DOCUMENT RESUME

ED 230 603 TM 830 398

AUTHOR	Kalk, John Michael; And Others
TITLE	Trends in Achievement as a Function of Age of Admission. No. AY-AA-51.
INSTITUTION	Education Commission of the States, Denver, Colo. National Assessment of Educational Progress.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
PUB DATE	Sep 82
GRANT	NIE-G-80-0003
NOTE	187p.
AVAILABLE FROM	National Assessment of Educational Progress, 1860 Lincoln Street, Suite 300, Denver, CO 80295 ($10.00).
PUB TYPE	Information Analyses (070) -- Statistical Data (110)
EDRS PRICE	MF01/PC08 Plus Postage.
DESCRIPTORS	*Academic Achievement; *Age Differences; Chronological Age; Educational Assessment; Educational Trends; Elementary Secondary Education; Federal Programs; Multiple Regression Analysis; *Outcomes of Education; Predictor Variables; *School Entrance Age
IDENTIFIERS	Data Interpretation; *National Assessment of Educational Progress; *Secondary Analysis

ABSTRACT

The changing achievement relationships among students, from elementary through high school, were investigated between their ages relative to their classmates and their ages at entry into first grade. A secondary analysis was performed on the data collected by the National Assessment of Educational Progress. The sample involved Caucasian students in grades four, eight and eleven (ages 9, 13 and 17 respectively). The achievement data included mathematics, science and reading. The predictor variables were relative age, class age, sex, parental education, home environment, and type of community. Relative age described a student's age relative to the other students in the classroom, while class age was a control for states with different school entrance cutoff dates. The predictor variables were entered in a stepwise multiple regression analysis, with class age and relative age entered first. The combined achievement data indicate that the significantly higher achievement found among the oldest students at age nine decreases but remains significant at age thirteen, and disappears by age seventeen. A second analysis of the proportion of students retained one grade revealed significantly increasing proportions of retained students as relative age becomes younger. Primary type of information provided: Results (Secondary Analysis) (Interpretation). (Author/PN)

TRENDS IN ACHIEVEMENT AS A FUNCTION OF AGE OF ADMISSION

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ABSTRACT

Studies comparing younger and older groups of students entering school under normal conditions have found that young normals receive lower grades, are rejected more often by their peers, have negative attitudes toward school, have higher retention rates and score lower on achievement tests. The purpose of this study was to investigate the changing achievement relationships among students, from elementary through high school, between their ages relative to their classmates and their ages at entry into first grade. A secondary analysis of the data collected by the National Assessment of Educational Progress provided data unavailable to prior researchers. The sample dealt only with Caucasian students in grades four, eight and eleven, whose ages were respectively nine, thirteen and seventeen. The achievement data included mathematics, science and reading. The predictor variables were relative age, class age, sex, parental education, home environment, and type of community. Relative age described a student's age relative to the other students in the classroom, while class age was a control for states with different school entrance cutoff dates.

The predictor variables were entered in a stepwise multiple regression analysis, with class age and relative age entered first. The combined achievement data indicates that the significantly higher achievement found among the oldest students at age nine decreases but remains significant at age thirteen, and disappears by age seventeen. A second analysis of the proportion of students retained one grade revealed significantly increasing proportions of retained students as relative age becomes younger.

In summary, clinical screening is suggested for several groups: (1) For districts with December, January, or February school entrance cutoff dates, the highest risk groups include males in the youngest half of the class, or females in the youngest quarter of the class. (2) For districts with September, October, and November cutoffs, the highest risk group includes males in the youngest third of the class. Signs of inadequate readiness found among these groups pose potentially serious threats to children's academic careers and suggest that entrance should be delayed until the following school year.

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ACKNOWLEDGEMENTS

This paper was based on the doctoral thesis of John Kalk (1981) who generated the original research question and provided the computer expertise essential to this research. However, many friends and colleagues contributed to the successful completion of this study. We would like to recognize the support provided by the National Assessment of Educational Progress and the numerous contributions of our colleagues at National Assessment. We wish to especially thank Dr. Jane Armstrong and Gene Johnson for the unlimited help and understanding they provided throughout this undertaking.

Chapter 1

INTRODUCTION

Is there a best age for a child to enter the first grade? This difficult question has been the concern of parents, educators, administrators and legislators for more than fifty years. The criterion most consistently used by school districts for determining entrance into first grade has been chronological age, with admission usually allowed only at the beginning of the school year (Jones, 1968). Such a simple criterion has obvious administrative advantages, but also encourages pressure for change from parents and teachers.

Parents have many reasons for wanting their child in school which do not necessarily reflect educational values. These may range from a view of schooling as an inexpensive babysitting facility to pride in reaching this parental milestone. However, it can be safely assumed that parents usually stress the best educational opportunities for their child. Such concerns often lead to conflict when parents disagree with school admission policies.

Teachers often become involved in this issue because they are responsible for the academic development of their students. Teachers are continually trying to control or modify entrance age requirements (especially to delay entrance) until the children are capable of effectively participating in the majority of classroom activities. Through this strategy teachers attempt to reduce the number of students that require a disproportionate amount of the time available for individual attention (Carline, 1964).

Thus, both parents and teachers are intensely concerned about the physical, mental, social and emotional aspects that determine a child's readiness for beginning formal schooling. The resulting pressure from parents and teachers causes frequent legislative reexamination of the laws governing entrance age requirements (Carline, 1964; Educational Research Service, 1975). But the consequences of school budget constraints and inadequate research have necessitated the continuation of the simple age criterion as the normal admission policy to first grade. However, the confusion and ambiguity produced with respect to these policies can be seen in the range of five calendar months found among the entrance age requirements for the nation's school districts (Educational Research Service, 1975; National Institute of Education, 1978).

Research questions concerning the optimal age for entering first grade have typically utilized a paradigm within which the oldest children in class are compared to the youngest. For the majority of these studies, the young group consisted of students who entered first grade younger than the required chronological age. These early entrants satisfied special criteria based on mental, physical, social and emotional factors. This young group was then compared to the older group, which was selected from some portion of the normal entrants. The results have shown that early entrants demonstrated equal or slightly superior academic performance (Hedges, 1977). But these studies have involved special groups of young students in an advanced state of readiness for school and the findings cannot be generalized to unselected younger students who may not have these special abilities.

Educators have typically overlooked less numerous studies comparing younger and older groups of normally entering first grade students. It has been found that younger normals received lower grades in school, were rejected more often by their peers, had negative attitudes toward school, had higher retention rates and scored lower on achievement tests in mathematics, science and reading (Hedges, 1977; Weinstein, 1968-69). These findings, demonstrating the existence of difficulties among younger normals, have been replicated throughout primary school (Halliwell & Stein, 1964; Miller & Norris, 1967). Of course this leads to concern about the persistence of the problems. However, the number of studies using junior high and high school students decreases dramatically as compared to primary age pupils, and the evidence for a continuing advantage for older classmates becomes inconsistent (Halliwell & Stein, 1964; Harrell, 1968).

In summary, some research has revealed that younger students in the group of normally entering first graders were at an academic disadvantage when compared to their older counterparts. Thus the question arises as to how and when, if ever, this academic deficiency changes as the student progresses through school. Put another way, does the achievement level of younger students ever catch up with and even possibly surpass the achievement of older students during their period of formal education?

THE DATA BASE

This study is based on a secondary analysis of the data collected by the National Assessment of Educational Progress (National Assessment or NAEP), which is a project funded by the National Institute of Education, U.S. Department of Education. National Assessment conducts an assessment of educational attainments on a national basis. Its purpose is to provide information for the general public, for educational decision makers and for practitioners that can be used to identify educational problem areas, to establish educational priorities and to determine the national progress of education (NAEP, 1974a).

TABLE 1

Learning Area Assessments and the School Year in Which They Were Conducted by the National Assessment of Educational Progress

Assessment Year	School Year	Learning Area(s) Assessed
01	1969-70	Science; Writing; Citizenship
02	1970-71	Reading; Literature
03	1971-72	Social Studies; Music
04	1972-73	Science; Mathematics
05	1973-74	Writing, Career and Occupational Development
06	1974-75	Reading; Art
07	1975-76	Citizenship; Social Studies
08	1976-77	Science
09	1977-78	Mathematics
10	1978-79	Writing; Art; Music

National Assessment provides information regarding the quality of educational outcomes by periodic assessments of the knowledge, understanding, skills and attitudes of certain age groups in the ten learning areas of Art, Career and Occupational Development, Citizenship, Literature, Mathematics, Music, Reading, Science, Social Studies and Writing (see Table 1). Each assessment gathers information about one or more of these learning areas from nine, thirteen and seventeen-year-old students. When adequate funding exists, special assessments are conducted and information is collected on seventeen-year-old out-of-school students and adults between the ages of twenty six and thirty five. Since National Assessment began in 1969, data have been collected on more than 850,000 persons with approximately 70,000 to 100,000 persons participating each year.

The information provided by National Assessment is defined in terms of educational objectives which govern the direction and composition of the assessment in a given learning area. These objectives are translated into questions or tasks which are termed "exercises". To measure educational progress nationally, National Assessment estimates the percentage of respondents at each age who are able to correctly answer an exercise.

Ages

The ages of nine, thirteen and seventeen were chosen for assessment because they represent the educational milestones attained by most students in public or private schools: at age nine, when most students have been exposed to the basic program of primary education, at age thirteen, when most have finished elementary school and at age seventeen, when most students are still in school and about to complete their secondary education (Hazlett, 1974, pp. 101-102). Information about later educational development is obtained from young adults to determine the skills, knowledge and attitudes of those who have been away from formal schooling for a number of years. Persons who are non-English speaking, institutionalized or handicapped physically, mentally or emotionally are excluded from National Assessment data.

Learning Areas

The evolution of each learning area assessment requires a lengthy consensus process which culminates in a set of exercises for each stated objective. This process uses a large number of persons with (1) expertise in the learning area, (2) knowledge of current trends in education, (3) knowledge of current educational practices and appropriate subject matter content, and (4) interest in education and civic affairs. Every effort is made to involve representatives from different regions of the country and from various ethnic and minority groups.

The objectives developed and reviewed by these consultants define a set of agreed upon and desirable goals which Americans should accomplish in both cognitive and affective areas during their formal education. These objectives are also detailed enough to serve as a clear guide to the consultants who developed both multiple choice and open-ended exercises. It is important to understand that the exercises and the objectives are not intended to set standards toward which all children should strive; rather, they are offered as a means of estimating what proportion of the population has ultimately achieved the behaviors implicit in the objectives. This means that exercises are not designed to measure differences between students but to determine students current levels of achievement. These constraints require the consultants to (1) develop exercises representing a full repertoire of tasks from simple to complex and ranging in item difficulty from easy to hard and (2) use exercise formats providing the most direct measure of the objective.

All potential exercises for an assessment are field tested. Intended answers are compared with the actual responses to eliminate misinterpreted exercises and unclear questions or distractors. Exercises are evaluated on the basis of these field test results and acceptable answers determined for each exercise. Exercises which pass the field test criteria are reviewed a final time by subject matter experts and other reviewers. Consultants then select a final set of learning area exercises, weighting the importance of each objective by the number of exercises representing that objective (NAEP, 1974b, 1978a, 1979b).

Once exercises are selected, they are carefully grouped into subsets of exercises and placed into a test booklet or "package". Part of the procedure for assigning exercises to a package is to maximize the measurement of as many objectives as possible and to include a wide range of item difficulties for each package. At the end of these procedures a learning area may have as many as thirty packages for assessing all age groups. Each student takes only one test package, which are designed to be administered to a group of students within a fifty minute class period. This item sampling technique allows National Assessment to maximize the number of students, to reduce administrative costs, and to maintain adequate exercise coverage of the educational objective of each learning area.

The field staff of permanent administrators is retrained each year before the actual assessment. All instructions and exercises are presented in written and audio paced tape form in order to guarantee adequate response times, to maintain uniform presentations, to help those students with reading problems, and to assure low non-response rates for all exercises. Responses to multiple choice exercises are scored by optical scanning machines, while responses to open-ended exercises are categorized by expert readers using carefully developed scoring guides (Finley, 1971).

Sample Design

For each age, students are selected in accordance with a deeply stratified, multistage design, with oversampling for low income and rural areas (Benrud & Smith, 1977; Moore, Chromy & Rogers, 1974). In the first stage of the sampling design, a selection is made of the primary sampling units (PSUs). Each PSU represents an area of land consisting of counties or groups of contiguous counties meeting a minimum size requirement (see Table 2). A sampling frame of PSUs is then constructed using the current U.S. Bureau of Census data. The PSUs are first stratified by region and then by size of community categories within region. The regions and size of community categories used for stratification in the 1975-76 assessment, for example, are shown in Table 2. From the stratified list of PSUs, a probability sample of PSUs is selected to represent all regions and types of communities.

In the next stage of sampling all schools within each PSU are listed along with their estimated number of eligible students. A probability sample of schools is then drawn for each PSU.

For the final stage of selection, a list is made of every eligible student in each selected school. Then a random sample of students is drawn and a package randomly assigned to each selected student.

Throughout the process, PSUs, schools and students are selected with known probabilities. Thus, an unbiased weight for each student is computed as the inverse of that student's probability of selection. Each student's weight represents the number of students in the population with the characteristics possessed by this student. These weights are necessary to avoid distortion in population estimates due to the differing probabilities of selection (NAEP, 1980b).

TABLE 2

National Assessment of Educational Progress Sampling Strata for the 1975-76 Assessment

Classification	Strata
Region	Northeast Southeast Central West
Size of Community	The thirteen largest Standard Metropolitan Statistical Areas (SMSAs) based on fourteen-year-old populations in the 1970 Census.
	The remaining 57 SMSAs with total populations in excess of 500,000
	The 162 remaining SMSAs.
	Non-SMSA counties with 65 percent or less of their fourteen-year-old population classified as rural in the 1970 Census.
	Non-SMSA counties with more than 65 percent of their fourteen-year-old population classified as rural in the 1970 Census.

LIMITATIONS

The large sample size of the nine, thirteen and seventeen-year-old populations of the National Assessment data provides a unique opportunity to study the effects of chronological age in one comprehensive study. The limitations to researchers that do exist in the data are described below.

One of these limitations is the fact that National Assessment does not provide information about the same student at two points in time. The lack of longitudinal data is a direct function of the cost and difficulty of tracking the large sample size assessed for each learning area.

A far more frustrating problem involves the student background information available to anyone interested in analyzing National Assessment data. Important educational questions and issues are usually raised by researchers, educators and administrators long after the completion of the learning area assessment. Since National Assessment can collect only a limited amount of background information about each student, vital information on specific topics is often not available to researchers.

Another limitation is the lack of experimental variables. Since the only treatment is the life experiences of each student, National Assessment provides no direct information about cause and effect. However, as this present study demonstrates, there are many questions that can be answered without direct experimental manipulation.

The life experiences of the students are another limiting factor that required the removal of all students except American Caucasians from this study. Changes in national events, local events, curricula or classroom practices could have affected the nine, thirteen and seventeen-year-old populations very differently. Since the purpose of this study was to examine trends in achievement as a student progressed through school, this task would be simplified by controlling the differences in life experiences not attributable to school that have occurred to the three populations. The addition of Blacks and other minorites would be beyond the scope of this study. Indeed, National Assessment data have yielded different patterns for Black performance as compared to Caucasian performance for nine, thirteen and seventeen-year-olds in the mathematics (NAEP, 1979a), science (NAEP, 1978b) and reading (NAEP, 1976) assessments. In addition, it is not likely that recent large scale educational changes (e.g., Head Start or Follow-through) have affected Caucasians educational opportunities as significantly as other groups. Selecting only Caucasians, a very homogeneous subpopulation, reduces the effects of these differences.

POPULATION FOR SECONDARY ANALYSES

At each age this study selects only Caucasian students who entered first grade at the normal time for their school district. The normal grades for the nine, thirteen and seventeen-year-old populations are grades three and four, grades seven and eight, and grades eleven and twelve respectively. Grades four, eight and eleven were used in this study because they contained the majority of the National Assessment student populations.

Vital background information about the exact age of a student upon entrance into school and the extent of any kindergarten experience was missing and caused difficulty during the selection of students for this present study. All that was known was (1) the student's birth month and year, (2) the student's current grade in school, (3) the state in which the student currently resided and (4) the state in which the student attended school at ages nine and thirteen. This information, along with school district entrance age policies, provided identification for those students who entered first grade within the normal entrance age range for their school district.

Chapter 2

PREVIOUS RESEARCH FINDINGS

School districts have typically admitted children to first grade only at the beginning of the school year. Thus all children who were age six by a given cutoff date entered first grade together. Actually, due to the existing promotion and retention policies in many school systems, the age range in first grade is usually greater than twelve months. Based upon results of special screening tests for mental, emotional, and physical maturity, some school systems have permitted parents to delay entrance of an immature child or enter an advanced child early. Choppin (1969) reported data about the sample of United States thirteen-year-old students selected by the International Study of Achievement in Mathematics. This data indicated that nationwide, four percent of the sample had been promoted one or more grades and that twenty four percent had been held back one or more grades. The purpose of this study was to determine the effect of this broad age range on the achievement of children progressing through school at the normal rate.

Much of the literature relevant to this question has investigated the optimal absolute age for the admission of children to first grade. Researchers have used a paradigm where students were divided into groups based upon their chronological age at entrance to first grade. The search for the optimal entrance age has led to two major variations of the paradigm.

One variation compared some portion of the normally entering children with a group of specially selected younger children who were allowed to enter first grade early. But results relevant to a special group of advanced younger children cannot be generalized to unselected younger children entering at the normal entrance age for their community. Moreover, when controlling for intelligence, some studies found that even among mentally advanced children, a younger entrance age may lead to an academic disadvantage (Baer, 1958; Hedges, 1977).

For these reasons, the following review of the literature focused on the research using the second version of the paradigm. These studies only selected students who had progressed normally through school and removed all students who had repeated a grade or were advanced for their age. When comparing academic achievement of children entering school at the opposite ends of the normal twelve month entrance age period, almost all investigators found that the younger students received lower school grades and scored lower on achievement tests.

RELATIONSHIP BETWEEN ACHIEVEMENT AND ENTRANCE AGE

One of the first studies which produced these conclusions was conducted by Bigelow (1934). One hundred and two of the students selected for this study entered first grade in September, 1930 and were less than six years and five months old when they entered school. A group of young students were created with an entrance age less than six years old and an old group with an entrance age between six years and six years four months inclusive. Both groups of young and old students were further divided depending on whether they were in fourth grade or had been retained one or more grades. The students of all four groups were given the Kuhlman-Anderson Intelligence Tests to provide IQ and mental age measures and the fourth grade students were administered the Modern School Achievement Test.

Distributions of student counts were created for the IQ and mental age variables for all four groups. These distributions for the young and old fourth graders were displayed separately for those students whose achievement score was above and below average. The entire data analysis for this study consisted of the conclusions drawn from these distributions of student counts (Bigelow, 1934).

> 1. If a child is chronologically between six years old and six years and four months old and has an intelligence quotient of 110 or more, he is practically certain to succeed in school.
>
> 2. A child less than six years old chronologically with an intelligence quotient of 120 or over will probably succeed, but personality factors should also be considered.
>
> 3. If a child is below six years old chronologically and has an intelligence quotient below 110, his chance of success is small. . . .
>
> 4. Children below six years old chronologically with intelligence quotients of 110-119, inclusive, and children chronologically between

six years old and six years and four months old with intelligence quotients of 100-109, inclusive, have a fair chance of success. . . .

5. If a child is below six years old chronologically and has a mental age of six years and ten months or above, he is practically certain to succeed in school. If his mental age is between six years and eight months and six years and nine months, inclusive, he has a good chance of success.

6. A child chronologically between six years and six years and four months of age has a good chance of success if his mental age is six years and four months or above.

7. A child who is chronologically below six years and four months of age and whose mental age is below six years has practically no chance of success. (p. 192)

Besides the lack of statistical validation for the conclusions drawn by Bigelow, a portion of the statements were based upon an erroneously augmented number of young retained students. Added to the third grade students were twenty five fourth grade students who were less than six years old and had been retained one grade, but who had entered first grade in September, 1929. Unfortunately the lumping of students of two different populations of students into the group of young retained students could alter the conclusions drawn from the data.

Bigelow's statements about IQ, mental age and achievement were based solely on these distributions. However, in a comprehensive review of the research on optimal entrance age to first grade, Hedges (1977) commented more than forty years later that "In all of the research I've reviewed to this point (1977), nothing has been located that basically contradicts Bigelow's conclusions" (p. 129). To bring the data into focus with respect to comparing younger and older students, the distributions presented in the article were analyzed by the present author using a Fisher's Exact test. The results of this analysis indicated that for children with an IQ of 110 or above, more older children had above average achievement than younger children ($p<.10$).

The next and frequently referenced study was conducted by King (1955) in Tennessee. Children who entered the first grade between the ages of five years and eight months to five years and eleven months were compared with an older group of children who entered first grade between the ages of six years and five months to six years and eight months. The sixth grade students with these qualifications were reduced to those children in the IQ range of 90 to 110. In her total subject group of 104 students, the higher intelligence of the younger group was statistically significant at the five percent level. Even with this IQ advantage, a significantly lower grade equivalent score on the Stanford Achievement Test of 6.20 was found for the younger group as compared to 7.68 for the older group.

These two groups also differed in their attendance and the number of students retained during their school career. A mean advantage of 17.6 more days of attendance for the older group differed significantly at the five percent level from the younger group. With respect to the retention rate, eleven of the fifty four students of the younger group were retained as compared to the retention of only one of the fifty students of the older group. King did not perform an analysis on this data, but using information provided in the study, a chi-square analysis demonstrated that significantly ($p<.01$) more students were retained out of the younger group as compared to the older group.

Since these younger students who had been retained one or more grades could not have been in grade six, they would not have received the same coverage of school material as did the sixth grade students. This problem of exposure posed a direct threat to the validity of the results. Fortunately the entire data set was available for reanalysis; the retained students were removed from the sample and entrance age and sex were analyzed in a two way analysis of variance.

The fundamental findings of this study were reaffirmed by this subsequent reanalysis of the data by the present authors. These results indicated that the younger group performed significantly worse than the older group on the achievement measure. The average grade equivalent was raised to 6.51 for the younger group and raised to 7.73 for the older group. Neither the main effect for sex nor the interaction of sex and entrance age showed a significant difference.

Green and Simmons (1962) attempted to control the younger and older students for differences in parental occupations, intelligence and sex. This was accomplished by selecting subjects so that distributions of parental occupations and intelligence test scores were very similar for males and females of both groups. The 118 fourth grade students had received the California Achievement Tests and were analyzed in a two way analysis of variance on reading, arithmetic and language.

Significant differences were found at the five percent level for the reading, arithmetic and language achievement tests in favor of the older pupils. The authors also reported the existence of a significant main effect for sex and a nonsignificant interaction of entrance age and sex. These results were not listed or discussed further in the article because they were not germain to the purposes of their study.

The study by Green and Simmons provided yet another difficulty in preparing an appropriate literature review for the present study. In many articles where explicit statements were lacking about the nature of the young and old groups, the cutoff date provided a means to determine whether younger students were specially selected in some way. Since no cutoff dates were provided by Green and Simmons, only a careful perusal of the article led to the conclusion that the students selected for this study were normally entering first graders.

Carroll (1963) examined differences in school adjustment and achievement by matching twenty nine pairs of young and old third grade students on sex, intelligence and socioeconomic status. Sixteen male and thirteen female student were chosen from normally entering first grade students between the ages of five years and nine months to six years and eight months; entering first grade before or after age six was the criterion used for selecting old and young student groups. The intelligence of each student was assessed on the California Test of Mental Maturity and the socioeconomic variable was based on parental education, parental occupation, family income, cultural advantages in the home and kind of home. Reading and mathematics achievement was measured by the California Achievement Test and school adjustment was described by teachers' ratings for ten traits commonly found in report and cumulative records.

Carroll found that the older group had significantly higher achievement than the younger group on all four achievement subtests in mathematics and reading. Even though male and female differences were not significant, she stated that the mean grade placement score of these four subtests suggested that males tended to find reading more difficult than females. Similarly, the school adjustment ratings by teachers placed a more favorable rating on the older group on seven of the ten traits. Two of these traits, attention span and independence were significant at the one percent level.

Dickinson and Larson (1963) found conflicting results depending upon how they analyzed their data. They compared the achievement of 480 children in the fourth grade of the Sioux Falls Public Schools who entered within the normal entrance age period of five years and eleven months to six years and ten months. Based upon the composite test score of the Iowa Test of Basic Skills, the comparison between the youngest twenty five percent of the students and the remaining older students yielded a significantly lower achievement score for the youngest students ($p<.05$). However, when the researchers divided the pupils into four age groups, each spanning three months, the pattern of means was only suggestive of significance ($p<.10$). This lower significance was caused by increasingly higher achievement means for increased age at all but the oldest three month level. Dickinson and Larson provided no explanation for these unusual results.

Hall (1963) considered the question of entrance age and achievement from several different perspectives. He reviewed the data in the cumulative records of approximately 12,800 elementary school children of various grades and found 801 children that had been retained one or more grades. These pupils were divided into two groups on the basis of age at entrance to first grade. Students attaining an age of at least six years and six months were labeled old and the remainder were labeled young. Hall found that seventy eight percent of the retained children belonged to the young group and that the retained students contained three times as many boys as girls. Since these statements were made on the basis of the raw data without statistical validation, the data were analyzed by the present author using a chi-square test. The analysis revealed significantly more younger male students had been retained one or more grades.

Hall also collected the Science Research Associates Achievement Series scores for 607 third grade and 556 sixth grade students. The mean achievement for each subtest was calculated for each combination of categories for grade, sex and entrance age. Similar conclusions were drawn from the achievement means for these variables and a recommendation was made to the school board to consider changing the beginning time of instruction for language arts and reading, especially for young males. No data analysis was performed and the lack of information precluded a reanalysis. As was demonstrated in the description of the Bigelow (1934) study, such conclusions may have no statistical support.

Predictions about the achievement of younger and older groups for mathematics and reading achievement were provided by Halliwell and Stein (1964). They felt that reading was presented more rapidly than arithmetic in the American elementary school. They argued that the usual reading program (1) was too rapid for the younger first and second grade students, (2) resulted in more unsatisfactory school experiences and (3) would interfere with performance in reading and reading related areas throughout their school careers.

Conversely, Halliwell and Stein hypothesized that arithmetic instruction was introduced at a more leisurely pace, allowing younger pupils to keep up with the class and to have less detrimental experiences. They argued that by grades four and five, there should be no significant difference in arithmetic ability between younger and older students. These hypotheses were adjusted depending upon the extent performance on the California Achievement Tests depended upon reading ability. It was postulated that the arithmetic fundamentals test required the least amount of reading ability followed by arithmetic reasoning, language, spelling, comprehension and vocabulary tests.

To test these hypotheses, Halliwell and Stein used fourth and fifth grade students entering first grade from age five years and ten months to age six years and nine months. Students from the oldest and youngest three months were selected for the two entrance age groups. Average intelligence was higher in the older group but was not significant in either grade. The older group scored higher on all six achievement tests for both grades. For grade four these differences were significant in every achievement area except arithmetic fundamentals and for grade five only the arithmetic fundamentals test showed a significant difference. Halliwell and Stein concluded that "The hypothesis that differences in achievement between the younger and older pupils would approach zero as the tests employed became less reading oriented was partially borne out" (p. 638).

One of the few studies that has found attenuated differences in achievement between younger and older students was conducted by Miller and Norris (1967). Students were drawn from the fourth and fifth grades of elementary schools where their entrance into formal schooling began in a nongraded environment. These students entered school during the normal entrance age span of five years and eight months to six years and seven months and were labeled young if they entered under six years of age and labled old otherwise. Upon entering the school system, each student was placed in one of eleven instructional levels based on teacher recommendations and reading achievement as measured by the Gates Reading Readiness Test. This organizational system emphasized the grouping of students at similar instructional levels to enhance reading instruction and individual pacing of progress to minimize failure and grade repetition. Since each student began and progressed through these eleven levels at different rates, they entered fourth grade at different times.

Miller and Norris selected only those students who had taken the Metropolitan Achievement Test every year and had progressed through the entire nongraded system into the normally structured fourth and fifth grades. During their fifth year in school the modified Tuddenham Reputation Test was administered to students. This sociometric scale consisted of eighteen positive and negative statements descriptive of children's characteristics and behaviors. The sociometric data indicated that the older entrants scored higher on all but one of the nine variables, but that none of the differences were significant. When the young and old groups were compared on all of the achievement subtests, the older group had higher achievement on twenty eight of the twenty nine tests. Only four of the twenty nine tests were significant at the five percent level and three of these tests were from the six subtests of the Gates Reading Readiness battery. From this Miller and Norris stated:

> It must be concluded that early entrants in this study were at a disadvantage when they began their school experience. However, significant differences in tested readiness did not persist as significant achievement differences beyond grade one. Halliwell and Stein (1964) found more significant achievement test differences between early (70 to 75 months) and late (76 to 81 months) entrants on reading related than on non-reading related subjects at the fourth and fifth grade level. It is considered likely that the absence of significant group achievement differences beyond first grade in the present study is attributable to the effectiveness of the Murfreesboro primary unit in individualizing reading instruction. (p. 59)

Many of the studies cited in this review have discussed the mental maturity differences between males and females in elementary school and have examined the differences between males and females with respect to the disproportionate number of males retained one or more grades in school. Several of the studies have even attempted to control for the effect of sex through covariance or by sampling equal numbers of males and females. But very few have made a concerted effort to examine achievement for interactions between sex and entrance age groups. This discrepancy was especially noticable in the Miller and Norris (1967) study. Since they placed heavy emphasis upon meeting the needs of all the children through a nongraded primary school, it would seem important to demonstrate that the nongraded school structure would show either no differences or attenuated differences between male and female achievement.

Several of the studies above have shown that significantly more younger students have been retained one or more grades, but few studies have offered any validation for claims of higher percentages of emotional problems encountered by younger students. A study by Weinstein (1968-69) was one of the exceptions. In her first study she took 250 children from a reeducation program for children considered too emotionally disturbed to remain at home or school. The prediction was made that disproportionately more of these disturbed children would have entered school among the youngest four months of the normal entrance age range. For each month of the year the percentage of the children at these two special schools was compared to the theoretical national birth rate. Children in the two schools were found to be significantly overrepresented for the youngest four months.

Because the two special schools had different cutoff dates, the youngest four months differed between the schools. The first school required their students to be six years old by October sixteenth and entered children between the ages of five years, ten and one half months to six years, two and one half months. Since the second school had a December thirty first cutoff date, September through December contained the youngest students. Thus September first to October sixteenth contained the overlap of the youngest students of the two schools. Using the June seventeenth to October sixteenth overlap between the two schools, Weinstein was able to determine whether being the youngest student within a class or whether starting school less than a specific chronological age caused the over representation of emotionally disturbed children in certain birth months. She found that the group of students in the four youngest months of the first school were not significantly overrepresented in the second school, and argued that the students' chronological ages were not as important as the students' ages relative to their classmates.

For the second study, principals of Nashville public schools were asked to nominate white males from grades one through six who they felt were sufficiently emotionally disturbed to require special professional help. Each child was matched for IQ, socioeconomic status and family composition with another child in the classroom. The teacher, principal and reseacher independently agreed about the designation of emotionally disturbed or normal for each matched pair of students in the classroom. The results indicated that the disturbed children had been significantly younger upon entrance to first grade.

