) for schooling, (*b*) by a significant increase in percent of variance explained (R^2) in test score due to years in school, and (*c*) by a significant partial correlation of years in school with adjusted test performance, controlling for sex, SES, and age.

The *b*'s and their significance level, the percent of variance accounted for (R^2), and partial *r*s for years in school on *adjusted* test performance are presented in Table 3. The *b*'s indicate the gain in test performance for each additional year in school. The data suggest that years in school had an effect on the three adjusted memory scores (Auditory Integration, Digit Memory, and Memory for Sentences), and response time on the MFF, but no significant effect on the Vocabulary Test, sum of correct responses on the MFF, or Sum and Time on the EFT.

For those tests that showed an effect of schooling, the effect of each additional year of school was examined in a regression in which number of years in school (coded as 1, 2, or 3 or more years of school) predicted test scores adjusted by sex, socioeconomic status, and age. The *b* values for each year in school indicate the average increases in the score that a child gains for each

TABLE 3
REGRESSION PARAMETERS OF YEARS IN SCHOOL ON ADJUSTED[a] TEST SCORES

Test	Slope (b)	Total R^2	Increase in R^2 due to years in school	Partial r
Auditory Integration	3.41**	75.5	19.9	.67**
EFT Sum	.18	60.0	.4	.07
EFT Time	−.072	8.90	.1	−.03
MFF Sum	.27	40.7	1.1	.13
MFF Time	.690**	35.6	4.9	.27**
Digit Memory	9.19**	49.7	9.4	.40**
Memory for Sentences	9.22**	51.1	3.2	.25**
Vocabulary	.57	55.4	.5	.10

Note: Years in school coded as 0, 1, 2, or 3+ years. MFF = Matching Familiar Figures Test; EFT = Embedded Figures Test. N = 150 per analysis (10 children did not have SES data).
[a] From regression forcing Sex, Teach, House, Chronological Age in months.
** $p < .01$.

additional year in school. These values and their significance levels appear in Table 4.

The effects of each additional year of school varied by test. For Auditory Integration, Memory for Sentences, and MFF Time, the first two years had higher slopes than the third, suggesting that the third year of school did not have much additional effect on the adjusted score. For Digit Memory, the slope for the third year was as high as it was for the first two years, although the slopes for the second and third years were not significant. These data do not support the hypothesis that beyond two years of schooling, more school increases psychological test performance.

One might expect that slower children would drop out of school sooner than more able children. If so, children with more years of school should be relatively higher on test performance than those of the same age with fewer years of school. If a cumulative effect of schooling on test performance had been found, it could not have been unambiguously interpreted. Therefore, the absence of a stronger cumulative effect in spite of a probable tendency for smarter children to stay in school longer, and in spite of a probable increase in test performance with schooling is surprising. One explanation for the absence of effect could be that the tests are at ceiling level at 11 years. However, although both the Vocabulary test and the EFT Sum measure may be approaching ceilings, the others appear to have similar variances in all four age

TABLE 4
SLOPES (*b*S) OF SUCCESSIVE YEARS IN SCHOOL ON ADJUSTED[a] TEST SCORES FOR TESTS WITH SIGNIFICANT SLOPES IN PREVIOUS ANALYSIS

Measure	Year 1	Year 2	Year 3+
Auditory Integration			
Slope	4.96**	3.46*	1.88
SD	.64	.98	1.00
Digit Memory			
Slope	8.35*	10.26	8.79
SD	3.75	5.73	5.82
Memory for Sentences			
Slope	11.42	15.64	− .15
SD	6.39	9.76	9.93
MFF Time			
Slope	6.92**	5.34	2.51
SD	3.16	4.84	4.92

Note: $N = 150$ per analysis; 10 children did not have SES data and were not included. MFF = Matching Familiar Figures Test.

[a] From (stepwise) regression forcing Sex, Teach, House, Chronological Age in Months, and then coded values for Years in School (0, 1, 2, 3 or more).

* $p < .05$.

** $p < .01$.

groups, and have plenty of range left. Therefore we cannot eliminate the possibility that schooling has little cumulative effect on mental development.

The effects of schooling appeared to be differentially related to the capacities measured by the test battery. The three memory tests and MFF Time related to years of schooling, whereas the perceptual and vocabulary tests did not. However, evidence for cumulative effects of schooling on these capacities was not strong. In order to determine whether there was a relation between the tests affected and instructional methods, observations of classroom activity were made with the use of a point-sampling technique. In four hours of observation on several different days, the most common activities recorded were repetition of syllables, words, and sentences; copying from the board; and teacher lecture. Student-teacher interactions were rare except for correction of work at desks. The lack of materials other than paper, pencil, blackboard, and a few posters meant that almost all instructions had to be verbal and teacher-directed.