Within each classroom containing one of the matched pair of children, all students filled out a sociometric questionnaire indicating the five classmates they would like to invite to a party and the five they would prefer not to have at a party. Among all the nondisturbed children in the classroom, the younger entering student received significantly fewer positive nominations and more rejections than their older classmates.

From these results Weinstein (1968-69) concluded that

> Children who start first grade young compared to their classmates are more likely to be referred to a residential treatment center. If they remain in public school, they are more likely to be seen as emotionally disturbed by school personnel. If they are not seen as disturbed by the school, they are more likely to fail a grade and to be rejected by their classmates than other non-disturbed children. (p. 27)

One of the few studies that examined high school achievement data and subsequent enrollment in college was conducted by Harrell (1970). Students were categorized as young or old if they belonged to the first or last six months of the normal first grade entrance age range from five years and ten months to six years and nine months. Achievement and grade point average in grades six and twelve were examined for 135 males and 170 females. Achievement was measured by the composite measures of the Stanford Achievement Test for sixth grade and the Iowa Test of Basic Skills for twelfth grade. The average grade point was (1) the average grade for all elementary courses except for art, music and physical education or (2) the average grade for all courses in grades ten through twelve.

The four dependent measures were analyzed separately by sex with an analysis of covariance. The covaried variables were mental age measured by the Kuhlman-Anderson Intelligence Test given to all sixth graders and a social and economic measure defined as the mean dollar value of the homes in their neighborhood. Among all eight comparisons the older students were favored in grade point and achievement. Seven of these were significant; only the grade point average between old and young females in elementary school was not significant.

The pervasive effect of entrance age on subsequent enrollment in college by graduates of this Oklahoma school system was measured by chi-square analysis. The college enrollment included 2,041 graduates from 1960 through 1967. Males and females were analyzed separately on the basis of whether a greater percentage of older than younger students attended college during the first, second, third or fourth years. For males all four comparisons significantly favored the older group, but for females only the first three years were significant.

The data analysis used by Harrell did not take advantage of a valuable opportunity to compare achievement changes across the school careers of these students. Since achievement and grade points were collected for a student across two points in time, there would be more internal consistency and increased statistical power for this study than for a study where two independent groups were compared at grades six and twelve. Another puzzling choice was made when males and females were not compared directly for potential interactions between sex and entrance age.

More recent studies have also failed to provide adequate or proper analysis of the data. Montgomery (1969) examined the student records from 549 sixth grade and 471 twelfth grade students currently enrolled in the public schools. The purpose of the study was to determine whether older students achieved and maintained a greater measure of educational success than younger students. Educational success was defined as a composite of eleven variables for the sixth grade and twenty nine variables at the twelfth grade.

The data were analyzed by a sign test in which the means for each variable were assigned a positive sign indicating that the older group scored higher and a negative sign when the younger group scored higher. Unfortunately, Montgomery's measure of educational success overemphasized some variables. For instance, at grade six the vocabulary, reading, language and arithmetic subtests and the composite measure of the Iowa Test of Basic Skills were treated as separate variables. Another basic cause for concern was the fact that many of the variables were based upon different populations. For example, one variable existed for only one third of the students who had teacher defined arithmetic progress scores. These difficulties in the data analysis made it impossible to determine the population of students to which the results were applicable.

Since 1970, very little research has been done to provide any new insight into the purpose of this study.

Since Milner (1976) has provided a more exhaustive description of these studies, no further discussion is necessary at this time.

BRITISH STUDIES

Barker-Lunn (1972) summarized a substantial number of research studies completed in Great Britain. British researchers have found patterns of results similar to United States studies, indicating that younger children were at an educational disadvantage when compared to their older classmates. In England and Wales, a child would normally enter school during or after the term in which he became five years old. Therefore, infant schools have generally admitted children during spring, summer or autumn terms and promoted them to junior school only once a year. This has resulted in children having varying lengths of infant schooling, where (1) the oldest children entered school during the autumn term and were born from September through December and (2) the youngest children entered in the summer term and were born in May through August. In a previous study, Barker-Lunn surveyed 15,000 children and found that before advancing to junior school twenty six percent had completed six terms of infant schooling and twenty six percent had completed nine terms. This represented a difference of up to one year in the amount of schooling between younger and older students who entered junior school at the same time.

The results of the prior research cited by Barker-Lunn have shown that in those schools were students were grouped according to ability, younger students were more likely to be found in lower ability groups throughout their infant schooling and less likely to be promoted into junior school. She concluded

> Most writers in this field have concentrated on the two major factors--variations in age and length of infant schooling--as the explanation for the relationship between school performance and season of birth. . . . little attempt has been made to separate out the effects of age and length of infant schooling in order to throw some light on the relative importance of these two factors. The aim of the present study is to determine the effect of length of infant schooling on the academic performance of children when date of birth is held constant. (p. 122)

In addition to this review, Barker-Lunn examined approximately 4000 students obtained from the Streaming

Research in Primary Schools project. She found a significant relationship between achievement scores and length of schooling for only the youngest, summer born, children. For each age, seven through ten, a significant increase in reading achievement was found as the number of terms of schooling increased from six to nine. This relationship was also demonstrated at all ages for arithmetic attainment, but was only significant at age eight.

As with many studies, several alternative theories could provide explanations for these results. Fogelman and Gorbach (1978) analyzed data from 10,300 students collected by the National Child Development Study. These students were born in England, Scotland and Wales from March third through ninth in 1958. About one half of these students entered the spring term of infant school at age four years and six months through four years and eleven months. The other half entered the summer term between the ages of five years and five years and six months. At age eleven these students received three achievement tests measuring general ability, reading and mathematic attainment. The results of the study indicated that an achievement advantage favoring the children entering the spring term had been reduced from a grade equivalent of three months, but was still statistically significant for all three achievement measures.

A critical aspect of the Fogelman and Gorbach study involved the March birthdate of the sampled students. In both Britain and the United States the first week of March has been the middle age range for normally entering students. Thus the study showed the importance of the length of schooling effect in the British data while controlling for the effects of being the youngest or oldest within the classroom. However, they did not determine the relative importance of either effect. Since the United States data had no obvious length of schooling effect, the majority of British research would be very difficult to interpret with respect to the present study.

Another important aspect of the Fogelman and Gorbach study was derived from the use of a large and nationally representative sample of children. The large sample size and the data available on a number of independent variables such as sex, social class, region of the country, school size, class size and attendance enabled them to account for other factors which might explain the results. Similarly, National Assessment data provided a large and nationally representative sample of children in the United States with independent variables like sex, region of the country, home environment, parental education and type of community. In the same manner, the secondary analysis of the National Assessment data provided insights into the achievement differences between younger and older classmates.

SUMMARY

The purpose of this study was to examine the relationship between chronological age and achievement over the formal academic career of the student. The majority of the literature relevant to this relationship has been conducted to investigate the optimal entrance age for children. These studies have used a paradigm which divided students into groups based upon their chronological age at entrance into first grade. The paradigm version relevant to this study compared age groupings of normally entering first graders.

The review of these studies indicate a fairly consistent picture of the relationship between chronological age and academic achievement. When comparing the older and younger ends of the normal entrance age range, more younger students (1) have difficulties in the academic, social and emotional areas, (2) have lower attendance, and (3) were retained one or more grades. These results are well documented in elementary school, but only a few studies exist at the junior high and high school levels.

Chapter 3

METHODOLOGY

This chapter defines the criterion and predictor variables, the target population, and discusses the rationale for the specific data analyses necessary to answer the proposed questions concerning the relationship between subsequent academic achievement and school entrance age. The relationship was analyzed using a student population entering first grade at the normal entrance age range for their school district. Subsequent achievement was defined in terms of three specific learning areas: mathematics, science and reading. Population variables such as entrance age, sex, parental education, type of community and home environment variables were also employed to distinguish subgroups within the student populations. For each of these learning areas, the data were analyzed for trends among the nine, thirteen and seventeen-year-old student populations.

A series of multiple regressions (Nie et al., 1975) were performed to provide statistical evidence for the research questions. The criterion variables for this analysis were inverse normal (probit) transformations (Statistical Analysis System, 1979) of percentile ranks on the achievement test for each learning area. A student's rank was based upon the percentage or number of correct answers of the learning area exercises with respect to all students who took the same assessment package. This ranking procedure equalized packages with differing numbers of exercises and exercise difficulty. The resulting uniform distribution of percentile ranks was converted to a normal distribution to satisfy assumptions of the subsequent regression analyses.

SAMPLE DESCRIPTION

The samples chosen for this study were reduced subsets of the original National Assessment samples for each age. These reductions were designed to select a group of students comparable to prior research populations and who were consistently identifiable for the three ages within each of the three learning areas.

Learning Areas

This study selected only the most recent assessments of mathematics, science and reading, assessment years nine, eight and six respectively (see Tables 1 and 3, pp. 3 and 27). The comparisons between the three age groups within each of the three learning areas were potentialy confounded by variables other than schooling. Comparisons of the recent assessments with their previous cycles would solve some of the problems associated with intervening events and determine how persistent the findings of this study were over time. However, the only nine-year-old populations sampled again at age thirteen were (1) the writing assessments of years one and five, (2) the reading assessements of years two and six, (3) the social studies assessments of years three and seven and (4) the science assessments of years four and eight. The added complexity of using this cohort data or other previous assessment data, to study the relationship of school entrance age and achievement, places it beyond the scope of this study, but under consideration for future research.

Grade Levels

This study only included Caucasian students in grades four, eight and eleven to make the results comparable to the prior research. The selection of these specific grades was a function of student birthdate ranges used to define the nine, thirteen and seventeen-year-old populations (see Table 3). These birthdate ranges made grades four, eight and eleven the modal grades for their respective populations.

For example, the nine-year old students of the year nine mathematics assessment were born in 1968, entered first grade in 1974 or 1975 and were assessed in third or fourth grade. In a state where the legal requirement for entering first grade was the attainment of six years of age by September first, all students born in January

TABLE 3

National Assessment of Educational Progress Birthdate Ranges of Sampled Students by Age Group and Assessment Year

Assessment Year and Learning Area(s)	Month and Year of Birth		
	Age 9	Age 13	Age 17
1: Citizenship; Writing; Science	01/60-12/60	01/56-12/56	10/51-09/52
2: Reading; Literature	01/61-12/61	01/57-12/57	10/53-09/54
3: Music; Social Studies	01/62-12/62	01/58-12/58	10/54-09/55
4: Science; Mathematics	01/63-12/63	01/59-12/59	10/55-09/56
5: Writing; Career and Occupational Development	01/64-12/64	01/60-12/60	10/56-09/57
6: Reading; Art	01/65-12/65	01/61-12/61	10/57-09/58
7: Citizenship; Social Studies	01/66-12/66	01/62-12/62	10/58-09/59
8: Science	01/67-12/67	01/63-12/63	10/59-09/60
9: Mathematics	01/68-12/68	01/64-12/64	10/60-09/61

through August would have entered school in 1974. These students were in grade four at the time of the mathematics assessment. The rest of the students would have entered school the following year and would have been in third grade. In a state where the cutoff date was October first, an even greater portion of the nine-year-old sample would have been in fourth grade. Since the fourth grade contained approximately seventy-five percent of the National Assessment nine-year-old sample, it was the modal grade (see Table 4).

TABLE 4

Grade Level for Cutoff Month by Birth Month for the Nine-Year-Old Sample

Cutoff Month	Birth Month											
	J	F	M	A	M	J	J	A	S	O	N	D
September	4	4	4	4	4	4	4	4	3	3	3	3
October	4	4	4	4	4	4	4	4	4	3	3	3
November	4	4	4	4	4	4	4	4	4	4	3	3
December	4	4	4	4	4	4	4	4	4	4	4	3
January	4	4	4	4	4	4	4	4	4	4	4	4
February	5	4	4	4	4	4	4	4	4	4	4	4

Similar logic was applied to the thirteen-year-old sample. The modal grade for this group is the eighth grade, with approximately three quarters of the students in eight grade and one quarter in seventh grade (see Table 5). But the seventeen-year-old sample presents a more complicated problem. These students were assessed during the spring of the school year. If National Assessment were to use all students born in a calendar year, the age range of the students at the time of assessment would be sixteen years and nine months to seventeen years and nine months, making the average age of the sample seventeen years and three months old. The proposed sampling procedure has the added disadvantage that a large percentage of the students to be tested would be in the twelfth grade. This was considered undesirable because the last semester before graduation is usually filled with many extra curricular activites and less than normal academic application by the seniors.

National Assessment solved this sampling problem by selecting the students born in October through December of one year and January through September of the next year. This allowed the age range of the seventeen-year-old sam-

TABLE 5

Grade Level for Cutoff Month by Birth Month for the Thirteen-Year-Old Sample

Cutoff Month	Birth Month											
	J	F	M	A	M	J	J	A	S	O	N	D
September	8	8	8	8	8	8	8	8	7	7	7	7
October	8	8	8	8	8	8	8	8	8	7	7	7
November	8	8	8	8	8	8	8	8	8	8	7	7
December	8	8	8	8	8	8	8	8	8	8	8	7
January	8	8	8	8	8	8	8	8	8	8	8	8
February	9	8	8	8	8	8	8	8	8	8	8	8

ple to be sixteen and one half to seventeen and one half at the time of the assessment. This procedure produced an average sample age of seventeen, with approximately ten percent twelfth graders, seventy-five percent eleventh graders and fifteen percent tenth graders (see Table 6). Because the prior research had assigned subjects by grade level, only the modal grade levels four, eight and eleven provided enough data to explore the questions relevant to this study.

Normal First Grade Entrance

For the creation of the samples used by this study, only those students who were progressing through school at the normal rate for their school district were selected from the National Assessment samples. The primary basis for classifying a student as normal, advanced or held back with respect to current grade level was a comparison of the student's birth month and the date by which a student had to be six years of age to be accepted into first grade. Since the entrance age requirement for a school district was not available in National Assessment data, a variety of other data was examined to determine the cutoff date within each school district.

TABLE 6

Grade Level for Cutoff Month by Birth Month for the Seventeen-Year-Old Sample

Cutoff Month	Birth Month											
	O	N	D	J	F	M	A	M	J	J	A	S
September	11	11	11	11	11	11	11	11	11	11	11	10
October	11	11	11	11	11	11	11	11	11	11	11	11
November	12	11	11	11	11	11	11	11	11	11	11	11
December	12	12	11	11	11	11	11	11	11	11	11	11
January	12	12	12	11	11	11	11	11	11	11	11	11
February	12	12	12	12	11	11	11	11	11	11	11	11

The Educational Research Service publications (1958, 1963, 1968, 1975) contained the legal entrance age requirements for each state during the years 1957-58, 1962-63, 1967-68 and 1974-75. About seventy percent of the states utilized a statewide cutoff date. The remaining states left the cutoff date entirely to the discretion of the local school district or provided only a lower bound for the entrance age. The Educational Research Service data also contained the actual school entrance date for ninty five percent of the school systems operating elementary schools and enrolling more than 12,000 students. Because of the small overlap between these school systems with known cutoff dates and the school districts sampled by National Assessment, the decision was made to assign a statewide cutoff date for these remaining states.

To obtain a statewide cutoff date for those states where entrance age was decided by local districts, tabulations were made of the number of districts requiring each entrance date. This information was combined with information from the nine and thirteen-year-old National Assessment samples to assign the most reasonable entrance date for all school districts within states without a statewide statute. By comparing the number of students in each grade for the twelve student birth months, estimates of the first grade entrance age were made for each of those states.

As previously noted, students within the National Assment nine-year-old sample were mostly in grades three and four. In a state where statutes stipulated a statewide September first cutoff, the majority of students born in each of the months January through August would have been in grade four while students born during September through December would have been in grade three. Therefore, by examining the number of students in third and fourth grade by month for the entire state, a notable shift would be found in the majority of students in fourth grade for August to third grade for September. If this state had a September fifteenth cutoff, the shift would be clearly seen between August and October while September would have shown approximately equal numbers of students in grades three and four.

This logic was applied to each state lacking a statewide statute. If the majority of the districts sampled in a state had a September first cutoff, then the shift should be seen in the data for the month of September; if a single month did not clearly show this shift, the final decision was based on tabulations across the nine and thirteen-year-old samples for several years. In this manner a statewide entrance date was assigned for each of the states without a statewide statute. Of the remaining thirty percent of the states needing this statewide cutoff assignment, the above procedures indicated that most school districts within a state were generally using cutoff dates within a thirty day period of each other.

Using this combination of Educational Research Service and National Assessment information, a cutoff month was assigned for each state. (See Table 40 in Appendix A for the state cutoff months used by this study.) Each student was categorized as normal, advanced or held back by comparing birth month to the state cutoff month. For those states where the cutoff date was the first or second day of the month, that month became the cutoff month for this study. When the date was at the end of the month, the next month was used as the cutoff month. Thus a state with a September twenty ninth cutoff date would be changed to an October first cutoff.

A midmonth cutoff date posed new problems for determing a student's membership in the normal category. Since only the birth month was available for each student, students born in the cutoff month were assumed to be in the correct grade. For example, a state with a September fifteenth cutoff date was assigned September as the cutoff month. All students born in September were considered normal if their current grade level was the modal grade. States lacking a statewide statute that did not demonstrate a clear beginning of the month date were treated as a state with a midmonth cutoff.

For the thirteen and seventeen-year-old samples, National Assessment data contained information about prior state residence at age nine and at ages nine and thirteen respectively. For purposes of quality control, a student was removed from this study when the cutoff month of any prior state residence did not agree with the current state's cutoff month.

Information was also available about whether the student was enrolled in a public or private school for the mathematics and science assessments. Since prior research dealt only with public schools (the enrollment procedures vary greatly in private schools), only students from public schools were selected for this study.

Seventeen-Year-Old Population

A significant number of the seventeen-year-old students eligible for the sample were not in school or not available on the days of the assessment. These out-of-school students were eliminated from the present study. The results of absentee studies performed by the Research Triangle Institute for National Assessment (Kalsbeek, Clemmer & Folsom, 1975; Rogers, Folsom, Kalsbeek and Clemmer, 1977) indicated that seventeen-year-olds who did not appear for an assessment could be divided into two groups, absentees and dropouts.

The first group was absent because they were (1) ill, (2) engaged in other school activities, (3) were not properly notified of the assessment session or (4) used this time period for truancy. These students performed similarly to students assessed during the regularly scheduled administrations. To cope with this absentee problem, National Assessment has taken into account information gathered from prior assessments about absentee rates in various types of schools. Using this information, a larger than needed sample is selected for each assessment. Additional attempts to assess absentees are made when less than two thirds of the students fail to appear for a session or when less than three fourths of the students selected from the entire school fail to appear for the sessions conducted in that school. In this manner National Assessment insures a minimum number of students in each sample.

The second group of absentees did not appear to be available in the schools at any time. These students had either moved out of the school attendance area and/or attended school infrequently; they had actually, if not formally, dropped out of school. As a consequence, their poor performance tended to depress achievement estimates. These students represented twelve percent of both absentee groups and only two percent of the total desired sample size. Since the National Assessment budget has allowed for the assessment of these two types of absentee groups for some, but not all of the learning area assessments, both groups were excluded from the present study.

Minimum Achievement

A final reduction of the sample size for all three age populations was a function of the criterion variable. When a student failed to respond to more than fifty percent of the learning area exercises in the package, the student was deleted from the sample. Students eliminated by this restriction were not expending the minimum effort needed to provide an accurate measure of their knowledge of the learning area. Even though the cutoff percentage was somewhat arbitrary, after the previous reductions had taken place, only an additional four percent were dropped from the sample.

Sample Size

The final group resulting from these procedures represented a national sample with the particular characteristics sought in this study. The difference in sample sizes between the total National Assessment samples and the samples used by this study for all ages in the reading, mathematics and science learning areas is given in Table 7. The minimum sample sizes used by this study were 6,849 for age nine, 11,032 for age thirteen and 10,472 for age seventeen.

TABLE 7

A Comparison by Age and Learning Area of National Assessment of Educational Progress Sample Sizes With the Reduced Sample Sizes in This Study

Assessment Year and Learning Area		Sample Sizes					
		National Assessment Ages			Current Study Ages		
		9	13	17	9	13	17
6	Reading	21,679	21,393	20,295	12,423	11,032	10,472
8	Science	17,345	25,653	34,514	8,535	11,400	14,109
9	Math	14,752	24,209	24,631	6,849	10,491	11,675

PREDICTOR VARIABLES

National Assessment data contained background information about each student's (1) birth month, (2) birth year, (3) current grade level, (4) sex, (5) parental education, (6) home environment, (7) state of residence and (8) type of community. The predictor variables created from this information were relative age, chronological age, class age, sex, region, parental education, home environment, and type of community. Students supplied information about their home environment and parental education, while information about the school environment was obtained through a questionnaire given to the school principal. The package administrator coded observable student information like race and sex, while grade level, birth month and birth year were obtained from school records.

Sex and Race

The information about the sex and race variables was collected by the administrator of the package. The values for the regression analyses were assigned arbitrarily as one for males and minus one for females.

Visual identification and surname were used to determine race. The definition of race has been modified during the course of previous assessments until Caucasian, Black, Hispanic and other have become standardized classifications. For reasons described above, only Caucasian students were examined in this study.

Chronological Age

The birth month information provided by National Assessment was used to create two separate variables for the regression analyses. The obvious variable, chronological age, arranged students from oldest to youngest. As shown in Table 3 (p. 27), the nine and thirteen-year-old samples covered an entire calender year with the oldest student born in January and the youngest born in December. But for reasons described above, the oldest seventeen-year-old student sampled was born in October and the youngest in September. To keep the chronological age variable consistent across the three ages, the seventeen-year-old students born in October were assigned the value two as the oldest chronological age within the sample. Incremental values were added for each month with the result that the youngest students, born in September, were given the value thirteen.

To eliminate any possible confusion when comparing the three age samples, students in the nine and thirteen-year-old samples born in January were assigned the value five to agree with seventeen-year-old students born in January. The incremental value assignments made the student values for the three age samples agree for the months January through September. However, as shown in Table 8, the younger students born in the month of October, November and December were assigned the values fourteen, fifteen and sixteen respectively.

Relative Age

The relative age variable was developed through a combination of the National Assessment birth month information and the cutoff month created for each state. Prior research generally used a population selected from a single school district. This meant that the oldest student chronologically was also the oldest student relative to the other students in the class. Because the National Assessment samples contained students from states with different cutoff month requirements, two students with the same chronological age could be at two different relative positions in the classrooms. An argument for the greater importance of relative age has been made by Weinstein (1968-69); however, for this study, relative age was crucial for the comparison with prior research.

TABLE 8

Chronological Age Value for Birth Month for the Nine, Thirteen and Seventeen-Year-Old Samples

Age	Birth Month											
	J	F	M	A	M	J	J	A	S	O	N	D
09	5	6	7	8	9	10	11	12	13	14	15	16
13	5	6	7	8	9	10	11	12	13	14	15	16
17	5	6	7	8	9	10	11	12	13	2	3	4

The relative age variable in the regression analyses has assigned values ranging from one for the oldest student in a given class to twelve for the youngest. As an example, consider the nine or thirteen-year-old sample in a state where the first grade entrance age requirement for all grades was age six by January first. For this state all students born in a calendar year would enter first grade concurrently. Students born in December would be assigned the value twelve as the youngest students and students born in January, the oldest, would be assigned the value one.

However, if a state has a December cutoff, the youngest students in the modal grade would be born in November and assigned the value twelve. As shown in Table 9, the students born in January, the oldest in the National Assessment sample, would be assigned the value two. The oldest students in the modal grade were born in December of the previous year and were not in the National Assessment sample. However, for a school district with a cutoff of September first, the students born in August would be assigned the value twelve for the youngest. But since the sample only contains students born from January to December in a single year, the oldest students for this class represented in the sample were born in January and assigned the value five, which concurs with the value assigned for chronological age.

TABLE 9

Relative Age Value for Cutoff Month by Birth Month in the Modal Grade for the Nine and Thirteen-Year-Old Samples

Cutoff Month	Birth Month											
	J	F	M	A	M	J	J	A	S	O	N	D
September	5	6	7	8	9	10	11	12	-	-	-	-
October	4	5	6	7	8	9	10	11	12	-	-	-
November	3	4	5	6	7	8	9	10	11	12	-	-
December	2	3	4	5	6	7	8	9	10	11	12	-
January	1	2	3	4	5	6	7	8	9	10	11	12
February	-	1	2	3	4	5	6	7	8	9	10	11

Students from a state with a midmonth cutoff were assigned a relative age as if the state's cutoff was at the first of the month. But as described earlier, a portion of the students born in the cutoff month were normally entering first graders. For the nine and thirteen-year-old samples, these students were given a relative value as if they were born in the preceding month. Thus, modal grade students born in September and August, who entered first grade in a state with a September fifteenth cutoff, would have received the value twelve as the youngest students in the class.

The nine and thirteen-year-old samples contained a higher percentage of the relatively youngest students in the modal grade as compared to the seventeen-year-old samples. This was caused by the National Assessment sampling of chronological ages from October of one year to September of the next year for the age seventeen sample. For example, if a state has a statewide January first cutoff, the students born in January would be the oldest in grade eleven and assigned a value of two. The youngest students sampled were born in September and were in relative age position nine. Examination of Table 10 reveals that as the cutoff is moved back towards September, those states contain more of the younger students in the modal grade. Finally, for states with October first cutoff dates, the entire classroom is represented in the National Assessment sample.

Class Age

The class age variable categorized the students into older and younger groups based on the average age of the students in the classroom. This variable can best be described by examining the relationship between chronological and relative age shown in Table 9 (p. 37). The oldest student in the nine or thirteen-year-old sample was born in January with chronological age value one. If the student entered a school district with a January first cutoff date, the student's relative age position would be one, indicating the oldest student in the classroom. However, entering a district with a September first cutoff, the same student would be in the middle of the class with a value five on the relative age variable.

Described from the perspectve of relative age, a student with relative age position six would be approximately the average age of all the students in the classroom. For a student to have relative age position six, the student would be born in June in a district with a January first cutoff, while the student would be born in February in a district with a September first cutoff. Thus two students can be up to four months apart in chronological age and still have the same relative age position in their respective classrooms.

TABLE 10

Relative Age Value for Cutoff Month by Birth Month in the Modal Grade for the Seventeen-Year-Old Sample

Cutoff Month	Birth Month											
	O	N	D	J	F	M	A	M	J	J	A	S
September	2	3	4	5	6	7	8	9	10	11	12	-
October	1	2	3	4	5	6	7	8	9	10	11	12
November	-	1	2	3	4	5	6	7	8	9	10	11
December	-	-	1	2	3	4	5	6	7	8	9	10
January	-	-	-	1	2	3	4	5	6	7	8	9
February	-	-	-	-	1	2	3	4	5	6	7	8

Assuming the classroom has approximately equal numbers of students in each birth month, then the mean chronological age of the classroom in a state using a September cutoff should be near the average age of students born in February and March. For a state using a January cutoff the mean age of the classroom would be the average age of students born in June and July. Therefore classrooms in states with September cutoffs have the oldest average classroom age while classrooms in states with a February cutoff have the youngest average classroom age.

The same logic applies to the seventeen-year-old sample. Examination of Table 10 reveals that average class age should fall between February and March for states using a September cutoff and between June and July for states using a January cutoff. The difference between the nine or thirteen-year-old samples and the seventeen-year-old samples is the portion of modal grade students who did not appear in the National Assessment samples. For the nine-year-old or thirteen-year-old samples, states with a September cutoff do not have approximately one quarter of their oldest students while those states with a February cutoff in the seventeen-year-old sample do not have one quarter of their youngest students.

The class age variable divided the students into two groups with approximately equal numbers of students. The older category consisted of those students entering states with either September, October or November cutoffs. The category with the younger mean age had all the students with cutoffs in December, January or February. In addition to relative age, class age was the other key variable in the regression analyses. If teachers' desires for an older entrance age are valid, the difference of five calendar months between the cutoff dates could show an academic advantage for students in classes with an older average age. This variable provided control over the potential distortion of the data caused by the multiple cutoff dates affecting the data. For the regression analyses the value one was assigned to students in the older category and a minus one value to students in the younger category.

TABLE 11

National Assessment Regions of the Country

Northeast	Southeast	Central	West
Connecticut	Alabama	Illinois	Alaska
Deleware	Arkansas	Indiana	Arizona
Dist. of Columbia	Florida	Iowa	California
Maine	Georgia	Kansas	Colorado
Maryland	Kentucky	Michigan	Hawaii
Massachusetts	Louisiana	Minnesota	Idaho
New Hampshire	Mississippi	Missouri	Montana
New Jersey	North Carolina	Nebraska	Nevada
New York	South Carolina	North Dakota	New mexico
Pennsylvania	Tennessee	Ohio	Oklahoma
Rhode Island	Virginia	South Dakota	Texas
Vermont	West Virginia	Wisconsin	Utah
			Washington
			Wyoming

Region

National Assessment divides the states into regions shown in Table 11. For the mathematics, science and reading assessments, National Assessment has reported the highest achievement for the northeast and the lowest achievement for the southeast. Northeast and southeast region variables were created by this study to examine any differential effects occuring by region of the country. For the northeast variable, students of the northeast region were assigned the value one and all other students the value zero. Similarly, students living in the southeast were assigned a one on the southeast variable and everyone else was assigned zero.

Parental Education

High and low parental education variables were based on information which National Assessment collects from the students about the amount of schooling completed by each parent. The student responses can be grouped into an "I don't know" response and a response when (1) both parents did not graduate from high school, (2) at least one parent graduated from high school, and (3) at least one parent had some post high school education. High and low parental education variables were created from this information for the regression analyses. For the high parental education variable, the value one was given to a student whose parents had some post high school education while all other students received a zero. Similarly for the low parental education variable, students whose parents did not graduate from high school received a one and everyone else received a zero. In this manner the regression analyses provided information about high, medium and low classifications of parental education.

Home Environment

Home environment variables are based upon four separate questions about the reading materials in the student's home. National Assessment asks each student whether their home (1) contains more than twenty-five books, (2) contains an encyclopedia, (3) receives magazines regularly and (4) receives a newspaper regularly. From this information high and low home environment variables were created in the same manner as described for the parental education variables. For the high home environment variable, students responding with four affirmative responses were assigned the value one and all others the value zero. The low home environment variable contrasted those students who had affirmative respones to less than three of the four questions with all other students by assigning the values one and zero respectively.

Type of Community

The high and low type of community variables are based upon the National Assessment classifications of extreme rural, advantaged urban, disadvantaged urban and other (NAEP, 1980b). These four categories are created from information obtained from the school principal about the size of the community where the school is located and the occupational profile of the area served by the school.

For the size of community information the principal estimated the proportion of students who lived in a rural area with less than 2500 persons, a town with 2500 to 10,000 persons or a town with more than 10,000 persons. Similarly, the occupational profile was created from the principal's estimation of the proportion of parents (1) who were professional or managerial personnel, (2) who were sales, clerical, technical or skilled workers, (3) who were factory or other blue collar workers, (4) who were farm workers, (5) who were not regularly employed or (6) who were on welfare. Rural, advantaged urban and disadvantaged urban indicies were constructed from the occupational profile.

Schools were automatically excluded from the extreme rural index when the current census did not classify the school as a "small place" or the school principal identified any proportion of the students as living in a community with a population greater than 10,000. The remaining schools were ordered from highest to lowest on the rural index. The extreme rural category comprised ten percent of the sampled students and was created by selecting schools with the highest level of the index (Research Triangle Institute, 1973, pp. 6-20).

Only schools classified as "big city" or "fringes around big cities" by the most recent census were eligible for respective classifications as advantaged and disadvantaged urbran. Again, eligible schools were arranged from highest to lowest on these indexes. The students of those schools with the highest level of the index were selected until ten percent of the national population became members of their respective categories.

In summary, students in the advantaged and disadvantaged urban groups attend schools in or around cities with a population greater than 200,000. The disadvantaged urban group live in a community where a high proportion of the residents were in professional or managerial positions, while those students classified in the disadvantaged urban group live in areas where a high proportion of the residents are not regularly employed or were on welfare. Students in the extreme rural group are in communities with populations under 10,000 and most of the residents were farmers or farm workers. All remaining students were classified as other.

These community definitions have been useful to National Assessment in identifying students more likely to be from opposite extremes on a rural-urban continuum (NAEP, 1980b). Since these categories contained the most extreme ten percent of the students within a given year, the population of these categories changed every year. For example, if a sample happened to be less rural than previous years, then the extreme rural category would represent a less rural population.

The four National Assessment categories were collapsed in a manner to create high, medium and low achieving groups of students for the regression analysis. For the high type of community variable, students of the advantaged urban category were assigned a one and all other students a zero. Similarly, students of the disadvantaged urban and extreme rural categories were assigned a one for the low type of community variable and all other students were assigned a zero. These two variables provided the information about high, medium and low achieving types of communities.

CRITERION VARIABLES

The criterion variable was constructed from the student's achievement on the learning area exercises. The initial achievement measure was the ratio of correct exercises to attempted exercises. A correct response for each exercise was scored one and an unacceptable response or an "I don't know" response was scored zero.

The denominator of the ratio was the total number of exercises attempted by the student. This number was created by subtracting the number of exercises a student failed to answer from the total number of learning area exercises in the package. This correction was possible because of the low nonresponse rates to the exercises. National Assessment has studied the problem and found that the mean percentages of nonresponse for the science learning area ranged from one half to one percent across all ages (NAEP, 1979c, pp. 67-69).

One reason for the low nonreponse rate was the "I don't know" choice provided for each exercise. Thus, the initial achievement measure was not corrected for guessing because National Assessment (1) encouraged each student, when appropriate, to respond "I don't know" to the multiple choice or open-ended exercise and (2) emphasized to the student that the assessment was not a test, in the usual sense, and that their scores would not be reported individually.

Even though National Assessment procedures required the full range of difficulty levels to be represented in a package, distributions of exercise difficulty levels varied from package to package. The resulting ratio of number correct to number attempted was comparable among students who took the same package, but not among students who took different packages. To obtain equality of packages for a learning area, the assumption was made that a percentile rank on any one of the packages represented the best estimate of that student's percentile rank on any other package. Therefore each student was ranked within his package, based upon this ratio, and these ranks were converted to a percentile score for each student. The assumption was appropriate because each age specific package represented a complete national sample of the target population of nine, thirteen or seventeen-year-olds.

The use of percentile ranks of the achievement score permitted comparisons between students taking different packages, but it transformed the achievement measure into a rectangular distribution. The inverse normal (probit) transformation was applied to create a symmetrical distribution to meet the normality assumptions of the multiple regression analyses.

The normalization of the percentile ranks provided a common and meaningful basis for comparing the pattern of results between the nine, thirteen and seventeen-year-old populations (1) in the same learning area, (2) between different ages in different learning areas, or (3) between different ages combined for an age across learning areas. This large number of potential comparisons could make it difficult to interpret the data systematically; therefore, it was necessary to devise a planned sequence of comparisons.

ANALYSIS PROCEDURES

The data analyses for this study consisted of a series of multiple regressions. The commonly available multiple regression programs assume the target population is sampled randomly and cannot account for the stratification or clustering effects found in the National Assessment sample design (Shah, Holt, & Folsom, 1977). Because of cost and administrative efficiency considerations, National Assessment data were obtained by selecting a number of primary sampling units (counties or clusters of counties), schools within the primary sampling unit and then selecting a number of students within each of the schools. Since students within the same general school environment tend to be relatively homogeneous, observations from the students are not independent (Hansen, Hurwitz, & Madow, 1953, pp. 259-268). Thus responses from a number of students within a school tend to be more similar than responses of students from different schools. Since the National Assessment sample design employed stratifications and clustering, it did not satisfy standard assumptions of regression analyses.

The weight assigned to each student causes another difficulty in using the available multiple regression programs. Since National Assessment produced a representative national sample, each student's weight represented the number of students with those unique characteristics. In order to insure adequate representation, certain subgroups of the population were sampled at a higher rate than the remainder of the population. Consequently these subgroups, which tended to have different characteristics than the remainder of the population, were overrepresented in the sample. Analyses which do not account for this overrepresentation would likely produce biased and misleading information.

For example, assume that each student in the sample represented 1000 students in the nation and that the overrepresented group had twice as many students in the sample. Proportionately, the overrepresented students should have a weight of 500 and everyone else a weight of 1000. If the overrepresented students had equal achievement for males and females but three quarters were male and one quarter female, then any unweighted analysis would lower the male performance twice as much as the female performance. This unweighted analysis would predict lower achievement than actually occurred in the nation for males and females and alters the relationship between the males and females. This difficulty was avoided by conducting a weighted multiple regression analysis in which the weight assigned to a student was related to the reciprocal of the probability of selecting the student (see the section titled "Sample Design" in Chapter One, p. 1).

The sampling design used by National Assessment results in clusterings of students which creates covariance between the student achievement data examined in this study. National Assessment has estimated the amount of the design effect to be two (NAEP, 1981a), meaning that the effective size of the sample is one half. In other words, if the National Assessment sample had been a simple random sample there would be no clustering effects and the design effect would be one. The prohibitive expense of such a design led National Assessment to simply double the size of the sample and determine the amount of covariance due to clustering. To account for the design effect, each student's weight is adjusted by multiplying it by an adjustment factor and performing a weighted regression analysis. This study used this factor, equal to the number of students included in the analysis divided by twice (the design effect value) their total weight, to adjust for the design effect in all its analyses.

DATA ANALYSIS

Since National Assessment collects data from school systems throughout the United States, students had entered school under several different first grade entrance age requirements. This is unique to this study because previous studies have almost exclusively used students meeting the same entrance age requirement. Chronological age, relative age and class age were the variables created by this study for comparison with past research. Because the past studies sampled students from only one district, the student's relative age position and chronological age position were identical. In this study, two students with the same relative age position in their respective classes could be up to four months apart in chronological age. Therefore, only the relative age variable (1) provided the basis for comparing this study with past research and (2) had an interpretable relationship with class age and the other predictor variables. All analyses were conducted with relative age and then repeated using chronological age. However, only the relative age results are described here. The results for chronological age have been placed in Appendix C.

The relative age and class age variables were entered into the multiple regression in the first step. The logic behind this decision was to confirm the relationships between relative age and academic achievement previously determined for nine-year-old students. This required adding class age as a control when comparing these results to past studies. In the second step, the remaining independent variables were allowed to enter the regression equation through a stepwise procedure.

The hypothesis that functional age of readiness might vary with the learning area provided another reason to add the class age variable. Halliwell and Stein (1964) argued that the elementary reading program, as compared to arithmetic instruction, was presented too rapidly for younger students. They felt that this inability to meet the individual needs of the younger pupils resulted in more unsatisfactory school experiences and poorer academic performance as compared to their classmates. The logical assumption would be that the most effective chronological age for introducing learning areas would be different. Since the majority of school entrance age cutoffs range from September first to January first, the range in chronological age for students at normal entrance age would differ up to four months. The class age variable with its two category classification was used to examine this question.

Sequence of Analyses

The first critical question was whether the student who entered first grade at the younger end of the normal entrance age range had lower achievement than their normally entering older classmates. Beginning with the sample of the nine-year-old population, the relative age variable was tested for a positive slope significantly different from zero, indicating superior performance for the older students. The students were then categorized by class age, sex, parental education, home environment, region and type of community variables. These subgroups of students were compared for differential effects of the academic performance between younger and older classmates. Once the pattern of results was known for the sample of the nine-year-old population, the samples of thirteen and seventeen-year-old populations were examined and comparisons were made between these ages. These analyses provided at least a partial answer to the question as to how and when, if ever, these academic differences changed as the students progressed through their formal academic careers.

SUMMARY

This study performed a secondary analysis using a subsample of the National Assessment data. The quality and amount of analyzable data was one of the most important aspects of this study and provided a much broader base than previous research. National Assessment assured consistent quality by employing uniform administration and scoring procedures and by requiring rigorous quality control in all phases of an assessment. These procedures insured that any biases affect all ages and all learning area data the same way.

The achievement data in mathematics, science and reading learning areas at the ages of nine, thirteen and seventeen were used to determine the relationship between the achievement of younger and older classmates. The achievement score for each student was converted to a percentile rank which provided an estimate of the student's achievement for the learning area. The criterion variable was a unit normal transformation of the percentile rank.

The relative age variable was the basis for comparing the younger and older classmates. Multiple regression procedures were performed at each age to determine the relationships for the sex, region, parental education, home environment and type of community variables. Within each learning area the pattern of relationships were determined for the ages of nine, thirteen and seventeen. These patterns were then compared and contrasted between the mathematics, science and reading learning areas.

Chapter 4

RESULTS AND DISCUSSION

This study involves an analysis of trends and relationships between relative age, class age, and specific kinds of academic achievement. These relationships will first be described for each of the three age samples, with achievement combined across the mathematics, science and reading assessments. The individual achievement areas will then be analyzed for each of the three age samples and comparisons will be made between trends found for the combined data and each of the learning areas.

The last portion of this chapter describes the remaining predictor variables. Type of community, home environment, region and parental education variables are presented only for the combined achievement samples at ages nine, thirteen and seventeen. Since the research predicts differential relationships between males and females as a function of learning area, each separate learning area was analyzed for sex differences.

RELATIVE AGE AND CLASS AGE VARIABLES

Because of the importance of the relative and class age variables, only these two variables were forced into the regression analyses at the first step, followed by the other predictor variables entered into a stepwise regression. The argument has been made for the importance of relative age and class age, not as the best predictors of achievement, but as the variables needed to 1) replicate prior research findings and 2) examine the relationship of achievement with variables that are manipulable.

Combined Nine-Year-Old Samples

The nine-year-old samples for mathematics, science and reading assessments were combined into one regression analysis. This results in a more stable estimate of the relationship between achievement and the predictor variables, by reducing the effect of a marked deviation in any one of the achievement samples. Table 12 contains the means and standard deviations for the twelve variables. The correlation matrix for this analysis and all other analyses of achievement conducted by this study are found in Appendix B.

TABLE 12

Means and Standard Deviations of Twelve Measures (N = 27,807) for Age Nine Combined for the Mathematics, Science and Reading Assessments

Variable	M	SD	Variable	M	SD
Relative Age	7.14	3.06	Chronological Age	9.64	3.00
Class Age	-.29	.96	Home Environment High	.37	.48
Parental Education High	.36	.48	Home Environment Low	.26	.44
Parental Education Low	.38	.49	Northeast	.27	.44
Type of Community High	.13	.33	Southeast	.21	.41
Type of Community Low	.12	.33	Sex	-.03	1.00

An explanation of the mean values presented in Table 12 for each variable will prove helpful to the reader in our subsequent analyses. The values assigned from one to twelve for relative age and from two to sixteen for chronological age have no practical interpretable value, but they do provide the order relationships between categories for the regression analysis. The means for the remaining predictor variables do provide information, though, about the proportional number of students in the nation for each category.

The dichotomous sex and class age variables would show a mean of zero, with equal numbers of students in each category. For sex, males were arbitrarily assigned the value one and females a minus one. Students entering first grade in states with a September, October or November cutoff were assigned a one, while students in states using the December, January or February cutoffs were assigned a minus one. Thus a mean of -.03 for sex indicates slightly more females in our sample while the mean of -.29 for class age indicates a heavier loading of students in states using the December, January and February cutoff months. Table 4 (p. 28) provides an explanation for the smaller proportion of students in the September, October and November class age category, as compared to the December, January and February category. Table 4 shows that approximately one quarter of the students entering school in a state with a September cutoff were in grade three. Moving down the table the proportion of the nine-year-old sample in the third grade decreases until it is zero for states with a January cutoff. This grouping of students by old and young mean class ages provides the most equal division of students for our sample.

For the remaining variables a student was assigned a value of one for the presence of the trait or zero for its absence. All the means can therefore be read as the proportion of students possessing this trait in the sample. For example, the means for parental education in Table 12 (p. 50) indicate that approximately thirty six percent of the students sampled have parents categorized as highly educated, thirty eight percent have parents categorized as low education, and twenty six percent are at the medium educational level.

Table 13 summarizes the multiple regression findings for the combined achievement analyses. As noted previously, class and relative age were entered first and the ten predictor variables emerged in a stepwise manner. The relative age ($F=30.9$, $p<.01$) and class age ($F=51.6$, $p<.01$) variables were statistically significant in the presence of the other predictors in the overall model. (Nonsignificant F values in the regression analyses are labeled "ns" in the summary tables.)

The relationship between achievement and the relative and class age variables is shown graphically in Figure 1. (For reasons described earlier the regression tables and figures displaying the multiple regression findings using the chronological age variable are located in Appendix C). In Figure 1, and in subsequent figures, the achievement measure, normalized percentile ranks, is located on the vertical axis in units of standard deviation. The vertical axis has a mean of zero and ranges from .250 to -.200 standard deviation units, in incremental steps of .0125 standard deviations. The horizontal axis is the relative age variable, with the twelve categories grouped into six two unit categories. Hence, the oldest two relative positions in the classroom are labeled "1" and the two youngest are labeled "6". The symbol "A" represents the average achievement for the students for each relative age category. Achievement for class age by each category of relative age is represented by an "O" for

TABLE 13

Summary of Multiple Regression for Age Nine Combined for the Mathematics, Science and Reading Assessments

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	-.015	30.9	.01	.002		-.048	20.4	.01
Class Age	.069	51.6	.01	.003	.003	.013	20.4	.01
Home Environment Low	-.264	163.6	.01	.047	.047	-.211	230.0	.01
Parental Education Low	-.242	137.7	.01	.077	.077	-.211	291.2	.01
Type of Community High	.237	90.5	.01	.089	.088	.122	269.9	.01
Home Environment High	.206	120.0	.01	.097	.097	.201	249.5	.01
Southeast	-.159	59.2	.01	.103	.102	-.094	227.1	.01
Parental Education High	.156	56.1	.01	.106	.106	.199	206.9	.01
Type of Community Low	-.118	23.0	.01	.108	.107	-.075	187.0	.01
Northeast	.086	16.7	.01	.109	.108	.073	170.1	.01
Sex	-.004	.2	ns	.109	.108	.017	154.7	.01

students entering first grade in states with September, October or November cutoffs and "Y" for states using December, January or February cutoffs. Classrooms in the "O" group have an older mean chronological age than classrooms in the "Y" group.

The absence of an "A" for the oldest students (category "1") on the relative age variable in Figure 1 is a function of the nine-year-old sampling procedure. Those students missing from the modal grade sample are the oldest students entering states with September, October or November cutoffs (see Table 9, p. 37). However, these students do exist in our sample for the December, January and February cutoff group ("Y"). Thus for category "1", only a "Y" is displayed in Figure 1. When the mean ("A") standard deviation overlaps the average standard deviation for either or both the "O" and "Y" groups, the "A" symbol identifies these hidden points.

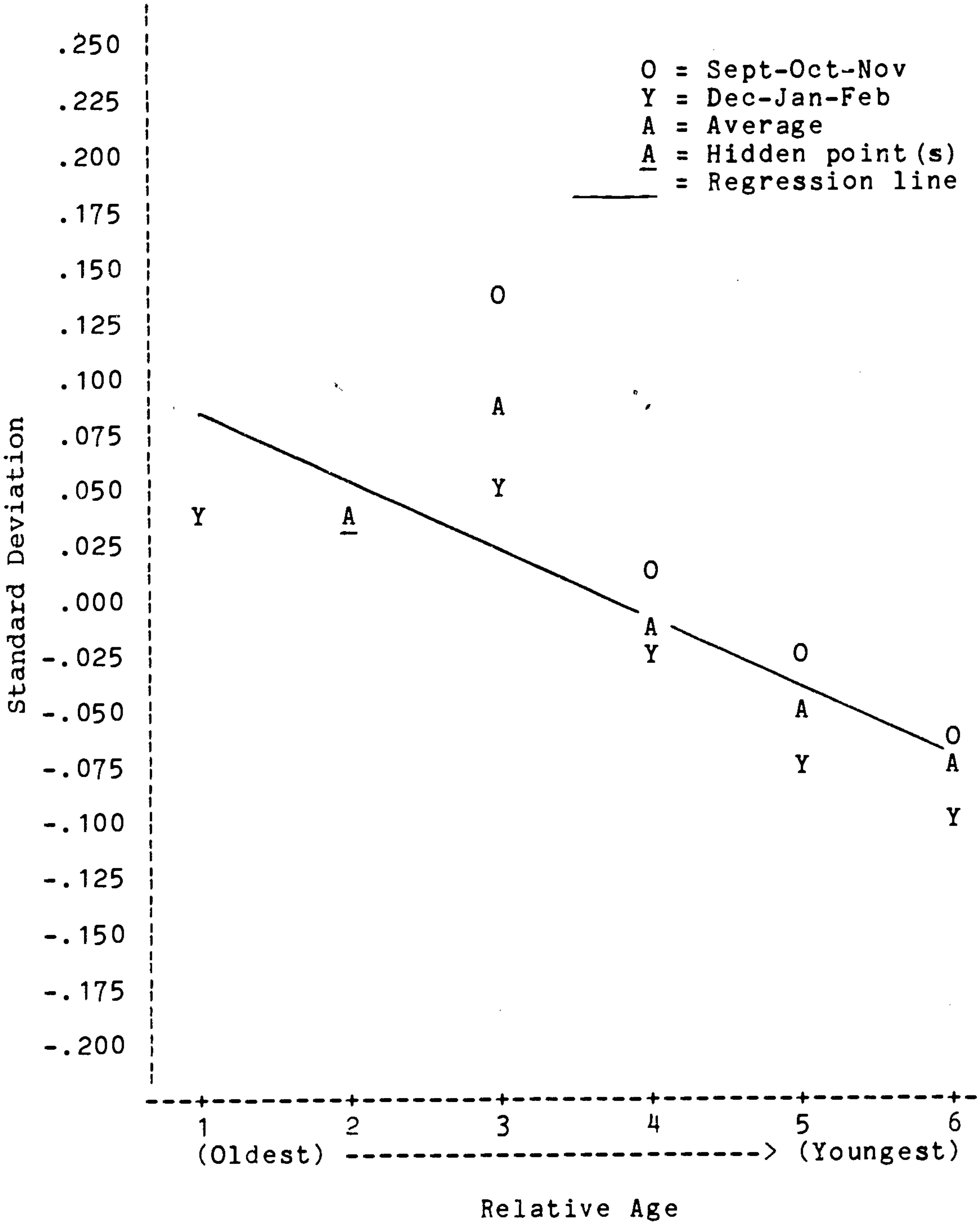

Figure 1. Combined mathematics, science and reading achievement by relative age among nine-year-olds.

The regression line displayed on this figure is the line which minimizes the sum of the shortest distances from all the data points. The line was generated by entering only the relative age variable in to the regression analysis. Using the slope and constant of the equation for the regression line, the positions of the two oldest and the two youngest relative age categories were computed for the regression line. The appropriate averages for categories "1" and "6" on the relative age variable of Figure 1 (p. 53) were used to draw the regression line. Table 14 gives the slopes and constants for the relative age and chronological age analyses for all three ages, across the combined and separate achievement samples.

TABLE 14

Regression Line Slopes and Constants for the Relative and Chronological Age Analyses of Achievement

Learning Area and Sample age	Relative Age		Chronological Age	
	Slope	Constant	Slope	Constant
Combined				
9	-.0155	.1098	-.0209	.2008
13	-.0086	.0607	-.0080	.0758
17	.0005	-.0036	.0031	-.0262
Mathematics				
9	-.0132	.0932	-.0224	.2161
13	-.0093	.0648	-.0068	.0646
17	.0000	-.0005	.0026	-.0214
Science				
9	-.0178	.1266	-.0260	.2478
13	-.0069	.0489	-.0099	.0941
17	-.0056	.0331	-.0023	.0182
Reading				
9	-.0153	.1082	-.0167	.1608
13	-.0096	.0679	-.0072	.0692
17	.0084	-.0519	.0101	-.0850

The regression line in Figure 1 (p. 53) has a significant negative slope which replicates findings from previous research. The negative beta weight (-.015) and statistically significant negative slope ($F=30.9$, $p<.01$) for relative age in Table 13 (p. 52) can be interpreted as demonstrating an academic advantage for older students. The National Assessment sample suggests it is a nationwide phenomenon, which complements previous findings for more narrowly based population samples. While the absolute difference between categories "1" and "6" of the regression line is less than one fifth of a standard deviation, it should be noted that a major portion of the original variance among students has been removed by selecting only Caucasian students progressing normally through school. In our estimation, for such a relatively homogeneous population a nationwide trend favoring older students is of concern to educators.

Percentile ranks provide an alternate means of describing the one fifth of a standard deviation difference between categories "1" and "6." Table 15 contains the percentile ranks for each standard deviation unit of the vertical axis on the figures displayed in Chapter Four and Appendicies C, D and E. For example, .075 and -.050 are conservative estimates for categories "1" and "6" of the regression line in Figure 1 (p. 53) and correspond to percentile ranks of .530 and .480 respectively. Using the regression line as the best estimate of the average performance of categories "1" and "6" yields a difference of five percentile ranks. For example each of the three nine-year-old populations (i.e. mathematics, science and reading) sampled contained about three and onehalf million students. Using these figures, a one percentile rank difference represents 35000 students. For the three combined nine-year-old samples used to produce Figure 1, one percentile rank difference represents 91,000 students.

Independent of relative age, class age also contributes significantly to the prediction of achievement. The positive beta weight (.069) for class age (see Table 13, p. 52) indicates that classrooms with an older mean age have significantly ($F=51.6$, $p<.01$) superior performance on the combined achievement measures when compared to classrooms with a younger mean age. Described another way, the class age variable measures the amount of achievement that can be explained by holding relative age constant and increasing the chronological age of the student. Thus class age compares students of differing chronological ages within the same relative age position in the classroom, while relative age measures the amount of achievement, independent of class age, explained by increasing age within the classroom.

TABLE 15

Percentile Rank Values Corresponding to the Standard Deviation Units of Displayed Figures

Standard Deviations	Percentile Ranks
.600	.726
.500	.691
.400	.655
.300	.618
.250	.599
.225	.589
.200	.579
.175	.569
.150	.560
.125	.550
.100	.540
.075	.530
.050	.520
.025	.510
.000	.500
-.025	.490
-.050	.480
-.075	.470
-.100	.460
-.125	.450
-.150	.440
-.175	.431
-.200	.421
-.300	.382
-.400	.345
-.500	.309
-.600	.274

There still remains the question of the specific interaction effects (if any) between relative age and class age. Such an interaction effect would indicate that as the mean age of the classroom changes so does the relationship among the relative age positions of students in the classroom. Consider the possiblity that the majority of students for the youngest four months (categories "5" and "6" of Figure 1) of the sample were not ready for formal schooling at the time they entered first grade. Assuming these students maintained the same relatively poor achievement level through fourth grade, the relative age curve in our nine-year-old sample would follow a downward trend for students born in January through August and then level off in September through December. Because of the National Assessment sampling procedure, states with a January first cutoff date would show this relationship of relative age and achievement while states with a September first cutoff would show a downward trend for all of the students in the classroom (see Table 4, p. 28). In addition, it could be argued the more time the teacher spent attempting to bring these less prepared students up to expected levels, the less time available for students possessing a higher readiness for formal schooling. If the loss of teacher time decreased the performance of older students, this would result graphically in an increasingly shallower downward trend as the percentage of immature students increases in the classroom.

The potential threat of a significant interaction between relative age and class age was tested by creating a variable which was a product of the original variables. The value assigned to a student for the interaction analyses was the product of the values assigned to the student for the class age (-1 or 1) and relative age (1, 2, ... 12) variables. The correlation between this interaction variable and the class age variable was high enough to create a colinearity problem in the regession analysis. To test this interaction effect the two oldest categories of the relative age variable were eliminated to remove missing cells of the old class age group and the remaining data were entered into a ten by two analysis of covariance. The covariates were the parental education and home environment variables with the students classified into high, medium and low categories. No significant interaction effect was found between relative age and class age.

The parallel downward trend favoring higher achievement for classrooms containing a higher proportion of older students supports previous research indicating that a student's relative position in a classroom has an important affect on achievement regardless of when the student entered first grade. For the nine-year-old population, the higher achievement found among older classrooms could be attributed in part to an increased readiness of the students to begin formal schooling. The existence of a significant interaction effect would have indicated that a group of students entered school below the minimum level of readiness for formal schooling. The lack of an interaction was interpreted as an indication that even the youngest students selected by any state in the nine-year-old samples were above this minimum level of readiness to begin formal education. However, the statistically significant difference between old and young mean class ages shows that increasing the chronological age of a student was of equal benefit to the student regardless of the student's relative position in the classroom. One explanation for the differences in achievement could be that the students in the older classrooms were able to assimilate a greater amount of the material because they were better prepared for the formal school experience and/or because teachers were able to teach the material at a higher rate or level of complexity. The extent to which this interpretation is valid vindicates teacher desires to delay entrance of students into first grade (Carline, 1964).

The issue can be presented in another manner. Assume the teachers in a given state convinced the legislature to alter the cutoff date by one month to remove the youngest students from the classroom. The results of this study would predict an increase in the average achievement of the classroom. But what effect would an increase in the mean age of the classroom have on the individual student? Our data can provide some insight into the issue of whether manipulation of the cutoff date will have a positive effect on the individual student. The relative amounts of contribution by class age and relative age to the prediction of achievement help provide a partial answer to this question; the relative importance of class age to relative age in the prediction of achievement is the ratio formed from their respective standard partial regression coefficients. After canceling out the standard deviations for achievement, this ratio is equal to the beta weight for each variable in the reqression equation multiplied by the standard deviation of that variable (Snedecor & Cochran, 1967, pp. 398-400). In other words, for each variable the beta weight multiplied by the standard deviation is equal to the change in achievement for one standard deviation change in that variable.

A hypothetical situation will clarify the issue. Assume a cutoff date of January first and that all twelve months are represented in the classroom, with an equal number of students in each month. Moving the cutoff date from January first to December first would deny entry for the December born students until the following year. In addition, the December first cutoff date would increase the mean age of the classroom and would lower the relative age of every student in the classroom by one position. In other words, children born in December are now the oldest, children born in January are now in the second relative position and children born in November are in the youngest relative position.

If the ratio of beta weights, for the relative contribution to the prediction of achievement of class age with respect to relative age, is equal to one, then the ratio would imply that for each unit change in the mean class age there would be a one unit change in relative age. (In this example one month equals one unit.) Since the analysis of the data found no interaction effect between relative age and class age, increasing the mean of the classroom would equally increase the achievement for every relative age position in the classroom. Hence the increase in a student's achievement gained by being in the older classroom would be exactly offset by being in a younger relative position. However, if the ratio were less than one, then the average achievement of the class would increase. But for each student, the achievement decrease due to the relative age loss would not be offset by the achievement gain due to the increase in the mean age of the class. Thus, each student's achievement would decrease when the cutoff date increased the mean age of the classroom by one month. Differences in this ratio between learning areas could be a function of such factors as sampling or differential patterns of achievement.

For the nine-year-old combined data, class age contributes relatively more to achievement (1.43=(.96)(.069)/(3.06)(.015), see Tables 12 and 13; pp. 50 and 52) than relative age. This suggests that some gain in student achievement can be obtained for those states using December, January or February cutoff months by changing the cutoff date to increase the mean age of the classroom. However, strictly interpreted, these data can only apply to a classroom where the cutoff date produces the exact mean student age found for the young mean age group. To clarify this point, assume the cutoff date for the school district was altered to increase the mean age of their classrooms to the exact mean age of the older mean age group. For each remaining student this would result in a greater gain in achievement due to the increased mean class age than the reduction in achievement due to the student's younger relative age position in the classroom.

The conclusion that younger students had greater difficulties in coping with the formal school experience was futher confirmed by an analysis of the number of students who had been retained one grade before entering first grade or at some point in their schooling. Prior studies have found a higher retention rate for younger students and for males (Hedges, 1977). To examine this hypothesis a three way categorization of relative age, class age and sex was created for students who should have been in the modal grade but who had been retained one grade. A national sample of the population of nine-year-old Caucasian students who should have been in fourth grade is the sum of these retained students and the normally entering fourth grade students selected by this study for analysis. For each cell of the three way categorization, the ratio of the sum of student weights was created by using the students who had been retained in third grade for the numerator and all the students who should have been in fourth grade for the denominator. Obviously, ability is a factor in retention. However, no direct assessment of ability was available in the data and hence the importance of this variable cannot be explored in this study.

The above procedure was applied to each of the three nine-year-old samples and an average taken for each cell of the three way categorization. Table 16 contains the proportion of retained students for the nationwide breakdown for the three way classification of relative age, class age and sex. A visual analysis reveals a larger proportion of male students (.1844) as compared to female students (.1083) has been retained one grade by age nine. Even greater concern should be given to the increasing proportions of retained students as the students relative age position becomes younger; it increases from approximately ten percent to over thirty percent for the youngest relative position.

Relative age, class age and sex were entered into a regression analysis using the proportion of retained students for each cell of the categorization as the criterion variable. The disproportionality described earlier for the mean (see Table 12, p. 50) of the class age variable would adversely affect the results of the regression analysis. Since more students were in the young mean age group, even for equal rates of retention there would be more students retained for this group. Control for the disproportionality of the class age variable was obtained by using the rate of retention as the criterion variable. As described in the analysis of covariance, another problem was the missing data for the oldest mean age group. Therefore the oldest three categories of relative age were eliminated from the analysis.

Other aspects of the relationship between the relative age, class age and sex variables were examined in this analysis. A test for a quadratic trend in the increasing number of retained students as relative age becomes younger was measured by entering a variable equal to the square of the relative age variable; the two way interaction effects were examined by creating three interaction variables which were the product of the original values of the two variables comprising each interaction effect.