Reading was taught through repetition of syllables written on the board. It is not surprising that schooling was most related to Auditory Integration, Digit and Sentence Memory, as they measure tasks similar to those occurring in school. The absence of a strong cumulative effect may suggest that the input of this kind of instruction does not continue to offer stimulation of these memory capacities after several years.

7. *Psychological Test Performance and National Examinations*

As a final exploration of the effects of schooling, performance on the test battery was compared with school success, as approximated by the child's score on the national language and math exams given at the end of the year to all schools in the country. One would expect a positive relationship of school success and test performance for those tests related to schooling: Digit Memory, Auditory Integration, Memory for Sentences, and MFF response time. *S*s were divided by grade level, rather than age, for the analysis. To insure reasonable sample sizes, the children were categorized as having 1, 2, or 3 or more years of school. Since all children who attend school do not take the national test, the number of *S*s in the analysis is smaller than in the previous analyses. Correlations are in Table 5.

Language and Mathematics scores on the national tests after one year in school were correlated with Auditory Integration and Digit Memory, but were

TABLE 5
CORRELATIONS OF NATIONAL SCHOOL TESTS AND PSYCHOLOGY BATTERY

Measure	1 year	2 years	3 or more years
Language National Test			
Auditory Integration	.59**	.02	.16
Digit Memory	.48**	.02	.16
Memory for Sentences	.10	.37	−.08
Vocabulary	.36	−.21	.21
EFT Sum	−.13	−.16	−.54**
EFT Time	−.09	−.17	−.03
MFF Sum	−.03	.09	.30
MFF Time	−.02	−.59	.24
Mathematics National Test			
Auditory Integration	.61**	.24	.22
Digit Memory	.43*	.02	.28
Memory for Sentences	.11	.27	.05
Vocabulary	.35	−.38	.49*
EFT Sum	−.08	.15	−.27
EFT Time	.15	−.01	−.09
MFF Sum	.02	.05	−.20
MFF Time	.01	−.18	.05
N	22	9	15

* $p < .05$.
** $p < .01$.

unrelated to any other measures. After more years of school, the relationships were not generally significant. For 3+ years, Mathematics and Vocabulary were positively correlated ($r = .48, p < .05$) and Language and EFT Sum were negatively correlated ($r = -.54, p < .05$). These correlations are congruent with previous indications that the number of years of schooling is most related to memory. Here success in schooling, at least in first grade, is related to memory.

D. Discussion

The data suggest that performance on these tests increases regularly over the age span of 5 to 11 and that two of the tests show significantly greater changes from 9 to 11 than from 5 to 7 or 7 to 9 years of age. This gain from 9 to 11 does not seem to be a function of the onset of schooling, since schooling for most children begins between 7 and 8 years of age. Substantial changes in memory performance, perhaps reflecting emergence of new memory strategies, appeared several years after the onset of schooling for the majority. On the other hand, there was a tendency for greater change in response time for both the EFT and MFF to occur from 7 to 9, suggesting a possible effect of onset of schooling on the time measures.

The regression analyses suggested that the effect of years of schooling was greatest for the three memory tests and for MFF response time. In contrast to other studies that have attributed increased language skills or capacity to generalize rules to school experience, increased schooling was unrelated to vocabulary or perceptual analysis measures. The data are consistent with Wagner's (12) recent report that schooling in rural and urban Yucatan is related to short-term memory. They are also consistent with teaching methods; observations in the classrooms in this village revealed that the majority of the class time was spent in repetition, copying, and teacher lecture. Reading was taught by syllable repetition. Almost no teacher-student interaction other than correcting written work was observed. The frequency of these instructional methods coincides closely with the findings that schooling is most related to memory measures.

Analysis of the relationship of schooling to socioeconomic status confirms the impression that, at least in this isolated village, children who attend school for more years are of higher social status than less-schooled children. Thus SES may be a confounding factor in other studies comparing schooled and unschooled populations in which the background differences between groups were not examined (i.e., 1, 12).

The effects of schooling in the present study were generally not cumulative; beyond the second year the effect of additional years of school experience varied by test. A third year of school experience contributed only to the Digit Memory score. Fahrmeier (2) also failed to find cumulative effects of schooling on mental test performance. These data suggest that the advantages attributed to schooling in this community may be limited to memory processes rather than to development of some of the mechanisms that have been suggested previously, such as increased practices in the use of abstractions (3). This applies both to years in school and level of achievement in school (end-of-year examinations). Evidence of overall cognitive growth associated with schooling was not found. A longitudinal design examining capacities before school begins, and periodically during schooling, is needed. A study of this sort is now in process in four neighboring villages. Second, the investigation of possible explanations for the observed larger increase in cognitive test performance between ages 9 and 11 in this population is indicated.

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