The results of the regression analysis of the retained population indicate that the increasing propor-

TABLE 16

Proportion of Nine-Year-Olds Who Belong in Fourth Grade But Have Been Retained One Grade

Relative Age	Class Age				Sex		
	Old (S,O,N cutoff)		Young (D,J,F cutoff)		M	F	Total
	Sex		Sex				
	M	F	M	F			
Oldest	.0000	.0000	.1011	.0698	.1011	.0698	.0861
2	.0000	.0000	.0928	.0597	.0928	.0597	.0770
3	.1104	.0248	.0993	.0481	.0986	.0465	.0725
4	.1127	.0766	.0954	.0697	.1002	.0712	.0856
5	.1062	.0570	.1304	.0687	.1220	.0641	.0933
6	.1067	.0663	.1139	.0687	.1113	.0681	.0899
7	.1081	.0560	.1468	.0877	.1318	.0762	.1045
8	.1010	.0817	.1769	.0772	.1475	.0782	.1119
9	.1742	.0917	.2104	.1098	.1965	.1035	.1508
10	.1951	.1101	.2806	.1541	.2464	.1369	.1931
11	.2062	.1064	.3934	.2461	.3151	.1938	.2548
Youngest	.2650	.1394	.4723	.3222	.3778	.2365	.3068
Total	.1592	.0893	.1971	.1177	.1844	.1083	.1467

tions of retained students as relative age becomes younger has both a statistically significant linear trend ($F=10.6$, $p<.01$) and a statistically significant quadratic component

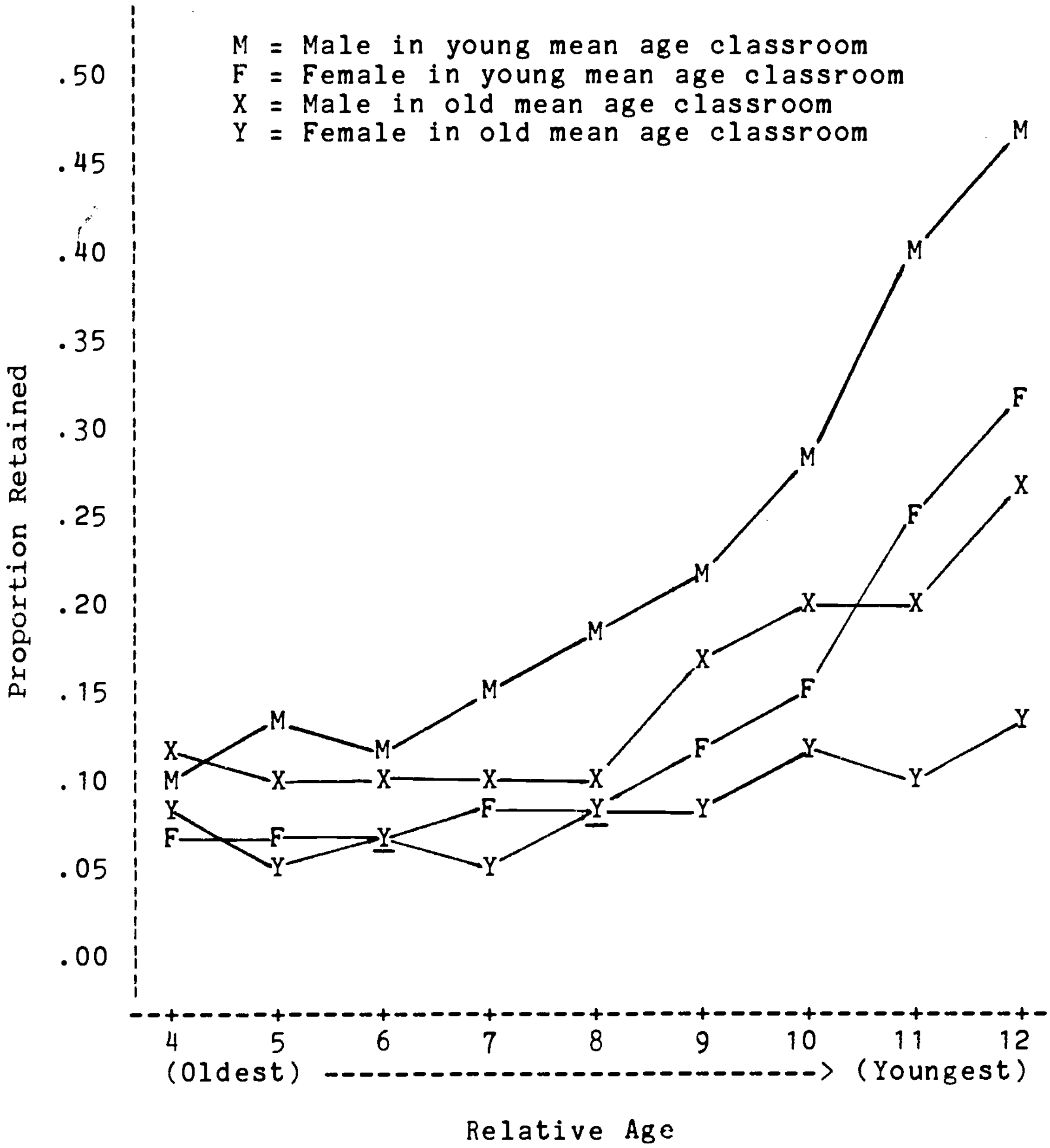

Figure 2: Proportion of Nine-Year-Olds Who Belong in Fourth Grade But Have Been Retained One Grade Categorized by the Relative Age, Class Age and Sex Variables

(F=67.8, p<.01). The higher percentage of males in the retained samples of prior studies was replicated in this study with a statistically significant interaction between relative age and sex (F=23.2, p<.01). Table 16 shows that the proportion of retained males increases significantly faster than females as the student's relative age becomes younger.

Figure 2 graphically depicts the relationship between relative age, class age and sex. The proportion of retained students, the criterion variable of the regression analysis, is located on the vertical axis (increments of .0166). The horizontal axis is the relative age variable without the three oldest categories. The symbols "M" and "F" represent the proportion of retained male and female students for the older mean class age category while the symbols "X" and "Y" represent males and females for the younger mean age category.

Examination of the relative age variable reveals that the youngest males who are members of classes with young mean ages are in the greatest jeopardy, while the youngest females who are members of classes with older mean ages fair the best throughout all relative age positions in the classroom. In fact the older mean class age students have significantly less students retained ($F=7.6$, $p<.01$), and the statistically significant interaction between relative age and class age ($F=69.8$, $p<.01$) also favored a slower rate of increase in the proportion of retained students as the student's relative age becomes younger.

These findings reemphasize the achievement results described above and reaffirm the teacher concerns for an older mean classroom age. The significant class age by relative age interaction demonstrates that a slightly older student in the classroom significantly slows the increasing proportion of students retained as relative age becomes younger. To reemphasize the findings, the youngest students in the classroom are at a significant academic disadvantage and are retained significantly more often.

Combined Thirteen-Year-Old Samples

The analysis of the thirteen-year-old combined sample examined the persistence of the achievement differences between the oldest and the youngest students. The means and standard deviations of the twelve variables for the multiple regression analysis combined for the three thirteen-year-old samples are found in Table 17 and the summary is found in Table 18 (p. 65). By age thirteen only the relative age variable was statistically significant ($F=6.8$, $p<.01$) in the presence of the other predictor variables.

TABLE 17

Means and Standard Deviations of Twelve Measures (N = 32,923) for Age Thirteen Combined for the Mathematics, Science and Reading Assessments

Variable	M	SD	Variable	M	SD
Relative Age	7.09	3.06	Chronological Age	9.57	3.01
Class Age	-.28	.96	Home Environment High	.63	.48
Parental Education High	.46	.50	Home Environment Low	.11	.32
Parental Education Low	.18	.38	Northeast	.28	.45
Type of Community High	.13	.34	Southeast	.20	.40
Type of Community Low	.12	.33	Sex	-.06	1.00

The attenuation in the effect of relative age and class age can be seen in Figure 3 (p. 66). The regression line has a significant but flatter negative slope than for the combined nine-year-old samples. The negative beta weight for relative age has decreased (-.007) but retained statistical significance ($F=6.8$, $p<.01$) at a lower F value. Comparing age thirteen to age nine the academic advantage for older students in the classroom has decreased, but the academic advantage for classrooms with an older mean age has vanished in the presence of the other predictor variables.

Graphically, if one compares Figure 1 (p. 53) for age nine to Figure 3 for age thirteen, there seems to have been a reversal in the relationship between the old mean class age ("O") and the young mean class age ("Y") groups. But the regression analysis clearly indicates that with the introduction of the other variables, the old mean class age group has a greater but nonsignificant advantage over the young mean class age group. In fact, the statistically significant ($F=6.2$, $p<.01$) beta weight for class age is negative at the first step of the regression analysis meaning that the "Y" group has better overall performance. This negative beta weight increases with each step until with the addition of the low type of community variable, the beta weight becomes positive. Thus when the other predictor variables are accounted for, the "O" group has better overall performance.

TABLE 18

Summary of Multiple Regression for Age Thirteen Combined for the Mathematics, Science and Reading Assessments

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	-.007	6.8	.01	.001		-.026	8.7	.01
Class Age	.014	2.5	ns	.001	.001	-.025	8.7	.01
Parental Education High	.338	398.4	.01	.069	.069	.261	393.8	.01
Home Environment High	.234	177.5	.01	.094	.094	.212	413.5	.01
Parental Education Low	-.233	113.9	.01	.102	.102	-.213	363.6	.01
Southeast	-.152	59.8	.01	.108	.108	-.097	322.1	.01
Home Environment Low	-.233	76.1	.01	.113	.112	-.183	289.2	.01
Type of Community High	.164	51.2	.01	.116	.115	.155	261.2	.01
Type of Community Low	-.104	19.5	.01	.117	.117	-.076	234.9	.01
Sex	.023	9.4	.01	.118	.117	.034	212.5	.01
Northeast	.055	7.8	.01	.119	.117	.052	194.0	.01

The class age variable illustrates another example of the quality of the National Assessment data selected for this study. Except for class age, the beta weight signs were consistent for all other variables throughout the stepwise addition. This fact combined with the small difference between the r square and the adjusted r square terms fully demonstrates the homogeneity of the data and its overall excellent quality.

For reasons described above, the possibility of an interaction effect between relative age and class age was tested using analysis of covariance; no interaction effect was found. With the disappearance of significant differences between the old and young mean class age categories, only the student's relative age within the classroom remained an important predictor of academic achievement.

Several explanations exist for the disappearance of the class age effect and the attenuation of the relative

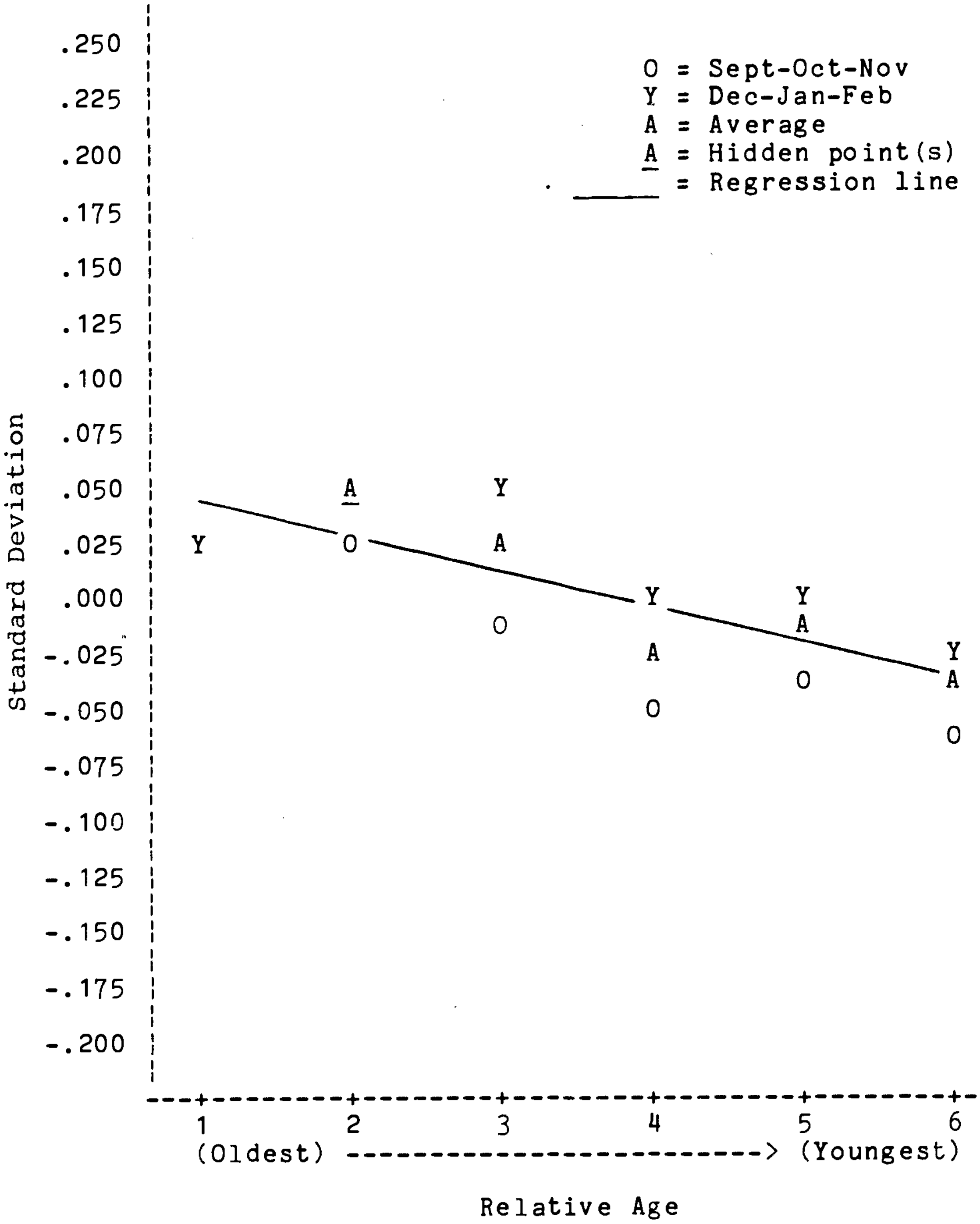

Figure 3. Combined mathematics, science and reading achievement by relative age among thirteen-year-olds.

age effect. One hypothesis lies in the meaning attributable to the class age variable; the effect of class age would be the same as holding the student's relative age within the class constant while increasing the student's chronological age. Thus the difference between two students born one month apart and at the same relative position in their respective classrooms is (1) the physical maturation of the organism and (2) the one extra month of life experiences before entering first grade and receiving the same school experience. Assuming the older student was born August first, the younger student was born September first and both students entered school on September first, then at the beginning of the school year the older student would be six years and one month old and the younger student would be exactly six years old. The older student would have a one month advantage in life experiences over the younger student which represents one month out of sixty one months at the beginning of first grade. But by age nine the difference would be one month out of 109 months and at age thirteen it would be one out of 157 months. Thus the percentage out of the student's life for this one month more of life experience has decreased substantially from age nine to thirteen.

The ability of the students to learn to adapt to the classroom situation and compensate for this academic disadvantage provides another plausible explanation. Combined with help from teachers and special remedial classes, the youngest students could adjust to the school environment and thereby reduce the difference between the older and younger students within the classroom. Since our achievement data imply that even the cutoffs accepting the youngest students meet a basic minimum for school readiness, the flattening of the regression line and the disappearance of the class age effect would seem to indicate that students can recover from this academic disadvantage.

But the results of the achievement data do not accurately describe the actual relationship between relative and class age. The analysis of the combined nine-year-old data demonstrates that the characteristics of our sample were changing because of the loss of the youngest students. Table 19 contains the proportions of students retained one grade who should have been in the modal grade. A visual inspection of the nationwide breakdown for the three way classification of relative age, class age and sex reveals for the thirteen year-old sample the same trends found for the combined nine-year-old samples. The 1.87 percent increase from 14.67 percent of the students retained for age nine to 16.54 percent retained at age thirteen cannot alone explain the increasing achievement of the youngest students in the classroom. However, it could contribute to increasing achievement when combined with the other explanations above.

TABLE 19

Proportion of Thirteen-Year-Olds Who Belong in Eighth Grade But Have Been Retained One Grade

Relative Age	Class Age				Sex		
	Old (S,O,N cutoff)		Young (D,J,F cutoff)		M	F	Total
	Sex		Sex				
	M	F	M	F			
Oldest	.0000	.0000	.1208	.0846	.1208	.0846	.1027
2	.0000	.0000	.1107	.0515	.1107	.0515	.0806
3	.1285	.0641	.1294	.0675	.1295	.0669	.0979
4	.1447	.0748	.1418	.0739	.1428	.0743	.1080
5	.1377	.0976	.1238	.0790	.1289	.0866	.1080
6	.1781	.0863	.1590	.0728	.1654	.0773	.1220
7	.1607	.0971	.1683	.1000	.1643	.0985	.1309
8	.1838	.0854	.2069	.0929	.1978	.0896	.1446
9	.1833	.1229	.2488	.1175	.2238	.1195	.1717
10	.2050	.1100	.2907	.1695	.2565	.1461	.2008
11	.2474	.1385	.3729	.2484	.3225	.2049	.2644
Youngest	.3278	.1591	.4598	.3463	.4001	.2585	.3304
Total	.2006	.1100	.2164	.1251	.2107	.1199	.1654

The regression analysis on these proportions provided a replication of the nine-year-old data. The results confirm that the increasing proportion of retained students as relative age becomes younger has both a statistically significant linear trend ($F=10.3$, $p<.01$) and a statistically significant quadratic trend ($F=58.5$, $p<.01$). The statistically significant interaction between relative age and sex ($F=13.2$, $p<.01$) replicates the higher percentage of retained males found at age nine. Figure 4 graphically depicts the relationship between relative age, class age and sex. Again, the examination of the relative age variable reveals that the youngest males who are members of classes with a young mean age are in the greatest jeopardy of being retained, while the youngest females who are members of classes with older mean ages fair the best throughout all relative age positions in the classroom. In fact, the older mean class age classrooms show significantly less students retained ($F=14.0$, $p<.01$) and the statistically significant interaction between relative age and class age ($F=61.5$, $p<.01$) also favors a slower rate in the increase in proportion of retained students as the student's relative age becomes younger.

Since National Assessment data contain no information about the point in time at which these students were retained, it could be argued that the conclusions from these results would change significantly if it could be determined that a large portion of the students eligible for entry into first grade were actually being entered in the next school year. Hence the students would be retained in one sense, but progressing normally otherwise. If this were true, the schools would already be successfully managing the problem of unprepared younger students.

However, since the majority of research on the prediction of achievement has been described as the means for determining the academic success of early entrants (Hedges, 1977), it is logical to assume that a high percentage of students were retained after entering school. Therefore the results from the analysis of retained students would indicate that a screening procedure should be applied to some portion of the youngest students of the classroom, and those diagnosed unprepared should either enter first grade the following year or receive special attention.

Examination of Figures 2 (p. 62) and 4 (p. 70) reveals that for schools with December, January and February cutoffs, the youngest four months of male students (categories "9" through "12") and the youngest two months of females should be screened for readiness. Only the males in the two to three youngest relative age positions need to be screened for schools with September, October or

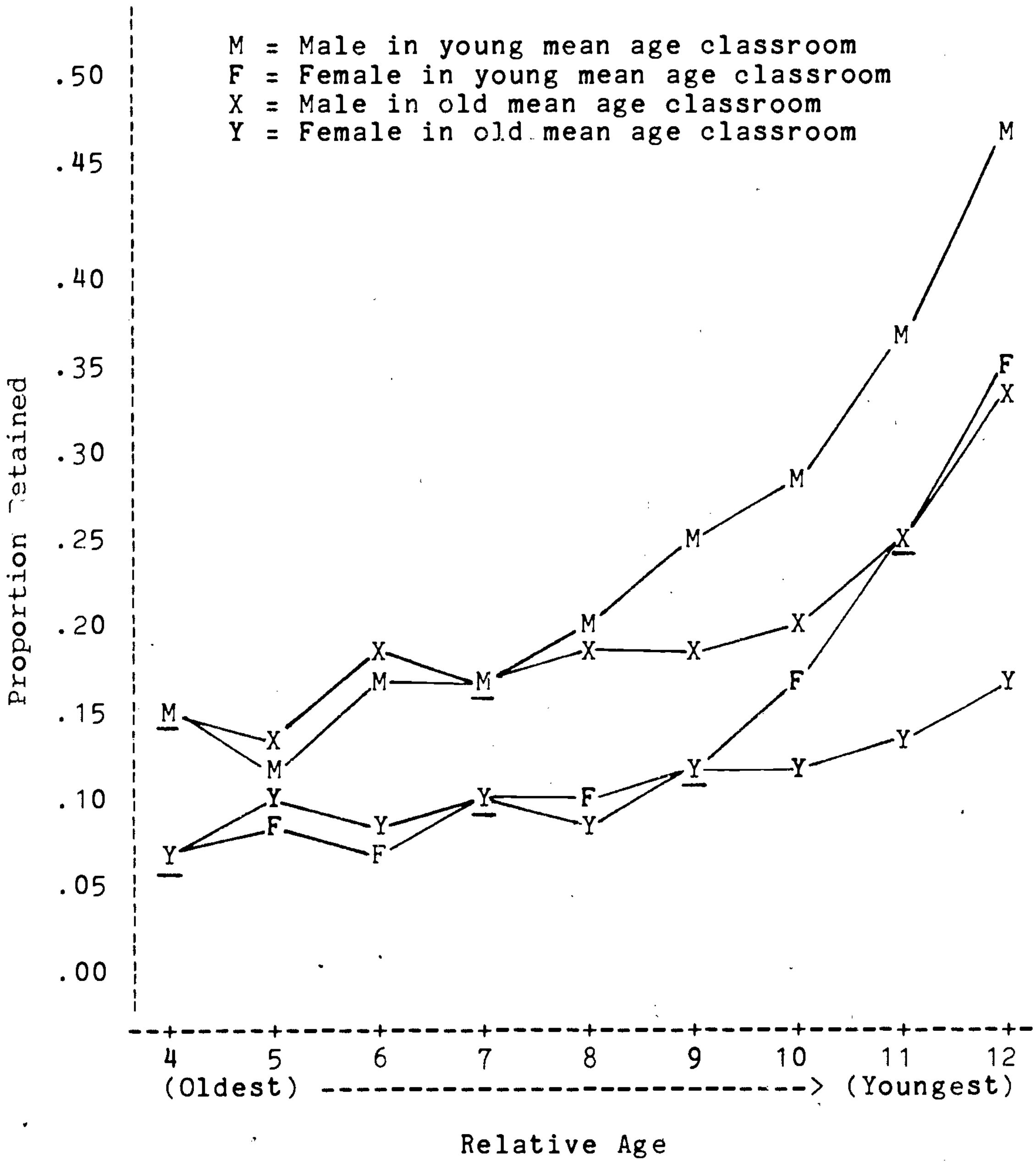

Figure 4: Proportion of Thirteen-Year-Olds Who Belong in Eighth Grade But Have Been Retained One Grade Categorized by the Relative Age, Class Age and Sex Variables

November cutoffs. However by age thirteen, the youngest half of all males appears to have substantially more difficulty than females in coping with the school experience and over forty percent of the youngest male students have been retained one grade. (The proportion of students retained two grades had not been determined at this time.) These data suggest that a male student who has just made the cutoff for school may not be able to succeed because of negative early school experiences due in some measure to a marked degree of relative unpreparedness as compared to other classmates.

TABLE 20

Means and Standard Deviations of Twelve Measures (N = 36,256) for Age Seventeen Combined for the Mathematics, Science and Reading Assessments

Variable	M	SD	Variable	M	SD
Relative Age	6.00	3.06	Chronological Age	8.31	3.03
Class Age	-.20	.98	Home Environment High	.69	.46
Parental Education High	.51	.50	Home Environment Low	.10	.30
Parental Education Low	.13	.34	Northeast	.23	.42
Type of Community High	.11	.31	Southeast	.17	.37
Type of Community Low	.13	.34	Sex	-.07	1.00

Combined Seventeen-Year-Old Samples

The seventeen-year-old combined sample was examined for the continuation of the trend for a decreasing achievement differential between the oldest and youngest students in the classroom. The means and standard deviations of the twelve variables for the multiple regression analysis combined for the three seventeen-year-old samples are found in Table 20 and the summary is found in Table 21 (p. 72). By age seventeen of a student's formal school experience neither the relative nor class age variables were statistically significant in the presence of the other predictor variables.

The continuing trend of the attenuation in the effect of relative age and class age can be seen in Figure 5 (p. 73). The regression line has a flat slope which

TABLE 21

Summary of Multiple Regression for Age Seventeen Combined for the Mathematics, Science and Reading Assessments

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	.002	.7	ns	.000		.002	9.0	.01
Class Age	.001	.0	ns	.001	.001	-.031	9.0	.01
Parental Education High	.342	461.8	.01	.058	.058	.239	355.1	.01
Home Environment High	.202	124.6	.01	.075	.075	.173	354.4	.01
Sex	.091	158.3	.01	.084	.084	.098	318.3	.01
Parental Education Low	-.213	82.7	.01	.089	.089	-.177	283.0	.01
Type of Community High	.168	49.7	.01	.092	.092	.092	252.0	.01
Home Environment Low	-.200	52.6	.01	.095	.095	-.139	228.0	.01
Northeast	.101	26.5	.01	.097	.097	.064	20[illegible].9	.01
Southeast	-.110	30.0	.01	.099	.098	-.067	190.1	.01
Type of Community Low	-.102	22.5	.01	.100	.099	-.067	175.1	.01

was not significantly different from zero. The relative age and class age variables are no longer relevant to the prediction of academic achievement. Several reasons, based on our analysis of the data and previous research, were offered for the decreasing importance of these variables. The reasons were teacher intervention, remedial instruction, successful student adaptation to the school environment and student retention (unsuccessful adaptation).

The following three sections describe the results of the mathematics, science and reading assessments. The three age samples will be compared to the trends in achievement found for the combined data.

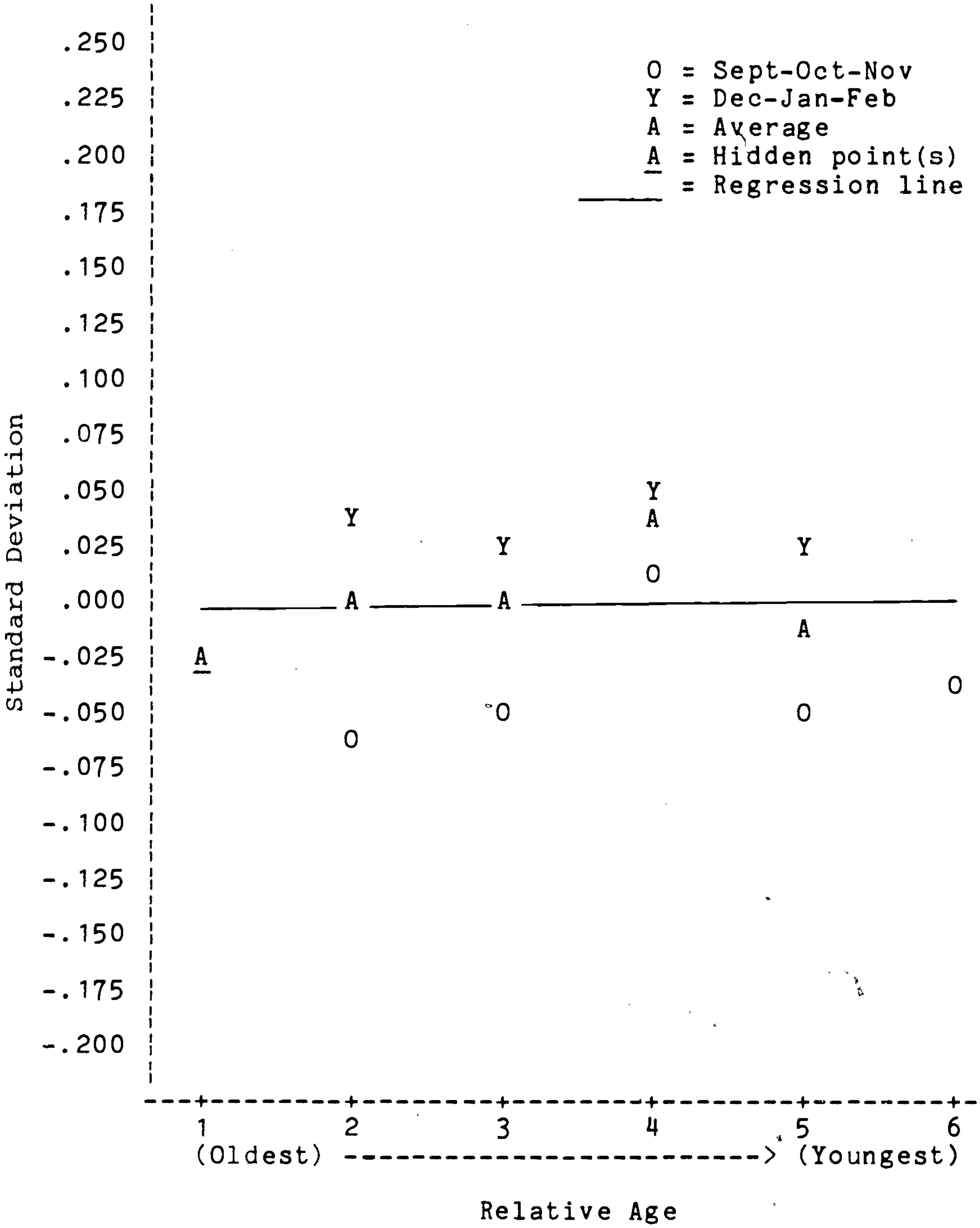

Figure 5. Combined mathematics, science and reading achievement by relative age among seventeen-year-olds.

Mathematics Assessment

Table 22 contains the means and standard deviations of the twelve variables of the nine-year-old mathematics sample used in the multiple regression analysis. The summation of the multiple regression is found in Table 25 (p. 76).

TABLE 22

Means and Standard Deviations of Twelve Measures (N = 6,849) for the Age Nine Mathematics Assessment

Variable	M	SD	Variable	M	SD
Relative Age	7.09	3.13	Chronological Age	9.67	3.06
Class Age	-.36	.93	Home Environment High	.41	.49
Parental Education High	.37	.48	Home Environment Low	.24	.43
Parental Education Low	.40	.49	Northeast	.24	.43
Type of Community High	.12	.33	Southeast	.24	.43
Type of Community Low	.11	.32	Sex	-.05	1.00

Just as in the combined nine-year-old sample, relative age ($F=9.9$, $p<.01$) and class age ($F=41.9$, $p<.01$) were statistically significant in the presence of the other predictor variables. The negative beta weight (-.016) for relative age demonstrates the achievement disadvantage for the youngest students in the classroom while the positive beta weight for class age means better achievement for classes with an older mean age. From Table 22 the ratio of the relative importance of class age to relative age in the prediction of achievement was found to be 2.3, higher, but in agreement with the ratio found for the combined nine-year-old sample.

The relationship of achievement with relative and class age is shown graphically in Figure 6 (p. 77). From the visual examination of this figure an interaction

TABLE 23

Means and Standard Deviations of Twelve Measures (N = 10,491) for the Age Thirteen Mathematics Assessment

Variable	M	SD	Variable	M	SD
Relative Age	7.01	3.05	Chronological Age	9.50	2.98
Class Age	-.33	.94	Home Environment High	.62	.48
Parental Education High	.46	.50	Home Environment Low	.12	.32
Parental Education Low	.18	.38	Northeast	.25	.43
Type of Community High	.10	.30	Southeast	.21	.41
Type of Community Low	.11	.31	Sex	-.06	1.00

TABLE 24

Means and Standard Deviations of Twelve Measures (N = 11,675) for the Age Seventeen Mathematics Assessment

Variable	M	SD	Variable	M	SD
Relative Age	5.91	3.05	Chronological Age	8.25	3.03
Class Age	-.26	.97	Home Environment High	.63	.48
Parental Education High	.52	.50	Home Environment Low	.16	.37
Parental Education Low	.12	.33	Northeast	.20	.40
Type of Community High	.11	.31	Southeast	.18	.38
Type of Community Low	.12	.33	Sex	-.08	1.00

TABLE 25

Summary of Multiple Regression for the Age Nine Mathematics Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Overall F	p
Relative Age	-.016	9.9	.01	.002		-.041	9.8	.01
Class Age	.124	41.9	.01	.006	.005	.050	9.8	.01
Home Environment Low	-.322	58.5	.01	.072	.071	-.260	87.8	.01
Parental Education Low	-.237	33.2	.01	.106	.105	-.235	101.2	.01
Type of Community High	.411	70.1	.01	.132	.131	.193	103.8	.01
Northeast	.214	26.7	.01	.144	.142	.118	95.7	.01
Home Environment High	.200	30.5	.01	.152	.150	.229	87.5	.01
Parental Education High	.178	18.3	.01	.157	.155	.230	79.7	.01
Southeast	-.175	20.0	.01	.162	.160	-.110	73.3	.01
Sex	.043	7.5	.01	.164	.161	.075	66.8	.01
Type of Community Low	-.134	7.0	.01	.166	.163	-.090	61.5	.01

effect might be expected between relative age and class age, but no interaction effect was found. All of the above results for nine-year-olds replicated the results of the combined sample.

For the thirteen-year-old mathematics sample, the means and standard deviations are in Table 23 (p. 75) and the summary of the multiple regression is in Table 26. No significant main or interaction effects were found for relative age and class age. The nonsignificant regression line displayed in Figure 7 (p. 79) indicates the same decreasing achievement differential between older and younger classmates found for the combined analysis.

Table 24 (p. 75) contains the means and standard deviations for the seventeen-year-old mathematics sample. The results of the regression analysis are found in Table 27 (p. 80) and mirror the combined seventeen-year-old sample: neither main effects nor an interaction

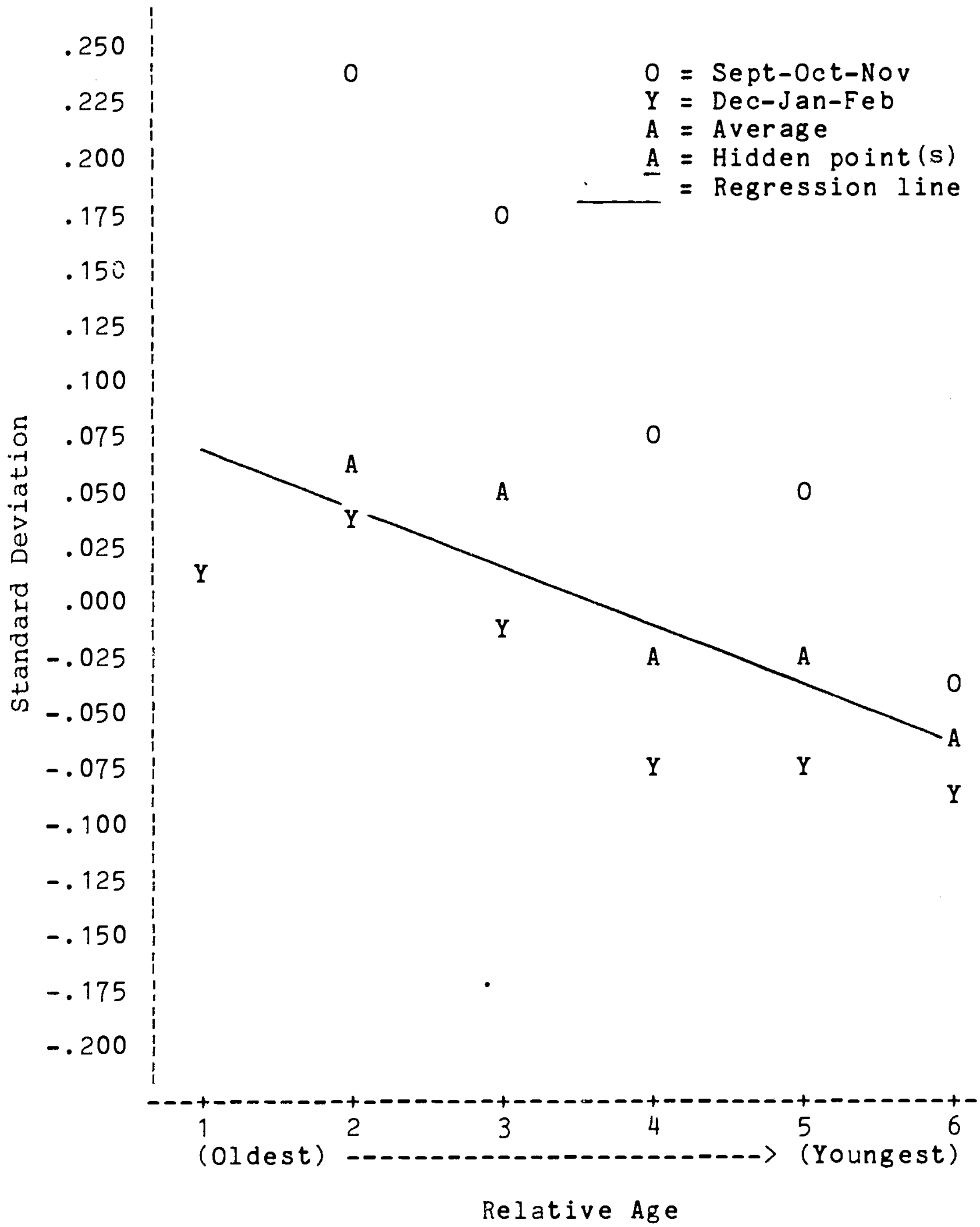

Figure 6. Mathematics achievement by relative age among nine-year-olds.

TABLE 26

Summary of Multiple Regression for the Age Thirteen Mathematics Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Overall F	p
Relative Age	-.005	1.5	ns	.001		-.028	7.0	.01
Class Age	.022	2.1	ns	.003	.002	-.049	7.0	.01
Parental Education High	.373	163.2	.01	.079	.079	.279	150.4	.01
Home Environment High	.196	41.7	.01	.099	.099	.195	144.4	.01
Southeast	-.265	64.3	.01	.117	.116	-.146	139.1	.01
Parental Education Low	-.260	47.9	.01	.126	.125	-.231	126.3	.01
Home Environment Low	-.216	22.6	.01	.131	.130	-.180	112.5	.01
Type of Community High	.223	25.0	.01	.135	.133	.124	101.7	.01
Northeast	.134	15.1	.01	.138	.136	.099	92.9	.01
Sex	.043	11.3	.01	.140	.138	.061	84.9	.01
Type of Community Low	-.110	6.9	.01	.141	.139	-.077	77.9	.01

effect were found for relative and class age. The nonsignificant regression line in Figure 8 (p. 81) has now become horizontal.

The results of the mathematics assessment show a decreasing trend as age increases for the achievement differential between older and younger students. The higher ratio of the predictive importance of class age to relative age and and the disappearance of the significant achievement disadvantage for the youngest students by age thirteen were the only different results between the mathematics samples and the combined samples. These two differences may be due to sampling error or may actually be differences in the relationship of the predictor variables with mathematics achievement as compared to combined achievement.

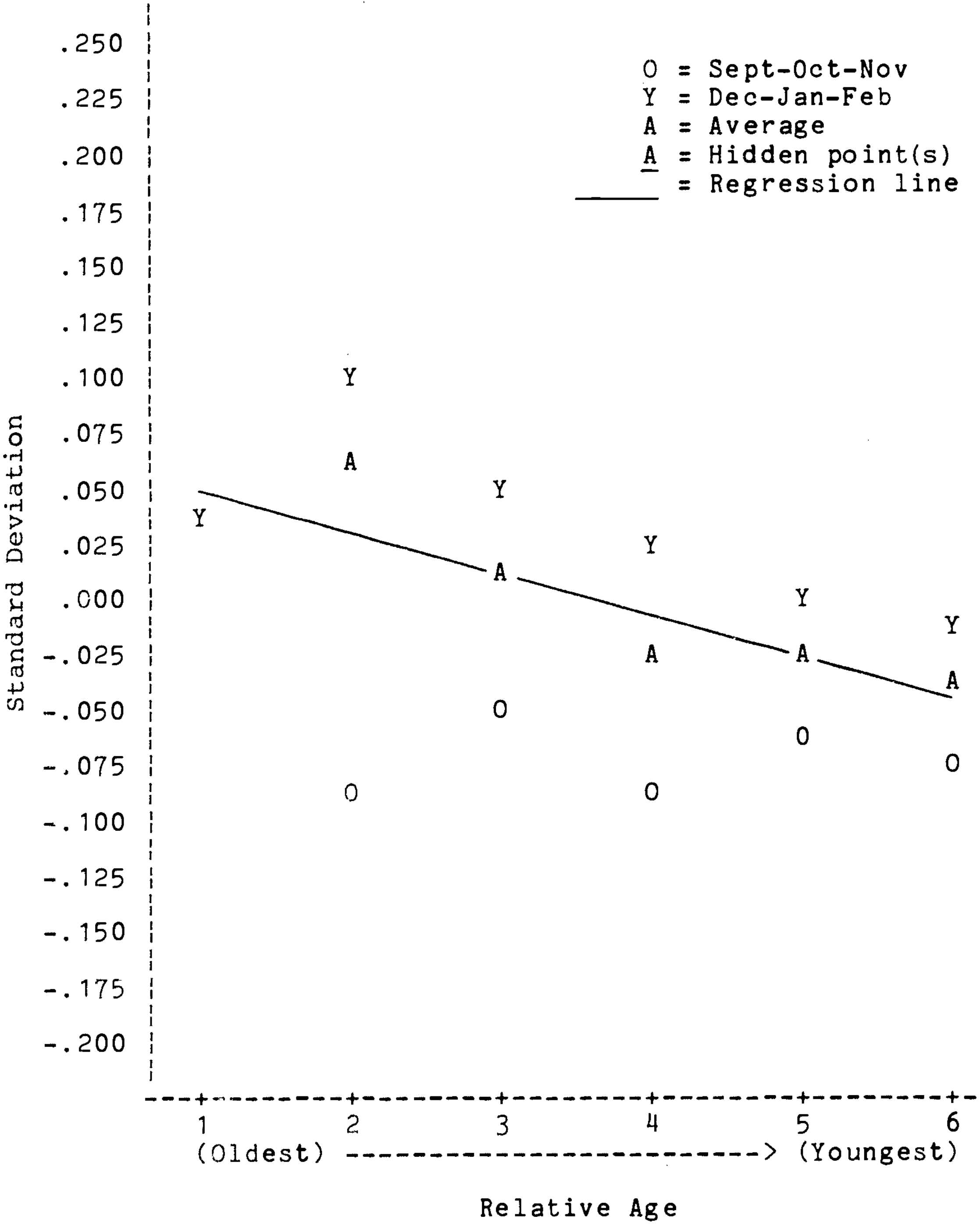

Figure 7. Mathematics achievement by relative age among thirteen-year-olds.

TABLE 27

Summary of Multiple Regression for the Age Seventeen Mathematics Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	.003	.6	ns	.000		.000	4.0	.05
Class Age	.001	.0	ns	.001	.001	-.037	4.0	.05
Parental Education High	.383	201.8	.01	.071	.070	.264	148.0	.01
Sex	.132	116.7	.01	.089	.088	.135	142.4	.01
Home Environment Low	-.207	26.1	.01	.102	.101	-.138	132.3	.01
Type of Community High	.291	52.6	.01	.112	.111	.135	122.1	.01
Parental Education Low	-.244	35.5	.01	.118	.117	-.188	111.5	.01
Northeast	.143	17.8	.01	.123	.121	.095	101.8	.01
Southeast	-.154	21.5	.01	.125	.124	-.087	92.8	.01
Home Environment High	.130	17.7	.01	.128	.127	.152	85.6	.01
Type of Community Low	-.132	11.7	.01	.130	.128	-.081	79.0	.01

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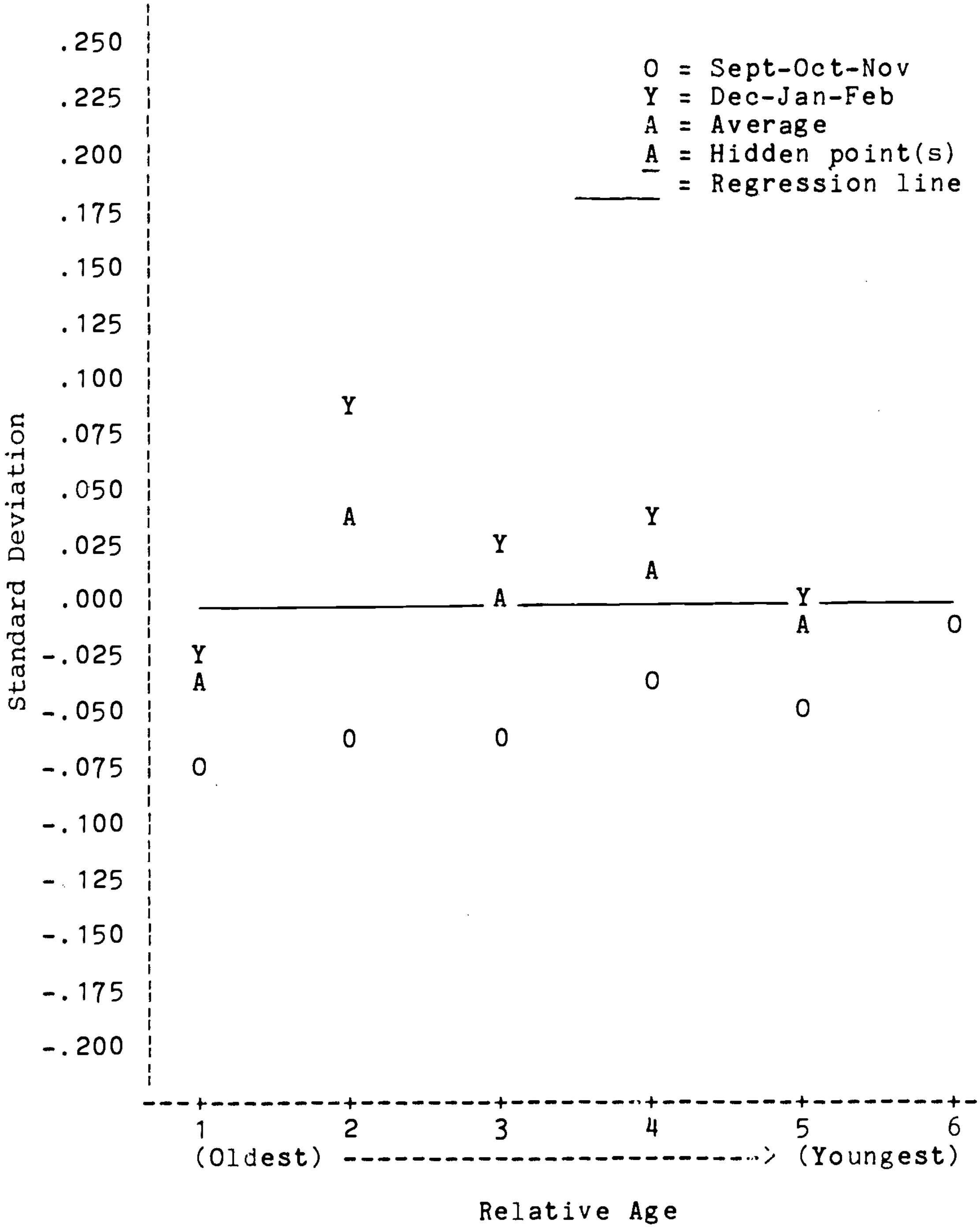

Figure 8. Mathematics achievement by relative age among seventeen-year-olds.

Science Assessment

The means and standard deviations for the predictor variables for the nine, thirteen and seventeen-year-old science samples are respectively found in Tables 28, 29 and 30 while the summaries of the multiple regression analyses are found in Tables 31, 32 and 33 (pp. 84, 86 and 88). The pattern of results for relative age was the same for the science assessment as it was for the mathematics assessment. The advantage for the older students was significant at age nine ($F=12.3$, $p<.01$) and decreased to nonsignificance by age thirteen.

TABLE 28

Means and Standard Deviations of Twelve Measures (N = 8,535) for the Age Nine Science Assessment

Variable	M	SD	Variable	M	SD
Relative Age	7.16	3.02	Chronological Age	9.57	2.94
Class Age	-.21	.98	Home Environment High	.34	.47
Parental Education High	.33	.47	Home Environment Low	.30	.46
Parental Education Low	.39	.49	Northeast	.24	.43
Type of Community High	.12	.33	Southeast	.21	.41
Type of Community Low	.15	.36	Sex	-.03	1.00

Figures 9, 10 and 11 (pp. 85, 87 and 89) graphically display the increasingly horizontal trend in the regression line. The significant negative slope for nine-year-olds flattens by age thirteen and vanishes by age seventeen.

As with all previous samples, none of the interaction effects between relative and class age were significant at ages nine, thirteen or seventeen. However, the old mean age classroom category had significantly higher

TABLE 29

Means and Standard Deviations of Twelve Measures (N = 11,400) for the Age Thirteen Science Assessment

Variable	M	SD	Variable	M	SD
Relative Age	7.15	3.05	Chronological Age	9.58	3.02
Class Age	-.20	.98	Home Environment High	.61	.49
Parental Education High	.46	.50	Home Environment Low	.12	.32
Parental Education Low	.18	.38	Northeast	.29	.45
Type of Community High	.15	.36	Southeast	.20	.40
Type of Community Low	.14	.35	Sex	-.05	1.00

TABLE 30

Means and Standard Deviations of Twelve Measures (N = 14,109) for the Age Seventeen Science Assessment

Variable	M	SD	Variable	M	SD
Relative Age	6.06	3.08	Chronological Age	8.36	3.04
Class Age	-.15	.99	Home Environment High	.71	.45
Parental Education High	.50	.50	Home Environment Low	.07	.26
Parental Education Low	.13	.34	Northeast	.23	.42
Type of Community High	.09	.29	Southeast	.15	.36
Type of Community Low	.12	.33	Sex	-.07	1.00

TABLE 31

Summary of Multiple Regression for the Age Nine Science Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	-.017	12.3	.01	.003		-.054	7.1	.01
Class Age	.038	5.1	.05	.003	.003	.006	7.1	.01
Parental Education Low	-.298	70.3	.01	.058	.057	-.235	87.5	.01
Home Environment High	.235	47.4	.01	.087	.086	.210	101.9	.01
Sex	.121	73.0	.01	.103	.102	.138	97.9	.01
Type of Community High	.318	49.6	.01	.116	.115	.116	93.1	.01
Home Environment Low	-.237	44.3	.01	.126	.124	-.206	87.6	.01
Southeast	-.219	34.4	.01	.133	.131	-.109	81.6	.01
Parental Education High	.146	15.8	.01	.136	.135	.201	74.3	.01
Type of Community Low	-.127	9.8	.01	.138	.136	-.083	68.4	.01
Northeast	-.043	1.1	ns	.139	.136	.051	62.3	.01

achievement than the young mean age group for both the nine-year-old (F=5.1, p<.05) and thirteen-year-old (F=6.7, p<.01) samples.

Another difference was the ratio of importance to the prediction of achievement for class age to relative age; it was .7 at age nine and 1.8 at age thirteen. Except for the significance of class age for the thirteen-year-old sample and the low ratio of predictive importance, all of these results replicate the mathematics assessment.

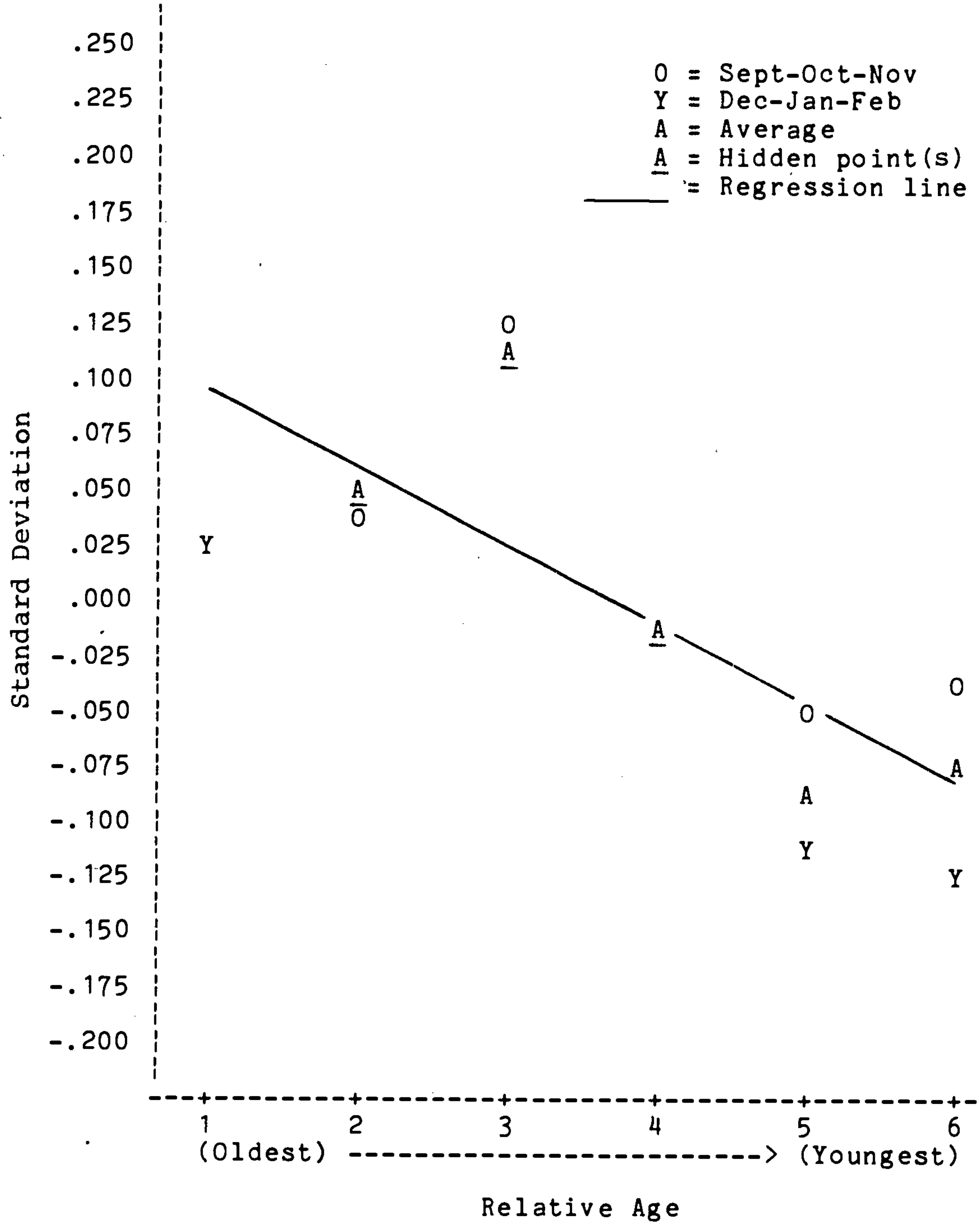

Figure 9. Science achievement by relative age among nine-year-olds.

TABLE 32

Summary of Multiple Regression for the Age Thirteen Science Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	-.007	3.0	ns	.000		-.021	1.6	ns
Class Age	.041	6.7	.01	.001	.000	.008	1.6	ns
Parental Education High	.330	128.0	.01	.069	.069	.262	129.3	.01
Sex	.177	191.3	.01	.101	.101	.190	146.6	.01
Home Environment High	.243	65.1	.01	.127	.126	.219	151.2	.01
Parental Education Low	-.232	37.8	.01	.135	.134	-.212	135.0	.01
Type of Community High	.196	27.6	.01	.140	.139	.116	121.2	.01
Home Environment Low	-.205	20.7	.01	.144	.143	-.181	109.5	.01
Northeast	.954	7.0	.01	.147	.145	.036	99.1	.01
Southeast	-.745	4.6	.05	.147	.146	-.083	89.7	.01
Type of Community Low	-.126	.1	ns	.147	.146	-.059	81.5	.01

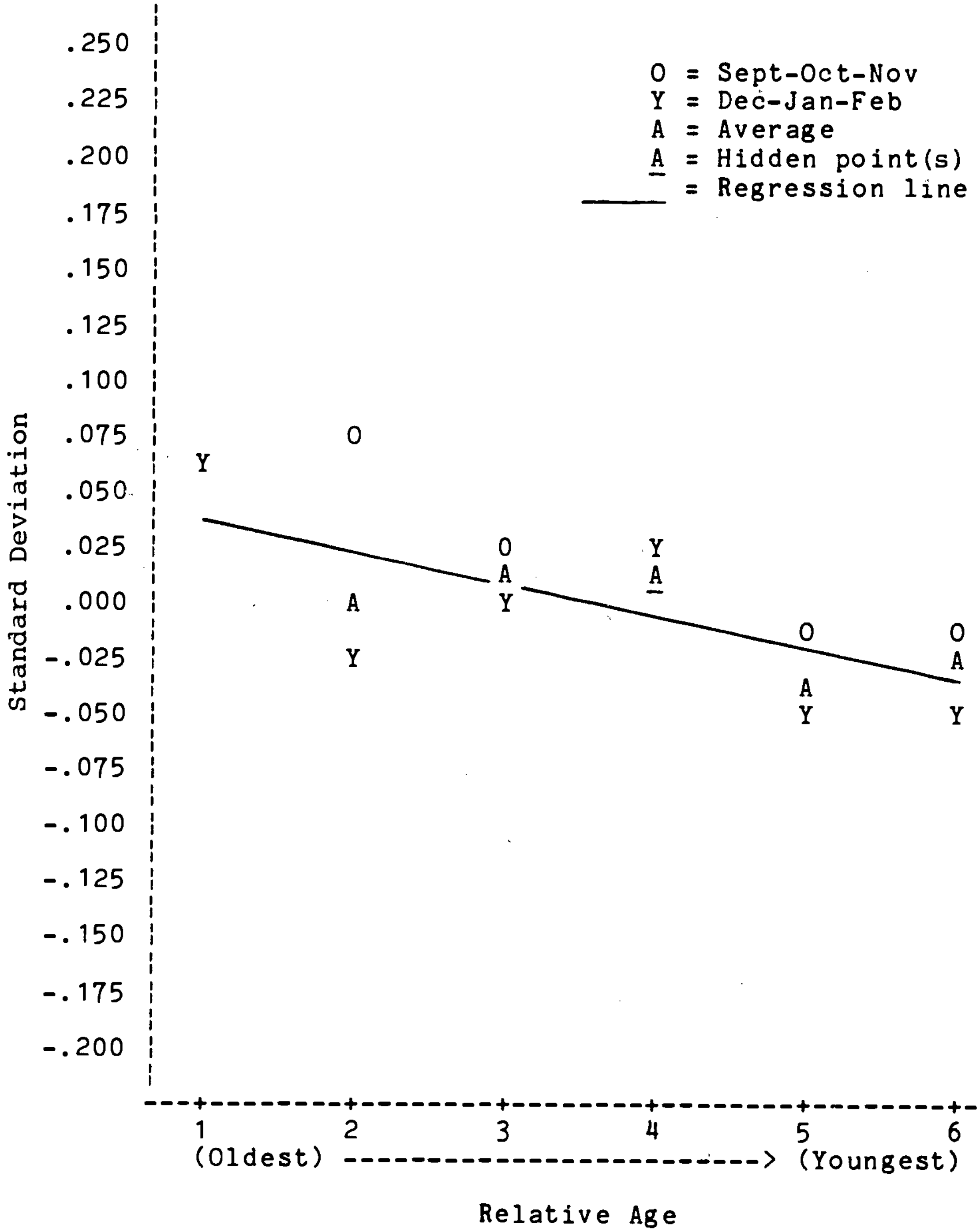

Figure 10. Science achievement by relative age among thirteen-year-olds.

TABLE 33

Summary of Multiple Regression for the Age Seventeen Science Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	-.003	.7	ns	.000		-.017	4.8	.05
Class Age	.009	.4	ns	.002	.001	-.038	4.8	.05
Parental Education High	.307	139.2	.01	.050	.050	.222	110.9	.01
Sex	.195	275.3	.01	.091	.091	.206	158.8	.01
Home Environment High	.228	61.0	.01	.112	.111	.193	158.8	.01
Home Environment Low	-.295	33.8	.01	.117	.116	-.158	139.3	.01
Parental Education Low	-.189	24.7	.01	.121	.120	-.169	124.0	.01
Northeast	.115	12.4	.01	.123	.122	.067	110.9	.01
Southeast	-.187	7.0	.01	.124	.123	-.066	99.4	.01
Type of Community Low	-.865	5.6	.05	.125	.124	-.058	90.2	.01
Type of Community High	.727	3.1	ns	.126	.124	.052	82.3	.01

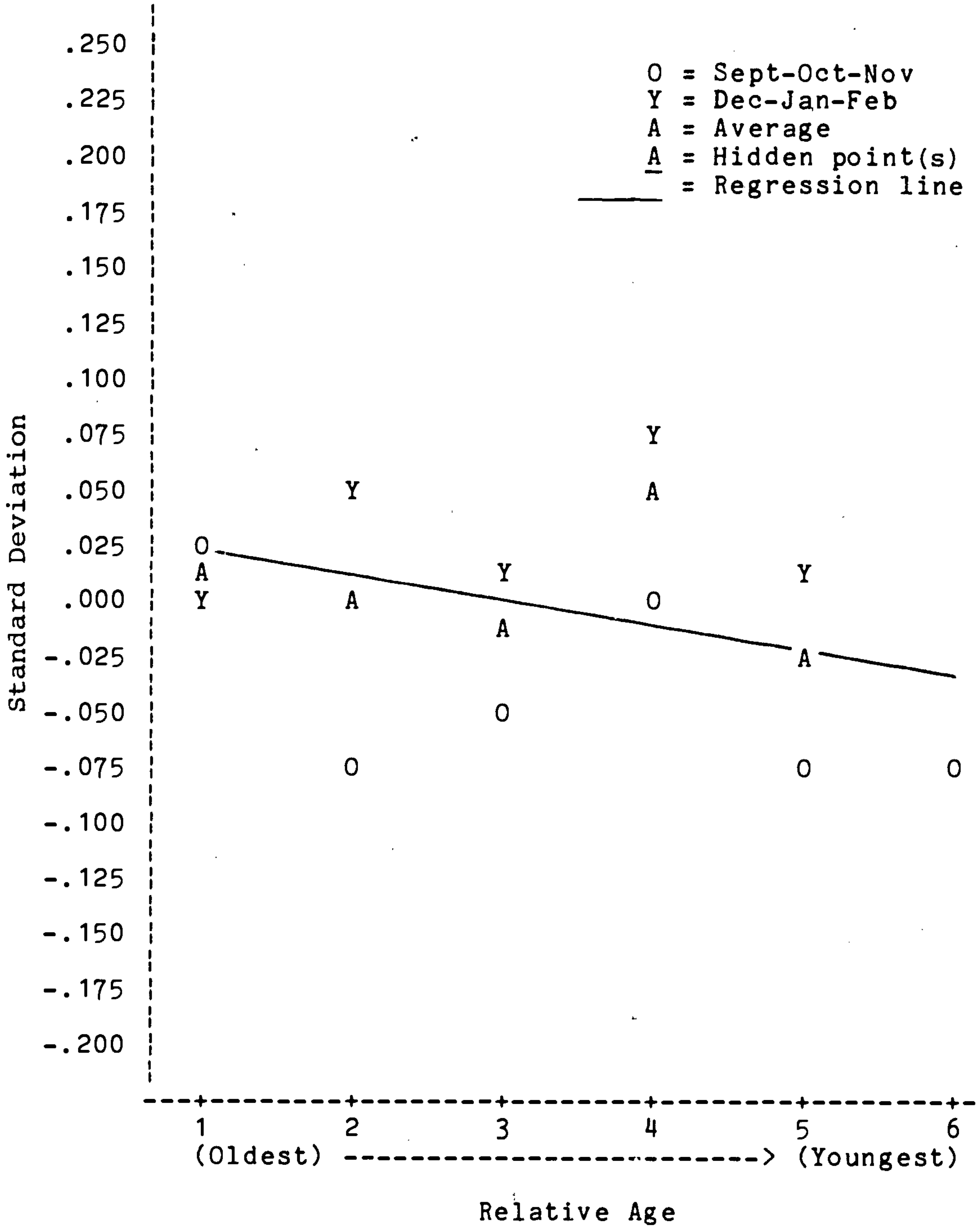

Figure 11. Science achievement by relative age among seventeen-year-olds.

Reading Assessment

Tables 34, 35 and 36 contain the means and standard deviations for the nine, thirteen and seventeen-year-old samples while Tables 37, 38 and 39 (pp. 92, 94 and 96) contain the summary of the multiple regression analyses. The reading assessment provides an exact replication of the mathematics assessment for relative and class age. The statistically significant academic disadvantage of the youngest students of the classroom at age nine ($F=12.6$, $p<.01$) decreases to nonsignificance by age thirteen and remains so at age seventeen.

TABLE 34

Means and Standard Deviations of Twelve Measures (N = 12,423) for the Age Nine Reading Assessment

Variable	M	SD	Variable	M	SD
Relative Age	7.16	3.06	Chronological Age	9.68	3.00
Class Age	-.31	.95	Home Environment High	.38	.48
Parental Education High	.38	.49	Home Environment Low	.25	.44
Parental Education Low	.37	.48	Northeast	.30	.46
Type of Community High	.13	.34	Southeast	.20	.40
Type of Community Low	.11	.32	Sex	-.03	1.00

Figures 12, 13 and 14 (pp. 93, 95 and 97) graphically display this relationship between achievement and relative age. No interaction effects between relative age and class age were statistically significant at any age, but class age was statistically significant at age nine ($F=11.7$, $p<.01$) and became nonsignificant by age thirteen. However, the age seventeen sample was unlike any prior sample; the regression line has actually gone past the horizontal slope to a positive slope. The positive beta weight (.007) for relative age remained nonsignificant but showed better achievement for the youngest students in the class.

TABLE 35

Means and Standard Deviations of Twelve Measures (N = 11,032) for the Age Thirteen Reading Assessment

Variable	M	SD	Variable	M	SD
Relative Age	7.10	3.07	Chronological Age	9.63	3.03
Class Age	-.31	.95	Home Environment High	.64	.48
Parental Education High	.46	.50	Home Environment Low	.10	.30
Parental Education Low	.18	.39	Northeast	.29	.46
Type of Community High	.14	.35	Southeast	.19	.39
Type of Community Low	.11	.31	Sex	-.05	1.00

TABLE 36

Means and Standard Deviations of Twelve Measures (N = 10,472) for the Age Seventeen Reading Assessment

Variable	M	SD	Variable	M	SD
Relative Age	6.02	3.06	Chronological Age	8.32	3.03
Class Age	-.19	.98	Home Environment High	.73	.44
Parental Education High	.51	.50	Home Environment Low	.07	.25
Parental Education Low	.14	.35	Northeast	.25	.43
Type of Community High	.11	.32	Southeast	.16	.37
Type of Community Low	.16	.37	Sex	-.08	1.00

TABLE 37

Summary of Multiple Regression for the Age Nine Reading Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	-.014	12.6	.01	.002		-.047	7.1	.01
Class Age	.050	11.7	.01	.002	.002	-.003	7.1	.01
Home Environment Low	-.259	67.9	.01	.038	.037	-.189	81.1	.01
Parental Education Low	-.197	39.0	.01	.060	.060	-.181	99.4	.01
Sex	-.117	94.5	.01	.074	.073	-.098	98.5	.01
Home Environment High	.189	45.1	.01	.082	.081	.179	92.3	.01
Parental Education High	.166	27.7	.01	.087	.086	.181	84.2	.01
Southeast	-.121	14.1	.01	.091	.089	-.074	77.3	.01
Northeast	.091	8.7	.01	.092	.091	.065	70.1	.01
Type of Community High	.100	7.2	.01	.094	.092	.089	64.0	.01
Type of Community Low	-.093	5.8	.05	.094	.093	-.061	58.8	.01

The significant positive beta weight ($F=11.7$, $p<.01$) for class age indicates that the older mean age category had a higher average achievement than the younger mean age category. For ages thirteen and seventeen all of the previous mathematics, reading and combined samples, the graphs displaying the relationship between relative and class age seemed to reverse. In fact for all these samples the beta weight was negative for class age on the first step of the regression analysis and became positive in the presence of the other predictor variables. However, class age was not significant for the thirteen and seventeen year old reading samples but the beta weight remained negative. Since the results were not significant, no explanation is offered for this finding.

The ratio of class to relative age in their predictive importance to achievement was 1.1 for the nine-year-old reading sample. Unlike the science assessment, this slight advantage did agree with the mathematics and combined samples.

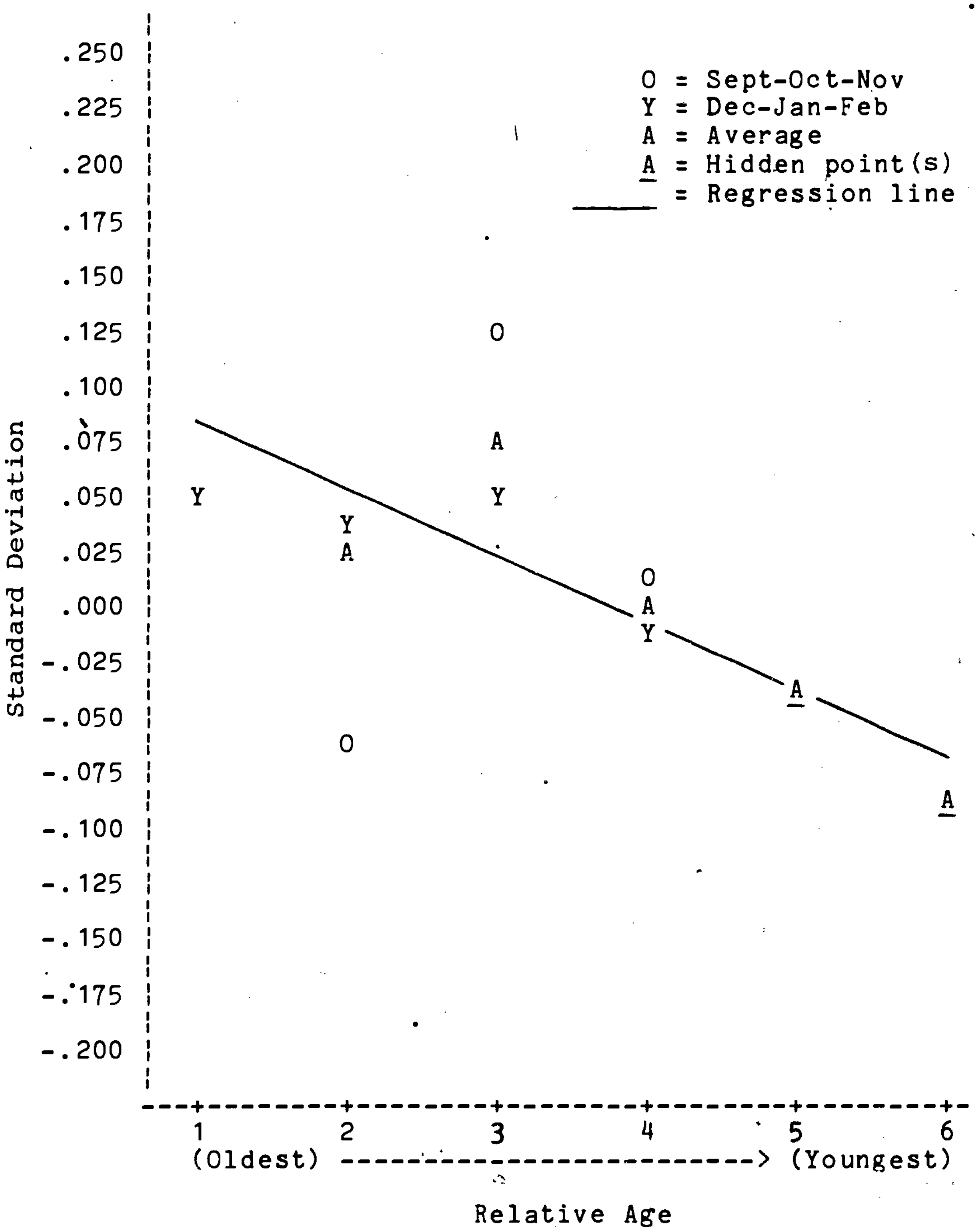

Figure 12. Reading achievement by relative age among nine-year-olds.

TABLE 38

Summary of Multiple Regression for the Age Thirteen Reading Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Relative Age	-.006	1.9	ns	.001		-.030	4.9	.05
Class Age	-.009	.4	ns	.002	.001	-.036	4.9	.05
Parental Education High	.300	108.2	.01	.060	.060	.243	117.5	.01
Home Environment High	.262	77.0	.01	.090	.089	.223	136.0	.01
Sex	-.143	129.3	.01	.110	.109	-.140	135.9	.01
Parental Education Low	-.218	35.2	.01	.117	.116	-.198	121.5	.01
Home Environment Low	-.273	33.7	.01	.123	.121	-.189	109.9	.01
Type of Community Low	-.184	20.1	.01	.126	.125	-.094	99.6	.01
Type of Community High	.134	12.6	.01	.129	.127	.110	90.4	.01
Southeast	-.100	8.5	.01	.130	.128	-.063	82.3	.01
Northeast	-.025	.6	ns	.130	.128	.025	74.9	.01

The main differences between the combined samples and the mathematics, science and the reading samples were the nonsignificance of relative age for thirteen-year-olds for all three assessments, the signfiicant class age effect for the thirteen-year-old science sample and the low ratio for the nine-year-old science sample. These inconsistencies could be either the result of sampling error or differences in the relationship of the predictor variables with the combined, mathematics, science and reading achievement. Only through replication of these results by examining the three age samples of another reading assessment will answers be found for these questions. However, as stated earlier, such an analysis is beyond the scope of the present study.

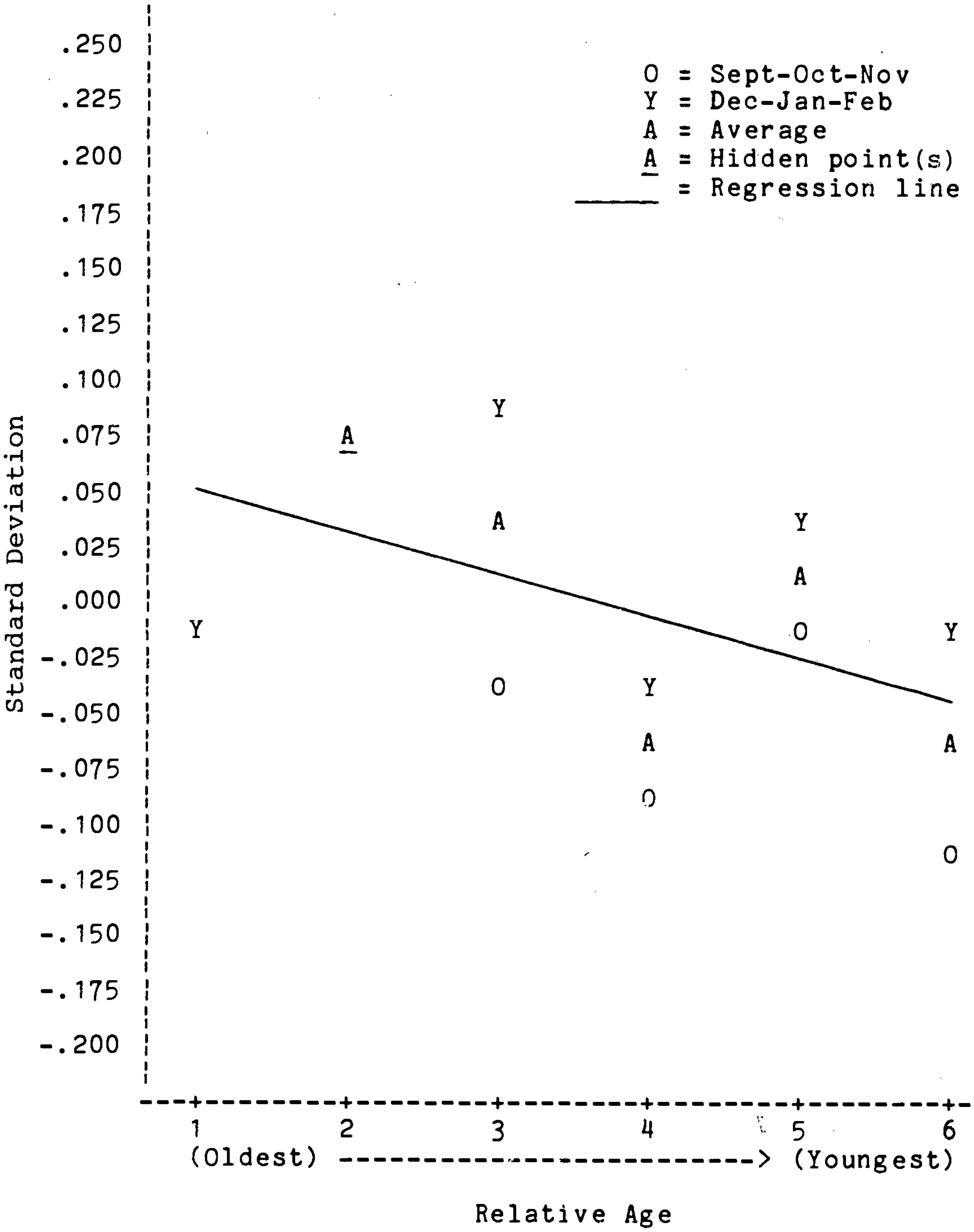

Figure 13. Reading achievement by relative age among thirteen-year-olds.

TABLE 39

Summary of Multiple Regression for the Age Seventeen Reading Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Overall F	p
Relative Age	.007	2.8	ns	.001		.026	3.2	ns
Class Age	-.007	.2	ns	.001	.001	-.017	3.2	ns
Parental Education High	.337	132.1	.01	.055	.054	.232	100.9	.01
Home Environment High	.243	52.7	.01	.074	.073	.178	103.9	.01
Sex	-.085	41.0	.01	.080	.080	-.074	91.5	.01
Parental Education Low	-.207	23.9	.01	.085	.084	-.173	81.3	.01
Type of Community High	.134	9.9	.01	.088	.087	.091	71.9	.01
Home Environment Low	-.193	10.8	.01	.090	.088	-.132	64.4	.01
Type of Community Low	-.043	5.4	.05	.091	.089	-.064	57.9	.01
Southeast	-.076	4.1	.05	.092	.090	-.046	52.6	.01
Northeast	.034	1.0	ns	.092	.090	.030	47.9	.01

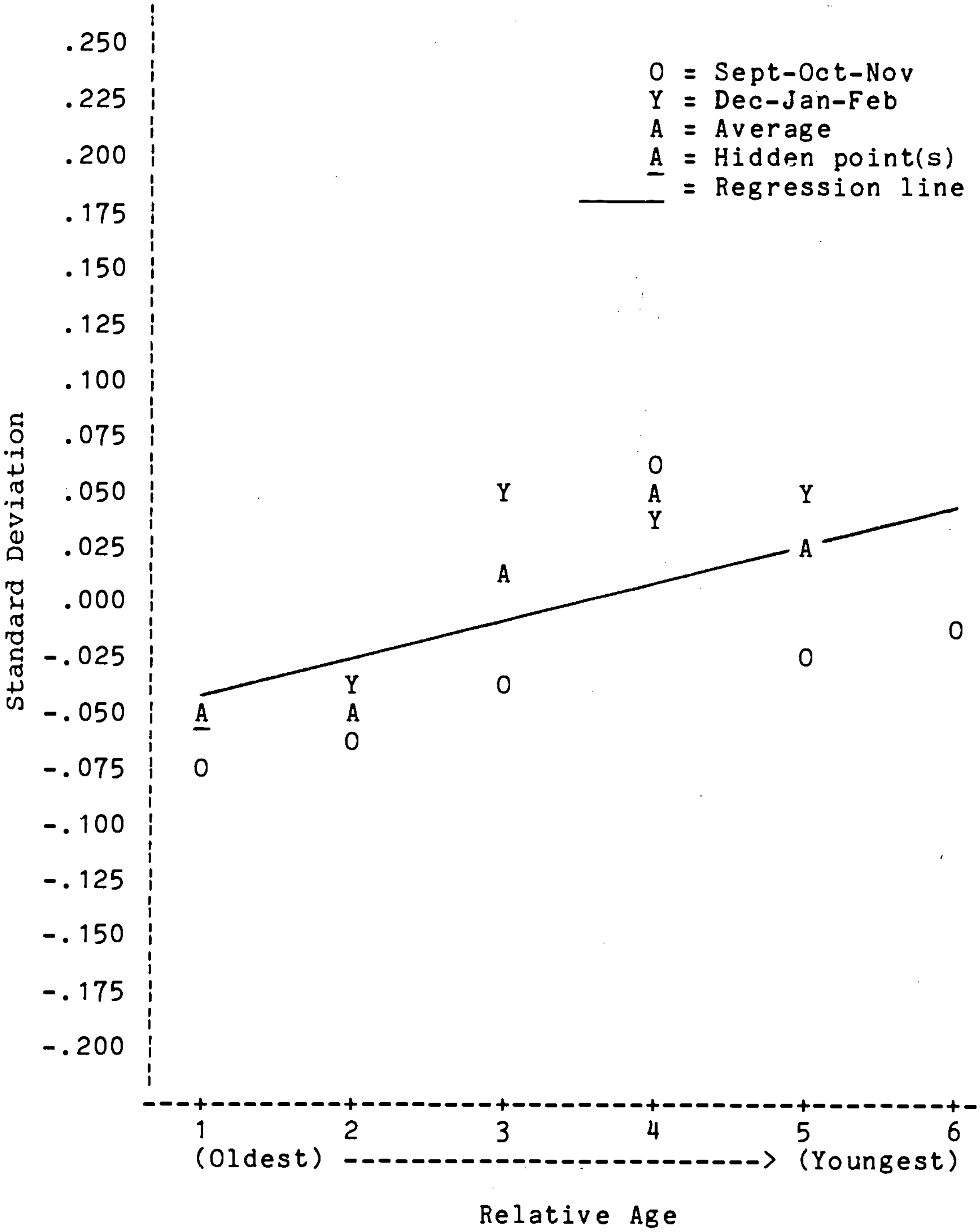

Figure 14. Reading achievement by relative age among seventeen-year-olds.

CONTROL VARIABLES

Sex, type of community, home environment, parental education and the region variables were entered into the regression analyses as controls for establishing the importance of relative age and class age in predicting academic achievement. The description of these variables is found in the section titled "Predictor Variables" of Chapter Three (p. 34).

Home Environment, Parental Education and Type of Community

Several consistent trends were found for the type of community, home environment and parental education variables. These variables have been previously linked to academic achievement not only with more limited samples (Bryant et al., 1974; Mullis, 1978) but also with National Assessement samples (NAEP, 1979c, 1980a, 1981b). Based on student background information, students were divided into high, medium and low groups for each of these variables with the intent to divide students into groups with high, medium and low academic achievement.

The relationship between these three groups was entered into the regression analysis by creating two variables. The high variable compared the high group of students against the remaining students while the low variable was defined in the same way using the low student group. If the high and low variables were statistically significant, then it would follow that the achievement differences between the high, medium and low groups of students would also be significant. In this manner high, medium and low groups were compared in the regression analyses for type of community, home environment and parental education.

Because the results were similar at all ages across the mathematics, science and reading samples, the three achievement groups were combined at each age. For each age level, the high category had a significantly greater achievement level than the remaining students, and the low category had statistically significant lower achievement than the remaining students (see Tables 13, 18 and 21; pp. 52, 65 and 72).

The graphs for these variables are presented in Appendix D. As mentioned previously, the vertical axis is described with respect to achievement in units of standard deviations, while the horizontal axis contains six relative age categories ordered from oldest to youngest. Each graph displays three parallel lines. In each instance the high group had a statistically significant higher level of achievement as compared to the low group of students. The achievement data for the high, medium and low groups parallels these results found for relative age; a negative slope at age nine which becomes horizontal by age seventeen.

Region

The region variable was obtained by dividing the sample into a northeast category, a southeast category and a combined central and west category. These categories were choosen because National Assessment has found northeast students typically have high achievement and southeast students have low achievement (NAEP, 1979c, 1980a, 1981b). In the same manner as describe above, a northeast and a southeast variable were entered into the regression analyses. For each age level, the northeast category had statistically significant greater achievement than the remaining students and the southeast category had statistically significant lower achievement than the rest of the students (see Tables 13, 18 and 21; pp. 52, 65 and 72).

Besides controlling for achievement, the region variable was added to control for a potentially biasing relationship with class age; the northeast states have a preponderance of cutoff dates in the young mean age category (see Table 40 in Appendix C). Therefore, region was added to the regression analysis to control for any distortion in the analyses caused by this relationship.

Sex

The male and female analysis was conducted separately for each learning area because of performance differences. For the mathematics and science learning areas males have shown higher achievement than females at all three ages (NAEP, 1978b, 1979a). In reading, however, females have performed significantly better than males at all three ages (NAEP, 1981b).

For the mathematics and science assessments the positive beta weight for sex indicated superior male performance and was statistically signficant at all three ages (see Tables 25, 26, 27, 31, 32 and 33; pp. 76, 78, 80, 84, 86 and 88). The beta weight was negative and statistically significant at all three ages for reading and indicates superior female performance (see Tables 37, 38 and 39; pp. 92, 94 and 96). The graphs demonstrating these relationships are found in Appendix F. Each graph displays two parallel lines with a negative slope that flattens with increasing age.

This chapter began with an analysis of the nine, thirteen and seventeen-year-old samples combined across the mathematics, science and reading assessments. The nine-year-old achievement data revealed a significant disadvantage for the youngest relative age positions, replicating previous research. The effect remained significant but had attenuated by age thirteen and completely vanished by age seventeen.

Several logical explanations were described to account for this trend, including teacher intervention, remedial instruction and student adaptation. However, a more distressing contributor was the changing sample characteristics. An analysis of students retained one grade yielded increasing proportions of relatively young students and a startling retention rate of over forty percent for the youngest males. Chapter Five will discuss the implications of these major findings and sugguestions for further research.

Chapter 5

CONCLUSIONS

Parents, teachers and educators have always been concerned about the physical, mental, social and emotional aspects that determine a child's readiness for entering first grade. But school budgets are often inadequate for the task of examining every entering student and states have committed themselves to the use of a simple age criterion as the normal admission policy. Using this simple age criterion, school boards have attempted to minimize the number of students unprepared for formal schooling, reserving clinical screening for a small group of students seeking early entry.

This rather simplistic age criterion has led to research on optimal ages for entering first grade as well as individual attributes necessary for successful early entry into school. The research paradigm typically used has compared groups of children who have entered below the minimum age specified by the cutoff date with students who attained the cutoff age before entering first grade. The results have shown that early entrants demonstrated equal or slightly superior academic performance (Hedges, 1977).

But policymakers have typically overlooked the few studies comparing younger and older groups of normally entering students. These studies have found that throughout elementary school younger normals receive lower grades, are rejected more often by their peers, have negative attitudes toward school, have higher retention rates and score lower on achievement tests in mathematics, science and reading (Hedges, 1977; Weinstein, 1968-69). Moreover, the persistence of this problem in later grades has been examined in only a few studies using junior and senior high school students, with inconsistent findings. The purpose of this study was to investigate the changing relationship between academic achievement, relative age and school entrance age throughout students' school careers.

DATA SAMPLE

This study is based on a secondary analysis of the data collected by the National Assessment of Educational Progress. National Assessment conducts an assessment of educational attainments of nine, thirteen and seventeen-year-olds on a national basis. The validity of the objectives and achievement measures, the quality of the sample design and the care taken to assess each learning area make the data appropriate for a number of secondary analyses. The quality and amount of analyzable data was one of the most important aspects of this study and provided a much broader base than was available to previous researchers.

The subsample of National Assessment data selected for this study consists of Caucasian students in grades four, eight and eleven from the nine, thirteen and seventeen-year-old samples of the mathematics, science and reading assessments. On the basis of student birth month and the state cutoff date requirement for first grade entrance, students of each state were categorized as retained, normal or advanced for their grade.

The criterion variable was constructed from the student's achievement on the learning area exercises. Since each student only took one package, a subset of the total exercises comprising the learning area, the assumption was made that a student's percentile rank on one package was the best estimate for any other subset of exercises. Therefore, based upon the percentage of correct answers, each student was ranked among those students taking the same package. This assumption was considered appropriate because a national sample of students responded to each package.

To satisfy normality assumptions of the multiple regression analyses, a probit transformation was applied to transform the rectangular percentile rank distribution into a normal distribution. The normalization of the percentile ranks provided a common and meaningful basis for comparing the pattern of results between the nine, thirteen and seventeen-year-old populations (1) in the same learning area, (2) between different ages in different learning areas, and (3) between different ages combined for an age across learning areas.

PREDICTOR VARIABLES

The National Assessment data also contained a variety of background information about each student's home and community environments. The predictor variables created from this information were relative age, class age, sex, parental education, home environment and type of community. The relative age variable described a student's age relative to the other students in the classroom while class age acted as a control for the different mean ages of the classroom caused by the use of multiple cutoff dates. These two variables were important to this study in terms of replication of prior research findings and in the examination of the relationship of achievement to variables that can be manipulated by educators. The remaining variables were entered into the regression analyses as controls for establishing the importance of relative age and class age in the presence of variables that predict academic achievement. The relative and class age variables were forced into the multiple regression analyses at the first step, followed by the other predictor variables entering in a stepwise regression.

ACHIEVEMENT FINDINGS

A significant negative slope for nine-year-old mathematics, science and reading samples replicated the academic advantage found for the oldest students in the classroom. Because of the consistency of the results for mathematics, science and reading at each age, the three learning area samples were combined into one sample. This analysis resulted in the most stable estimate of the relationships of achievement and the predictor variables by dampening the effect of any significant distortion attributable to sampling error.

Examination of the combined nine, thirteen and seventeen-year-old Caucasian samples indicates that the significant advantage found for the oldest students at age nine decreases but remains significant at age thirteen, and disappears by age seventeen. The possible reasons offered for the decreasing importance of relative age were teacher intervention, remedial instruction, successful student adaptation to the school environment and student retention.

The interaction effect between relative and class age offered the most promise for providing information about each specific learning area. If a significant interaction had occured for a particular learning area, predictions could have been made about student readiness for this learning area. However, no interaction effects were found for any of the learning areas or the combined samples. Standing on its own merits, this finding was originally interpreted as meaning that even the youngest students in the classrooms from states with the youngest mean student age (states with December, January and February cutoffs), were above the basic minimum necessary to succeed academically in school.

THE MINIMAL COMPETENCY QUESTION

This assumption of minimal academic competence is not without some complications; classrooms with an older mean age had significantly greater achievement than classrooms with a younger mean age. The relative importance of class age to relative age in the prediction of achievement was examined and found to be less than one for science and greater than one for mathematics, reading and the combined samples. While causality cannot be directly inferred, the data suggest several possibilities. When the ratio is greater than one, if a student could be moved from a younger to an older mean age classroom, then the decrease in achievement caused by becoming relatively younger would be more than offset by the increase in achievement attributable to belonging to a classroom with an older mean age.

Another difficulty with the interpretation of minimum academic competence is the increasing proportion of retained students as the relative age of the students become younger. Relative age, class age and sex were examined in the combined nine and thirteen-year-old samples for differences in the proportion of retained Caucasian students who should have been in the modal grade (grades four and eight). The results of the regression analyses for ages nine and thirteen indicate increasing proportions of retained students as the student's relative age becomes younger. These increased proportions have both statistically significant linear and quadratic components.

The statistically significant interaction between relative age and sex was a function of the retention rate increasing faster for males than females, as relative age becomes younger. With the additional finding that significantly more students were retained from young mean age classrooms (states with December, January and February cutoffs), the identification of the students with the potentially greatest difficulty adapting to the school environment becomes easier. That is, the major problem group consists of the youngest male students with December, January and February cutoffs. By age thirteen slightly more than a third of these youngest students have over a twenty percent failure rate, which increases to over a forty five percent failure for the youngest relative age position. For females of the young mean age group, the youngest two relative age positions have over a twenty percent failure rate, but interestingly enough, the youngest females who are members of classrooms with older mean ages fare best throughout all relative age positions in the classroom. Similar results from prior studies have led some researchers to advocate an older entrance age for males as a solution for this differential maturation rate between males and females (Pauley, 1951; Bear, 1958; Hedges, 1977).

The problem of high proportions of retained students would not be entirely alleviated by changing the cutoff date for those states with December, January or February cutoffs (young mean age classrooms) to September, October or November cutoffs (old mean age classrooms). For instance, changing the cutoff date of a state which matched the mean age of the young class age category so that it matched the mean age of the old class age category, would decrease the average proportion of retained students for the youngest quarter of the classroom from .3745 to .2601 for males and from .2547 to .1359 for females (see Table 19, p. 68). Furthermore, a larger increase in the mean classroom age would begin to retain female students who are fully capable of successfully participating in formal schooling.

In other words, the problem of retention seems to be a problem of the male student. Even males occupying the middle relative age position in older classrooms have a sixteen percent retention rate, double that of the female students in the same position. Certainly a most important question is whether our nation should have a male failure rate this high.

POTENTIAL SOLUTIONS

Potential solutions may have multiple elements. Those states with December, January or February cutoffs might consider increasing the mean classroom age. In addition, clinical screening should be given to some portion of the youngest students, especially males, even though they have passed the cutoff age criterion. In those states with September, October and November cutoffs, only the youngest males need this special attention.

Through individual teacher attention and remedial instruction a portion of these students may be kept from failure. Individual and self paced instruction may provide at least a partial instructional solution to this problem. Miller and Norris (1967) found attenuated differences in achievement between the youngest and oldest students drawn from the fourth and fifth grades. Upon entering the school system, each student was placed in one of eleven instructional levels based upon teacher recommendation and reading achievment scores. This organizational system emphasized the grouping of students at similar instructional levels to enhance reading instruction and individual pacing of progress to minimize failure and grade competetion. Since each student progressed through these eleven levels at different rates, they entered fourth grade at different times. When the young and old groups were compared on all the achievement subtests, the older group had higher achievement on twenty eight of the twenty nine tests, but only four were significant at the five percent level. These results are promising and should be replicated.

In summary, clinical screening is suggested for several groups: (1) For districts with December, January, or February cutoffs, the highest risk groups include males in the youngest half of the class, or females in the youngest quarter of the class. (2) For districts with September, October, and November cutoffs, the highest risk group include males in the youngest third of the class. Signs of inadequate readiness found among these groups pose potentially serious threats to the child's academic career and suggests delaying entrance until the following school year.

FUTURE RESEARCH

Several lines of investigation have been beyond the scope of this study. One of the first reductions in our sample was the removal of minority students. With our understanding of the homogeneous Causasian students as a base, the investigation of minority achievement is now feasible.

During the analyses, the question of replication was raised because of differential results between the mathematics, science and reading learning areas. However, the replication of a learning area automatically raises questions about the effect of changes in national events, local events, curricula or classroom practices that have occurred between the two assessments. Examination of National Assessment cohort data would decrease this problem and is vital to the analysis of any minority data.

Finally, any means to reduce the proportions of retained students should be examined carefully. For instance, changes is school structure that would maintain classrooms for the first four grades that contain only the oldest half or the youngest half of the students might be effected and studied for impact on achievement. The partial answer provided by Miller and Norris (1967) on individual and self paced instruction should be examined further to determine its effects on the youngest students.

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Appendix A

STATE CUTOFF MONTHS

Table 40 contains the cutoff month used by this study to reject modal grade students 1) who have been advanced one or more grades or 2) who have been retained one or more grades. All cutoff months listed in this table are treated as a first day of the month cutoff date. States with cutoffs occurring in the middle of the month are marked with an asterisk. Modal grade students born in the cutoff month for a state using a midmonth cutoff are automatically assumed to have progressed through school at the normal rate.

TABLE 40

State Cutoff Months Used by This Study for the Nine, Thirteen and Seventeen-Year-Old Samples

State	Years										
	64	65	66	67	68	69	70	71	72	73	74
Alabama	10	10	10	10	10	10	10	10	10	10	10
Alaska	11	11	11	11	11	11	11	11	11	11	11
Arizona	1	1	1	1	1	1	1	1	1	1	1
Arkansas	10	10	10	10	10	10	10	10	10	10	10

TABLE 40

(Continued)

State	Years										
	64	65	66	67	68	69	70	71	72	73	74
California	12	12	12	12	12	12	12	12	12	12	12
Colorado	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*
Connecticut	1	1	1	1	1	1	1	1	1	1	1
Deleware	1	1	1	1	1	1	1	1	1	1	1
District of Columbia	1	1	1	1	1	1	1	1	1	1	1
Florida	1	1	1	1	1	1	1	1	1	1	1
Georgia	12*	12*	12*	12*	12*	12*	12*	12*	12*	12*	12*
Hawaii	1	1	1	1	1	1	1	1	1	1	1
Idaho	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*
Illinois	12	12	12	12	12	12	12	12	12	12	12
Indiana	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*
Iowa	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*
Kansas	9	9	9	9	9	9	9	9	9	9	9
Kentucky	1	1	1	1	1	1	1	1	1	1	1
Louisana	1	1	1	1	1	1	1	1	1	1	1
Maine	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*
Maryland	1	1	1	1	1	1	1	1	1	1	1
Massachusetts	1	1	1	1	1	1	1	1	1	1	1
Michigan	12	12	12	12	12	12	12	12	12	12	12
Minnesota	9	9	9	9	9	9	9	9	9	9	9

TABLE 40

(Continued)

State	Years										
	64	65	66	67	68	69	70	71	72	73	74
Mississippi	1	1	1	1	1	1	1	1	1	1	1
Missouri	10	10	10	10	10	10	10	10	10	10	10
Montana	11	11	11	11	11	11	11	11	11	11	11
Nebraska	10	10	10	10	10	10	10	10	10	10	10
Nevada	12	12	12	12	12	12	12	12	12	12	12
New Hampshire	12	12	12	12	12	12	12	12	12	12	12
New Jersey	12	12	12	12	12	12	12	12	12	12	12
New Mexico	1	1	1	1	1	1	1	1	1	1	1
New York	12	12	12	12	12	12	12	12	12	12	12
North Carolina	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*
North Dakota	11	11	11	11	11	11	11	11	11	11	11
Ohio	10	10	10	10	10	10	10	10	10	10	10
Oklahoma	11	11	11	11	11	11	11	11	11	11	11
Oregon	11*	11*	11*	11*	11*	11*	11*	11*	11*	11*	11*
Pennsylvania	1	1	1	1	1	1	1	1	1	1	1
Rhode Island	1	1	1	1	1	1	1	1	1	1	1
South Carolina	11	11	11	11	11	11	11	11	11	11	11
South Dakota	11	11	11	11	11	11	11	11	11	11	11
Tennessee	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*
Texas	9	9	9	9	9	9	9	9	9	9	9

TABLE 40

(Continued)

State	Years										
	64	65	66	67	68	69	70	71	72	73	74
Utah	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*
Vermont	1	1	1	1	1	1	1	1	1	1	1
Virginia	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*	10*
Washington	10	10	10	10	10	10	10	10	10	10	10
West Virginia	11	11	11	11	11	11	11	11	11	11	11
Wisconsin	12	12	12	12	12	12	12	12	12	12	12
Wyoming	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*	9*

* State with cutoffs occurring in the middle of the month.

Appendix B

CORRELATION MATRIX OF THE TWELVE PREDICTOR VARIABLES

TABLE 41

Correlations for the Twelve Measures (N = 27,807) for Age Nine Combined for the Mathematics, Science and Reading Assessments

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.260	1.000				
3 Sex	-.034	.009	1.000			
4 Parental Ed. High	-.016	-.001	.037	1.000		
5 Parental Ed. Low	.015	-.028	-.045	-.596	1.000	
6 Type of Community H	-.017	-.118	-.002	.102	-.048	1.000
7 Type of Community L	.017	.073	.005	-.079	.044	-.143
8 Home Environment H	-.030	-.025	.046	.174	-.165	.089
9 Home Environment L	.032	.035	-.048	-.177	.186	-.065
10 Northeast	-.142	-.441	.003	.030	-.023	.184
11 Southeast	.024	.139	-.011	-.030	.015	-.124
12 Chronological Age	.903	-.136	-.039	-.014	.024	.012

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.048	1.000				
9 Home Environment L	.072	-.464	1.000			
10 Northeast	-.082	.068	-.065	1.000		
11 Southeast	.024	-.042	.049	-.313	1.000	
12 Chronological Age	-.014	-.022	.022	.068	.039	1.000

TABLE 42

Correlations for the Twelve Measures (N = 32,923) for Age Thirteen Combined for the Mathematics, Science and Reading Assessments

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.241	1.000				
3 Sex	-.013	.009	1.000			
4 Parental Ed. High	-.004	-.025	.029	1.000		
5 Parental Ed. Low	-.007	.003	-.026	-.435	1.000	
6 Type of Community H	-.011	-.087	.013	.173	-.077	1.000
7 Type of Community L	.049	.154	.004	-.089	.050	-.143
8 Home Environment H	-.020	-.003	.010	.222	-.208	.069
9 Home Environment L	.008	.013	-.021	-.164	.208	-.063
10 Northeast	-.137	-.461	-.003	-.011	-.013	.008
11 Southeast	.015	.117	-.003	-.043	.071	-.119
12 Chronological Age	.902	-.156	-.018	.000	-.004	-.006

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.043	1.000				
9 Home Environment L	.049	-.461	1.000			
10 Northeast	-.158	.030	-.049	1.000		
11 Southeast	.034	-.033	.059	-.311	1.000	
12 Chronological Age	-.017	-.021	.006	.081	.037	1.000

TABLE 43

Correlations for the Twelve Measures (N = 36,256) for Age Seventeen Combined for the Mathematics, Science and Reading Assessments

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.234	1.000				
3 Sex	-.018	.021	1.000			
4 Parental Ed. High	.007	-.024	.018	1.000		
5 Parental Ed. Low	-.009	.028	-.030	-.397	1.000	
6 Type of Community H	-.010	-.087	-.004	.138	-.073	1.000
7 Type of Community L	.031	.130	-.002	-.099	.050	-.135
8 Home Environment H	.008	-.028	.022	.182	-.175	.026
9 Home Environment L	-.002	.026	-.009	-.118	.129	-.001
10 Northeast	-.100	-.436	-.013	.014	-.015	.046
11 Southeast	.002	.144	-.008	-.042	.079	-.065
12 Chronological Age	.901	-.167	-.029	.011	-.012	.015

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.019	1.000				
9 Home Environment L	.003	-.495	1.000			
10 Northeast	-.083	.036	-.044	1.000		
11 Southeast	-.018	-.005	-.004	-.240	1.000	
12 Chronological Age	-.025	-.003	.006	.115	.017	1.000

TABLE 44

Correlations for the Twelve Measures (N = 6,849) for the Age Nine Mathematics Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.272	1.000				
3 Sex	-.042	.005	1.000			
4 Parental Ed. High	.009	.038	.052	1.000		
5 Parental Ed. Low	.007	-.061	-.063	-.620	1.000	
6 Type of Community H	.012	-.073	-.003	.124	-.077	1.000
7 Type of Community L	.022	.103	-.008	-.075	.047	-.133
8 Home Environment H	-.010	.024	.066	.154	.153	.120
9 Home Environment L	.033	-.024	-.078	-.184	.193	-.103
10 Northeast	-.121	-.384	.006	.018	-.009	.098
11 Southeast	.046	.247	.002	-.050	.006	-.095
12 Chronological Age	.901	-.135	-.048	-.012	.033	.025

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.041	1.000				
9 Home Environment L	.069	-.472	1.000			
10 Northeast	-.153	.069	-.081	1.000		
11 Southeast	.010	-.050	.066	-.319	1.000	
12 Chronological Age	-.022	-.021	.046	.080	.035	1.000

TABLE 45

Correlations for the Twelve Measures (N = 10,491) for the Age Thirteen Mathematics Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.261	1.000				
3 Sex	-.037	.001	1.000			
4 Parental Ed. High	-.006	-.056	.028	1.000		
5 Parental Ed. Low	-.007	.014	-.033	-.435	1.000	
6 Type of Community H	-.025	-.120	.020	.181	-.075	1.000
7 Type of Community L	.069	.172	-.014	-.067	.025	-.117
8 Home Environment H	-.016	.005	.023	.203	-.206	.067
9 Home Environment L	-.008	-.016	-.038	-.157	.214	-.051
10 Northeast	-.130	-.411	.022	.006	-.015	-.058
11 Southeast	.028	.164	-.008	-.038	.067	-.064
12 Chronological Age	.897	-.152	-.038	.009	-.005	.004

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.022	1.000				
9 Home Environment L	.028	-.469	1.000			
10 Northeast	-.199	.048	-.054	1.000		
11 Southeast	.052	.008	.047	-.300	1.000	
12 Chronological Age	-.008	-.016	-.002	.069	.049	1.000

TABLE 46

Correlations for the Twelve Measures (N = 11,675) for the Age Seventeen Mathematics Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.243	1.000				
3 Sex	-.025	.013	1.000			
4 Parental Ed. High	.008	-.013	.002	1.000		
5 Parental Ed. Low	-.011	.023	-.013	-.387	1.000	
6 Type of Community H	-.017	-.058	.012	.150	-.073	1.000
7 Type of Community L	.047	.173	-.005	-.093	.050	-.129
8 Home Environment H	.014	.062	.005	.163	-.152	-.004
9 Home Environment L	-.015	-.078	.005	-.108	.116	.037
10 Northeast	-.097	-.387	.005	.035	-.030	.030
11 Southeast	.029	.199	-.001	-.046	.067	-.070
12 Chronological Age	.896	-.177	-.033	.009	-.017	-.000

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.001	1.000				
9 Home Environment L	-.016	-.566	1.000			
10 Northeast	-.114	.058	-.055	1.000		
11 Southeast	-.024	.016	-.046	-.236	1.000	
12 Chronological Age	-.026	-.005	.009	.110	.023	1.000

TABLE 47

Correlations for the Twelve Measures (N = 8,535) for the Age Nine Science Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.256	1.000				
3 Sex	-.013	.013	1.000			
4 Parental Ed. High	-.019	-.022	.017	1.000		
5 Parental Ed. Low	.025	.004	-.035	-.563	1.000	
6 Type of Community H	-.018	-.135	.015	.041	.005	1.000
7 Type of Community L	.020	.077	.008	-.083	.057	-.155
8 Home Environment H	-.038	-.049	.027	.172	-.176	.031
9 Home Environment L	.028	.071	-.021	-.165	.200	.009
10 Northeast	-.161	-.452	.005	.034	-.043	.229
11 Southeast	-.024	-.056	-.028	-.031	.025	-.076
12 Chronological Age	.902	-.133	-.020	-.012	.026	.014

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.050	1.000				
9 Home Environment L	.054	-.469	1.000			
10 Northeast	-.045	.075	-.081	1.000		
11 Southeast	.001	-.026	.034	-.287	1.000	
12 Chronological Age	-.017	-.030	.011	.043	.065	1.000

TABLE 48

Correlations for the Twelve Measures (N = 11,400) for the Age Thirteen Science Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.225	1.000				
3 Sex	-.007	.009	1.000			
4 Parental Ed. High	.013	.015	.043	1.000		
5 Parental Ed. Low	.023	-.020	-.021	-.433	1.000	
6 Type of Community H	.005	-.081	.009	.148	-.067	1.000
7 Type of Community L	.044	.167	.008	-.142	.089	-.172
8 Home Environment H	-.024	-.005	.015	.237	-.216	.060
9 Home Environment L	.016	.023	-.019	-.164	.205	-.074
10 Northeast	-.150	-.524	-.008	-.032	-.007	-.023
11 Southeast	.005	.048	.001	-.048	.076	-.152
12 Chronological Age	.904	-.158	-.012	.007	-.014	-.020

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.052	1.000				
9 Home Environment L	.060	-.461	1.000			
10 Northeast	-.161	.030	-.063	1.000		
11 Southeast	.035	-.075	.099	-.322	1.000	
12 Chronological Age	-.033	-.024	.011	.088	.045	1.000

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TABLE 49

Correlations for the Twelve Measures (N = 14,109) for the Age Seventeen Science Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.226	1.000				
3 Sex	-.007	.021	1.000			
4 Parental Ed. High	.003	-.050	-.014	1.000		
5 Parental Ed. Low	-.001	.048	-.031	-.397	1.000	
6 Type of Community H	-.023	-.134	-.010	.123	-.071	1.000
7 Type of Community L	.055	.213	-.001	-.107	.058	-.122
8 Home Environment H	-.007	-.014	.042	.203	-.188	.028
9 Home Environment L	.011	.031	-.016	-.134	.135	-.025
10 Northeast	-.110	-.471	-.005	.020	.032	-.015
11 Southeast	-.030	.058	-.020	-.048	.103	-.065
12 Chronological Age	.908	-.152	-.018	.013	.008	.018

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.027	1.000				
9 Home Environment L	.019	-.435	1.000			
10 Northeast	-.095	.036	-.044	1.000		
11 Southeast	-.024	-.020	.026	-.233	1.000	
12 Chronological Age	-.034	-.006	.004	.111	.025	1.000

TABLE 50

Correlations for the Twelve Measures (N = 12,423) for the Age Nine Reading Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.256	1.000				
3 Sex	-.043	.007	1.000			
4 Parental Ed. High	-.028	-.002	.044	1.000		
5 Parental Ed. Low	.013	-.034	-.042	-.607	1.000	
6 Type of Community H	-.032	-.129	-.013	.128	-.066	1.000
7 Type of Community L	.010	.048	.009	-.073	.032	-.140
8 Home Environment H	-.035	-.028	.048	.183	-.166	.110
9 Home Environment L	.032	.031	-.053	-.178	.172	-.096
10 Northeast	-.142	-.464	-.002	.029	-.015	.198
11 Southeast	.046	.222	-.005	-.018	.012	-.173
12 Chronological Age	.905	-.138	-.048	-.019	.018	.002

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.045	1.000				
9 Home Environment L	.083	-.454	1.000			
10 Northeast	-.069	.063	-.044	1.000		
11 Southeast	.051	-.052	.052	-.325	1.000	
12 Chronological Age	-.005	-.020	.019	.076	.022	1.000

TABLE 51

Correlations for the Twelve Measures (N = 11,032) for the Age Thirteen Reading Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.236	1.000				
3 Sex	.004	.016	1.000			
4 Parental Ed. High	-.019	-.036	.016	1.000		
5 Parental Ed. Low	.009	.016	-.023	-.438	1.000	
6 Type of Community H	-.018	-.076	.012	.193	-.088	1.000
7 Type of Community L	.033	.117	.017	-.083	.034	-.141
8 Home Environment H	-.018	-.006	-.007	.225	-.202	.081
9 Home Environment L	.016	.031	-.005	-.169	.205	-.063
10 Northeast	-.132	-.454	-.021	-.008	-.017	.082
11 Southeast	.012	.142	-.002	-.043	.070	-.132
12 Chronological Age	.904	-.159	-.004	-.015	.008	-.003

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.049	1.000				
9 Home Environment L	.056	-.452	1.000			
10 Northeast	-.120	.014	-.029	1.000		
11 Southeast	.016	-.032	.031	-.311	1.000	
12 Chronological Age	-.010	-.024	.011	.083	.020	1.000

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TABLE 52

Correlations for the Twelve Measures (N = 10,472) for the Age Seventeen Reading Assessment

Variable	1	2	3	4	5	6
1 Relative Age	1.000					
2 Class Age	.231	1.000				
3 Sex	-.022	.031	1.000			
4 Parental Ed. High	.011	-.001	.039	1.000		
5 Parental Ed. Low	-.017	.007	.046	-.408	1.000	
6 Type of Community H	.012	-.064	-.012	.141	-.075	1.000
7 Type of Community L	-.010	-.003	.000	-.097	.039	-.158
8 Home Environment H	.012	.026	.018	.187	-.199	.061
9 Home Environment L	.015	.006	-.024	-.135	.169	-.035
10 Northeast	-.097	-.452	-.042	-.014	.016	.128
11 Southeast	.010	.187	-.001	-.032	.067	-.060
12 Chronological Age	.899	-.177	-.040	.011	-.013	.030

Variable	7	8	9	10	11	12
7 Type of Community L	1.000					
8 Home Environment H	-.040	1.000				
9 Home Environment L	.029	-.440	1.000			
10 Northeast	-.048	-.003	-.010	1.000		
11 Southeast	-.006	-.003	.015	-.250	1.000	
12 Chronological Age	-.017	-.002	.014	.122	.003	1.000

Appendix C

CHRONOLOGICAL AGE REGRESSION ANALYSES INFORMATION

This appendix contains the summary tables of the multiple regression analyses using the chronological age variable for the combined, mathematics, science and reading samples at ages nine, thirteen and seventeen. Accompaning each table is a figure graphically displaying the relationship of academic achievement with the chronological age and class age variables. Any questions about the descriptions of these tables and figures is answered in Chapter Four.

TABLE 53

Summary of Multiple Regression Using Chronological Age for Age Nine Combined for the Mathematics, Science and Reading Assessments

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.050	28.4	.01	.000	.000	.013	27.6	.01
Chronological Age	-.017	37.5	.01	.004	.004	-.063	27.6	.01
Home Environment Low	-.264	163.1	.01	.048	.048	-.211	234.4	.01
Parental Education Low	-.242	137.7	.01	.078	.078	-.211	294.8	.01
Type of Community High	.234	88.6	.01	.089	.089	.122	272.2	.01
Home Environment High	.206	119.8	.01	.098	.098	.201	251.5	.01
Southeast	-.148	51.5	.01	.103	.102	-.094	227.6	.01
Parental Education High	.157	56.4	.01	.107	.106	.199	207.4	.01
Type of Community Low	-.118	23.1	.01	.108	.108	-.075	187.4	.01
Northeast	.094	19.9	.01	.110	.109	.073	170.9	.01
Sex	-.004	.3	ns	.110	.109	.017	155.4	.01

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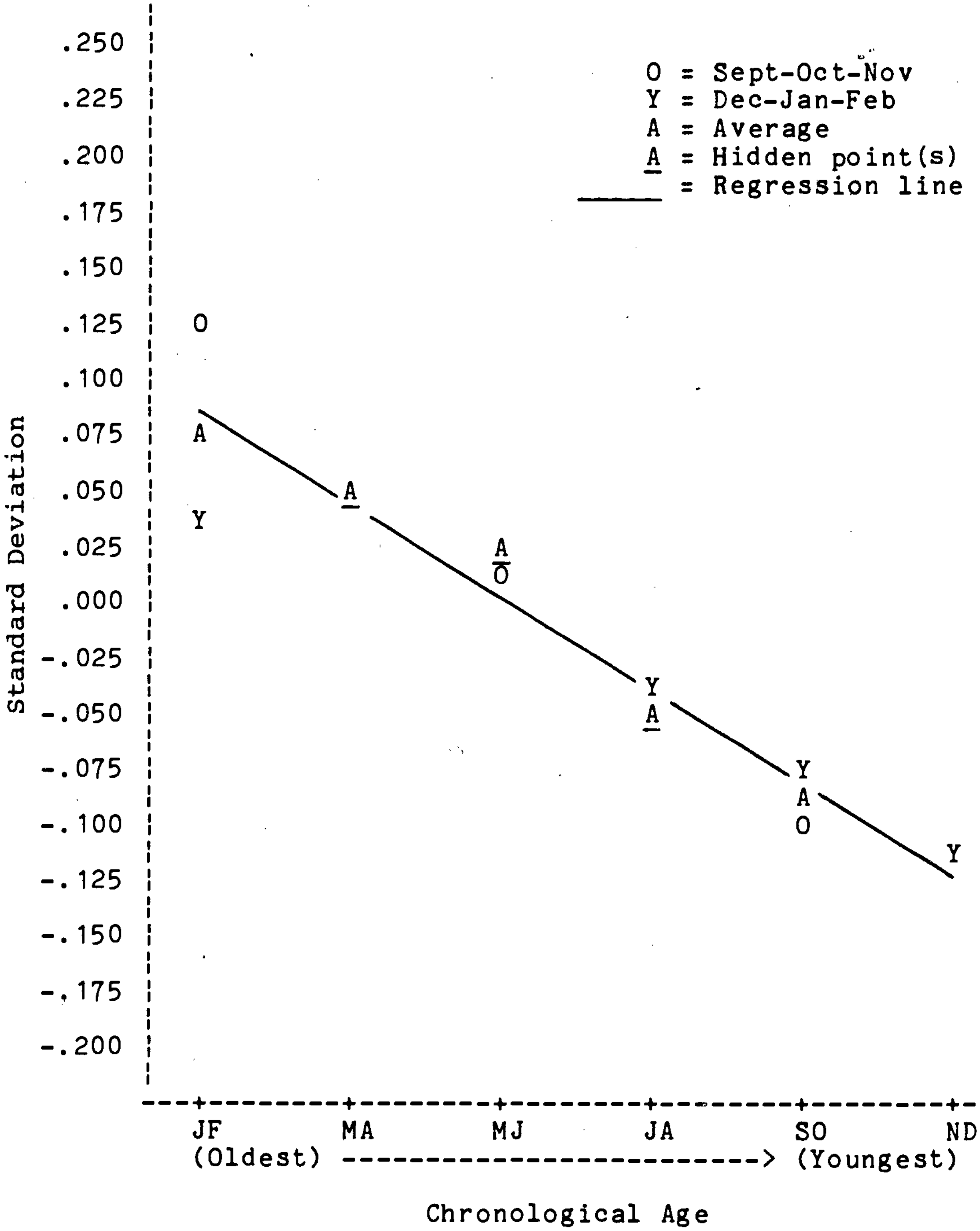

Figure 15. Combined mathematics, science and reading achievement by chronological age among nine-year-olds.

TABLE 54

Summary of Multiple Regression Using Chronological Age for Age Thirteen Combined for the Mathematics, Science and Reading Assessments

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.006	.5	ns	.001		-.025	11.6	.01
Chronological Age	-.007	7.2	.01	.001	.001	-.240	11.6	.01
Parental Education High	.339	398.6	.01	.069	.069	.261	395.6	.01
Home Environment High	.234	177.4	.01	.094	.094	.212	414.7	.01
Parental Education Low	-.233	114.0	.01	.103	.102	-.213	364.6	.01
Southeast	-.148	56.2	.01	.108	.108	-.097	322.1	.01
Home Environment Low	-.233	76.1	.01	.113	.112	-.183	289.3	.01
Type of Community High	.162	50.5	.01	.116	.115	.115	261.1	.01
Type of Community Low	-.104	19.6	.01	.117	.117	-.076	234.9	.01
Sex	.023	9.3	.01	.118	.117	.034	212.4	.01
Northeast	.058	8.7	.01	.118	.117	.052	194.0	.01

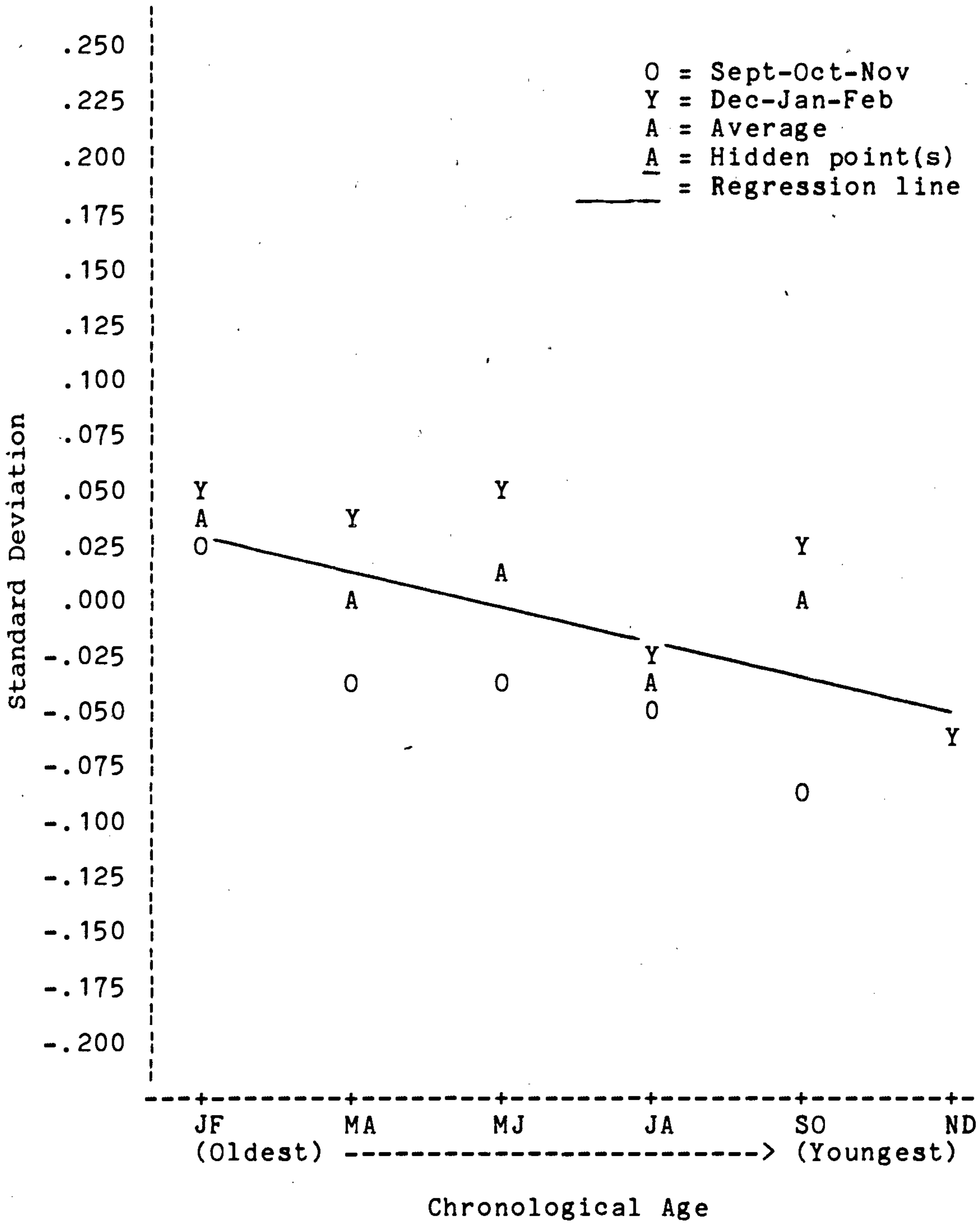

Figure 16. Combined mathematics, science and reading achievement by chronological age among thirteen-year-olds.

TABLE 55

Summary of Multiple Regression Using Chronological Age for Age Seventeen Combined for the Mathematics, Science and Reading Assessments

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.003	.2	ns	.001		-.031	8.4	.01
Chronological Age	.002	.4	ns	.001	.001	.009	8.4	.01
Parental Education High	.342	461.8	.01	.058	.058	.239	354.9	.01
Home Environment High	.202	124.6	.01	.075	.075	.173	354.2	.01
Sex	.091	158.2	.01	.084	.084	.098	318.1	.01
Parental Education Low	-.213	82.7	.01	.089	.089	-.177	282.9	.01
Type of Community High	.168	49.7	.01	.092	.092	.092	252.0	.01
Home Environment Low	-.200	52.6	.01	.095	.095	-.139	228.0	.01
Northeast	.100	26.0	.01	.097	.097	.064	207.8	.01
Southeast	-.111	30.6	.01	.099	.098	-.067	190.1	.01
Type of Community Low	-.102	22.5	.01	.100	.099	-.067	175.1	.01

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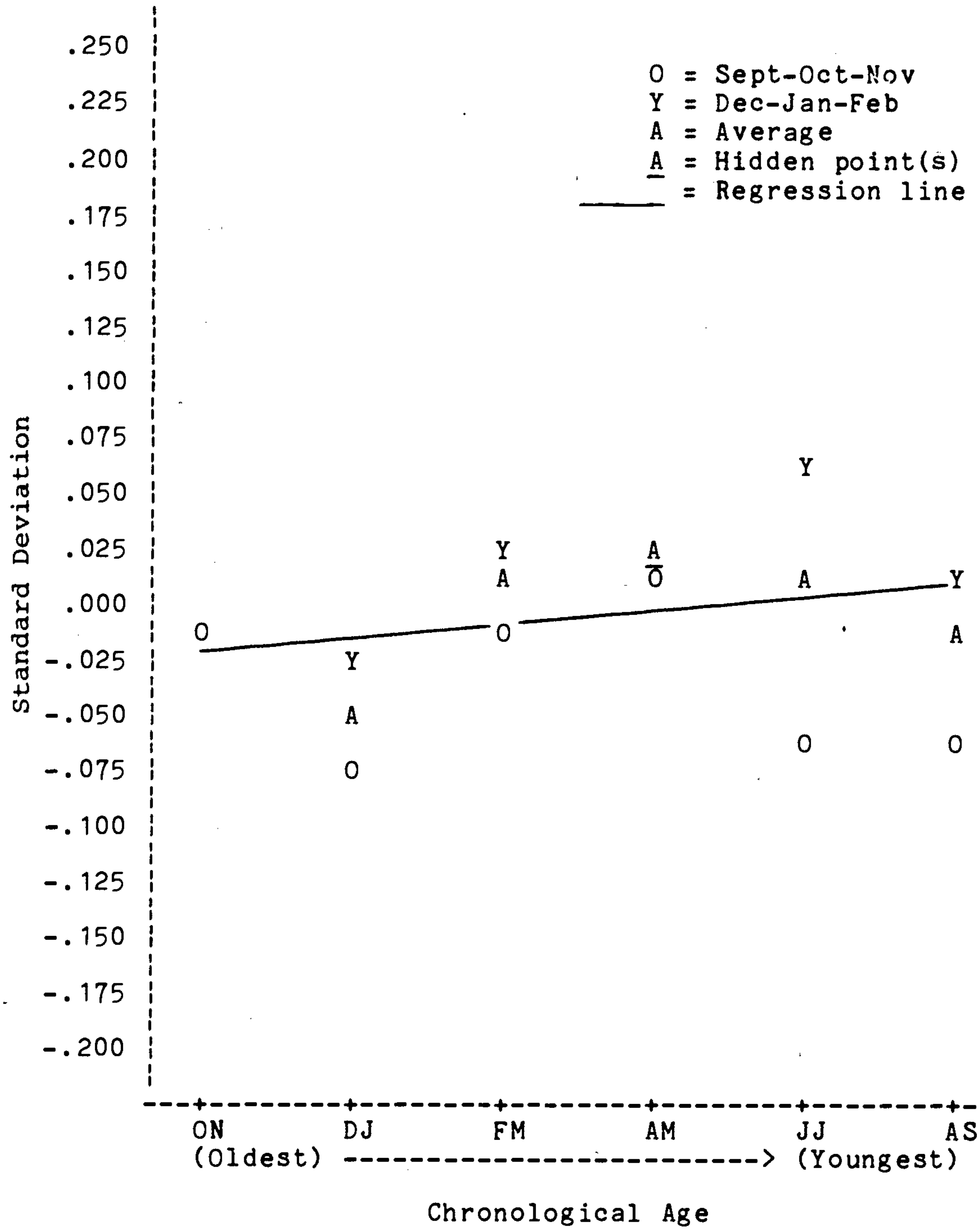

Figure 17. Combined mathematics, science and reading achievement by chronological age among seventeen-year-olds.

TABLE 56

Summary of Multiple Regression Using Chronological Age for the Age Nine Mathematics Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.102	29.8	.01	.002		.050	10.9	.01
Chronological Age	-.016	9.9	.01	.006	.006	-.068	10.9	.01
Home Environment Low	-.322	58.6	.01	.072	.071	-.260	88.5	.01
Parental Education Low	-.237	33.3	.01	.106	.105	-.235	101.7	.01
Type of Community High	.409	69.4	.01	.132	.131	.193	104.0	.01
Northeast	.224	29.2	.01	.145	.143	.118	96.3	.01
Home Environment High	.201	30.5	.01	.153	.151	.229	88.1	.01
Parental Education High	.178	18.3	.01	.158	.156	.230	80.2	.01
Southeast	-.161	17.0	.01	.162	.160	-.110	73.3	.01
Sex	-.043	7.5	.01	.164	.161	.075	66.9	.01
Type of Community Low	-.133	6.9	.01	.166	.163	-.090	61.5	.01

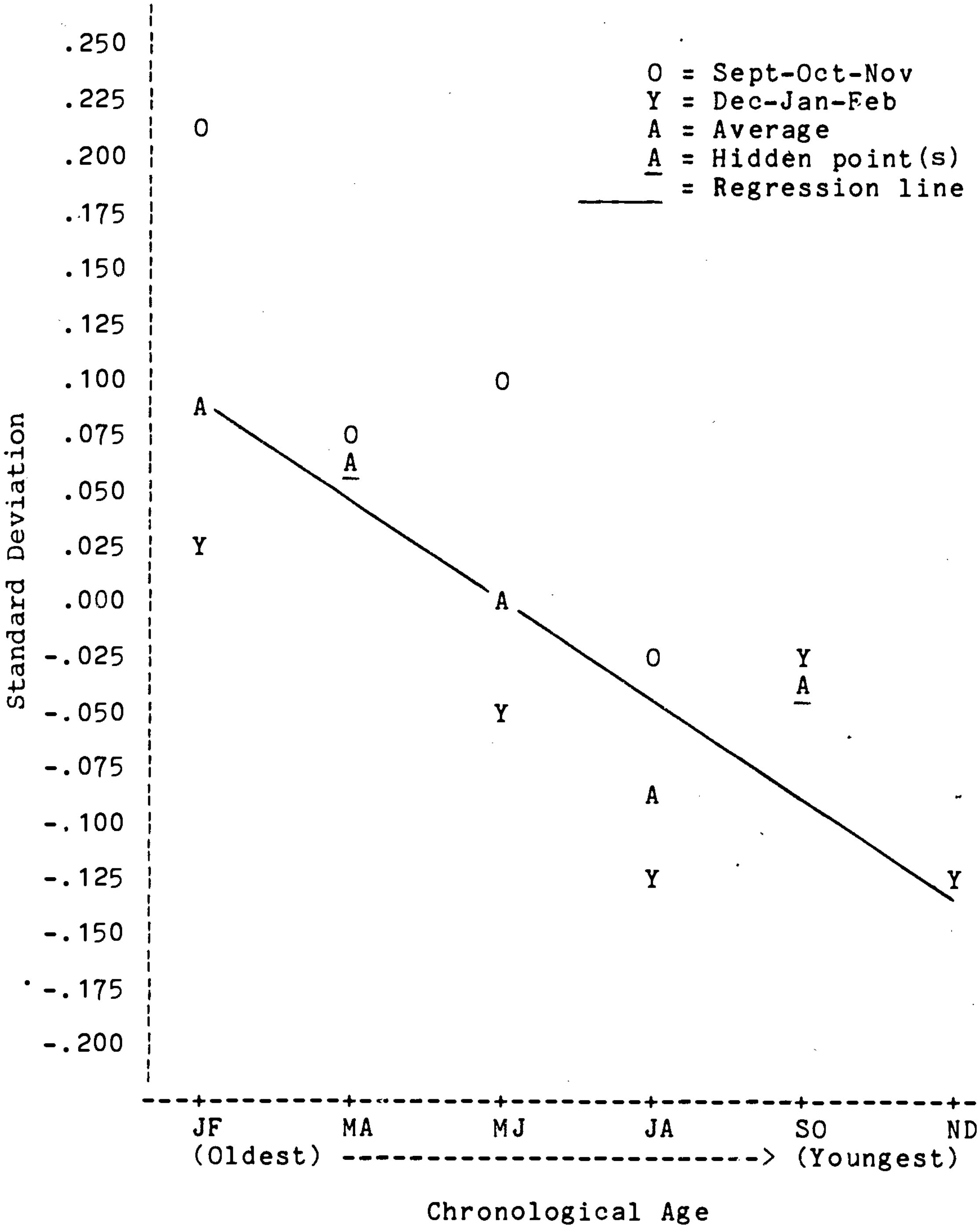

Figure 18. Mathematics achievement by chronological age among nine-year-olds.

TABLE 57

Summary of Multiple Regression Using Chronological Age for the Age Thirteen Mathematics Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over- all F	p
Class Age	.015	1.0	ns	.002		-.049	8.4	.01
Chronological Age	-.006	1.7	ns	.003	.003	-.020	8.4	.01
Parental Education High	.373	163.1	.01	.080	.079	.279	151.4	.01
Home Environment High	.196	41.6	.01	.100	.099	.195	145.1	.01
Southeast	-.261	61.9	.01	.117	.116	-.146	139.0	.01
Parental Education Low	-.260	47.9	.01	.126	.125	-.231	126.2	.01
Home Environment Low	-.217	22.7	.01	.131	.129	-.180	112.4	.01
Type of Community High	.223	24.9	.01	.134	.133	.124	101.6	.01
Northeast	.136	15.6	.01	.138	.136	.099	92.9	.01
Sex	.043	11.3	.01	.140	.138	.061	84.9	.01
Type of Community Low	-.110	6.9	.01	.141	.139	-.077	77.9	.01

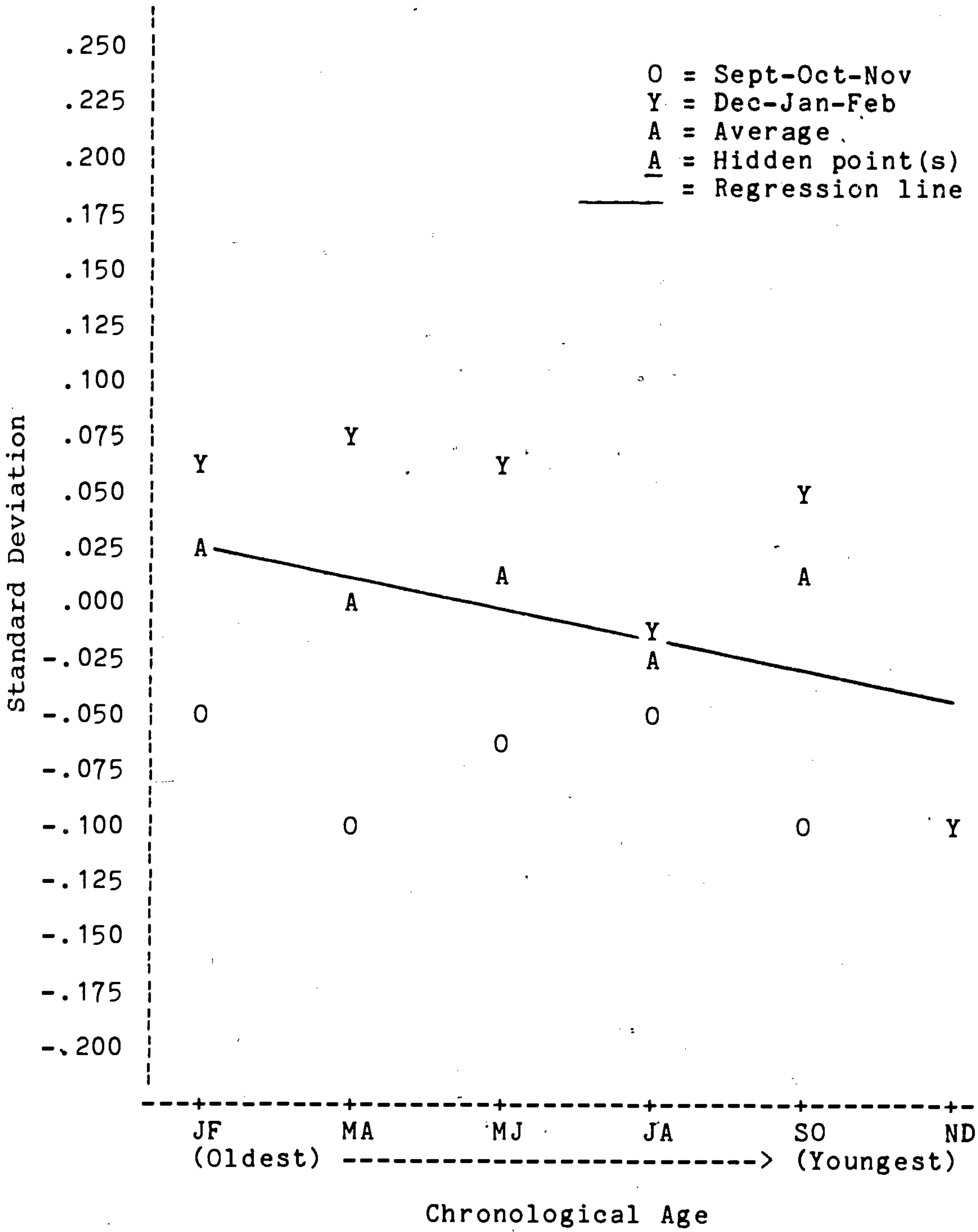

Figure 19. Mathematics achievement by chronological age among thirteen-year-olds.

TABLE 58

Summary of Multiple Regression Using Chronological Age for the Age Seventeen Mathematics Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.004	.1	ns	.001		-.036	3.8	ns
Chronological Age	.002	.1	ns	.001	.001	.008	3.8	ns
Parental Education High	.383	201.9	.01	.071	.070	.264	147.9	.01
Sex	.132	116.5	.01	.089	.088	.135	142.3	.01
Home Environment Low	-.207	26.1	.01	.102	.101	-.138	132.2	.01
Type of Community High	.291	52.6	.01	.112	.111	.135	122.0	.01
Parental Education Low	-.244	35.5	.01	.118	.117	-.188	111.4	.01
Northeast	.142	17.5	.01	.122	.121	.095	101.7	.01
Southeast	-.155	21.8	.01	.125	.124	-.087	92.8	.01
Home Environment High	.130	17.7	.01	.128	.127	.152	85.5	.01
Type of Community Low	-.132	11.7	.01	.130	.128	-.081	78.9	.01

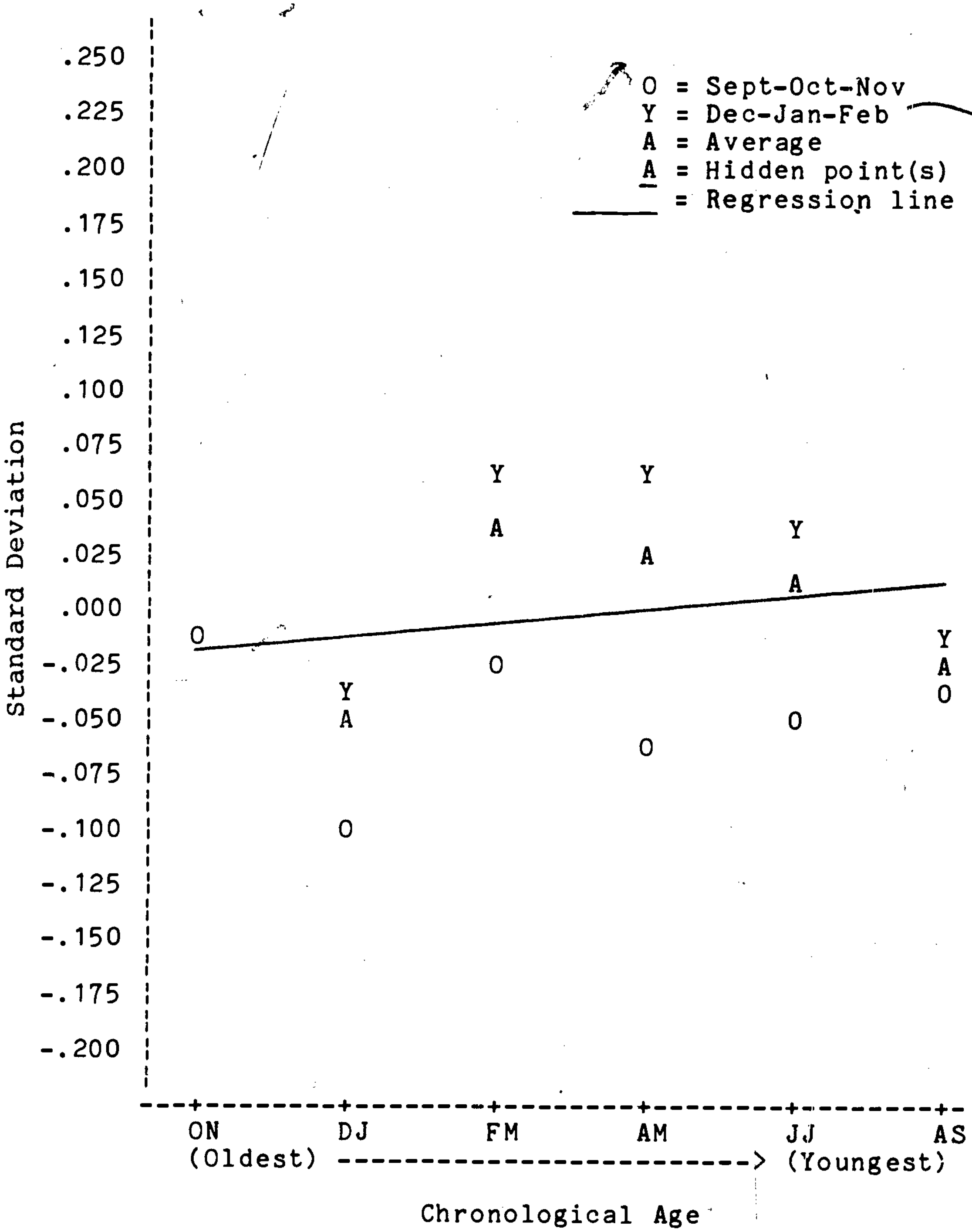

Figure 20. Mathematics achievement by chronological age among seventeen-year-olds.

TABLE 59

Summary of Multiple Regression Using Chronological Age for the Age Nine Science Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.019	1.3	ns	.000		.006	12.6	.01
Chronological Age	-.020	16.6	.01	.006	.005	-.077	12.6	.01
Parental Education Low	-.297	70.0	.01	.060	.060	-.235	91.1	.01
Home Environment High	.234	46.8	.01	.089	.088	.210	104.3	.01
Sex	.121	73.0	.01	.105	.104	.138	99.8	.01
Type of Community High	.314	48.2	.01	.118	.116	.116	94.6	.01
Home Environment Low	-.236	44.0	.01	.127	.126	-.206	88.8	.01
Southeast	-.207	30.6	.01	.134	.132	-.109	82.2	.01
Parental Education High	.147	16.0	.01	.137	.136	.201	75.3	.01
Type of Community Low	-.129	10.1	.01	.139	.137	-.083	68.9	.01
Northeast	-.033	1.7	ns	.140	.137	.051	62.7	.01

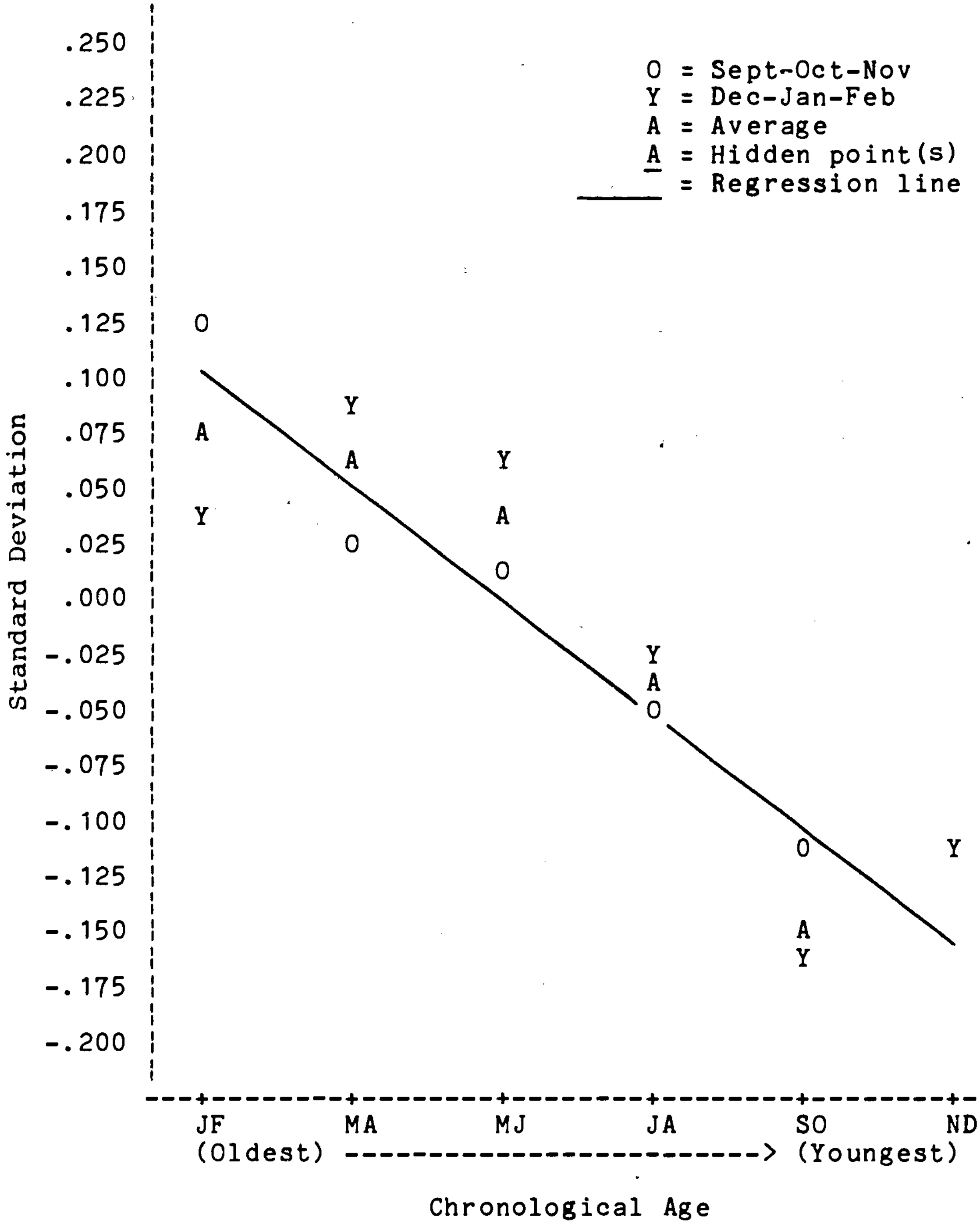

Figure 21. Science achievement by chronological age among nine-year-olds.

TABLE 60

Summary of Multiple Regression Using Chronological Age for the Age Thirteen Science Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.033	4.4	.05	.000		.008	2.4	ns
Chronological Age	-.008	3.1	ns	.001	.001	-.030	2.4	ns
Parental Education High	.331	128.3	.01	.070	.069	.262	129.8	.01
Sex	.177	191.3	.01	.102	.101	.190	147.1	.01
Home Environment High	.243	65.2	.01	.127	.126	.219	151.5	.01
Parental Education Low	-.232	37.9	.01	.135	.134	-.212	135.3	.01
Type of Community High	.193	6.9	.01	.140	.139	.116	121.2	.01
Home Environment Low	-.205	20.7	.01	.144	.143	-.181	109.5	.01
Northeast	.099	7.6	.01	.147	.145	.036	99.2	.01
Southeast	-.070	4.1	.05	.147	.146	-.083	89.7	.01
Type of Community Low	-.014	.1	ns	.147	.146	-.059	81.6	.01

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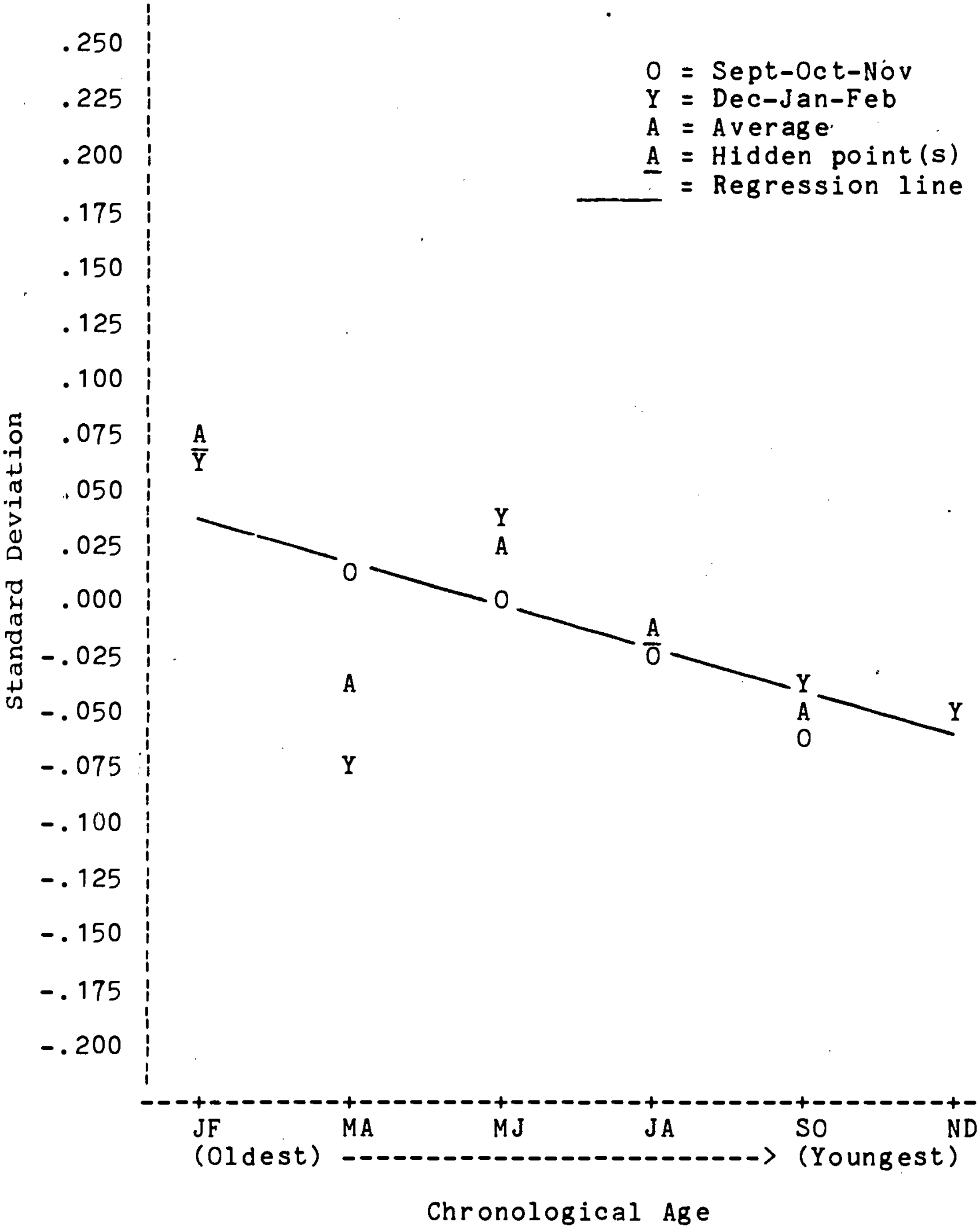

Figure 22. Science achievement by chronological age among thirteen-year-olds.

TABLE 61

Summary of Multiple Regression Using Chronological Age for the Age Seventeen Science Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.005	.2	ns	.001		-.038	5.0	.05
Chronological Age	-.003	.7	ns	.002	.001	-.007	5.0	.05
Parental Education High	.307	139.1	.01	.050	.050	.222	111.1	.01
Sex	.195	275.3	.01	.091	.091	.206	158.8	.01
Home Environment High	.228	61.0	.01	.112	.111	.193	158.8	.01
Home Environment Low	-.295	33.8	.01	.117	.116	-.158	139.4	.01
Parental Education Low	-.189	24.6	.01	.121	.120	-.169	124.0	.01
Northeast	.117	12.8	.01	.123	.122	.067	110.9	.01
Southeast	-.087	6.6	.05	.124	.123	-.066	99.4	.01
Type of Community Low	-.087	5.6	.05	.125	.124	-.058	90.2	.01
Type of Community High	.073	3.1	ns	.126	.124	.052	82.3	.01

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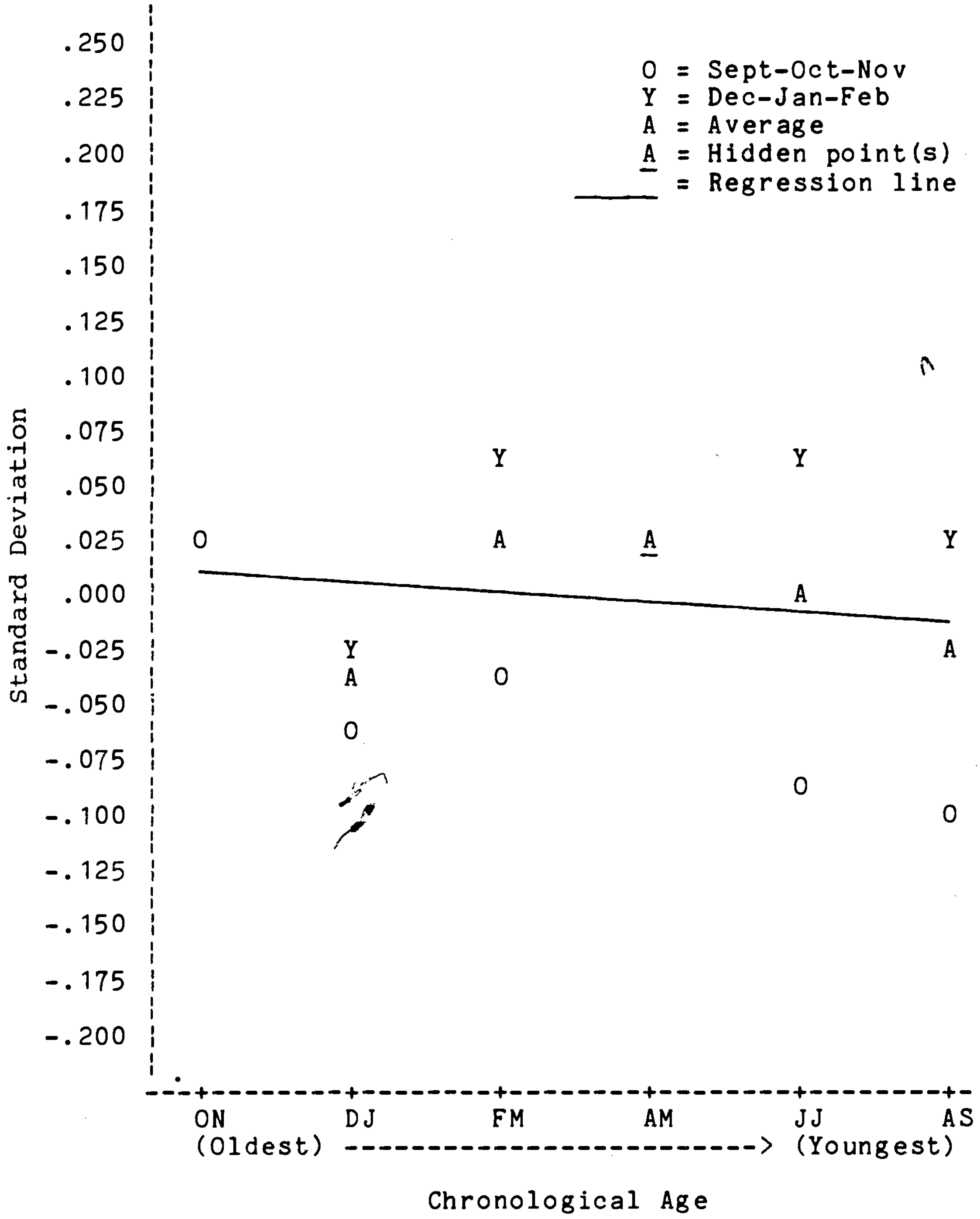

Figure 23. Science achievement by chronological age among seventeen-year-olds.

TABLE 62

Summary of Multiple Regression Using Chronological Age for the Age Nine Reading Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.032	5.0	.05	.000		-.003	8.2	.01
Chronological Age	-.016	14.9	.01	.003	.002	-.050	8.2	.01
Home Environment Low	-.259	67.9	.01	.038	.038	-.189	81.9	.01
Parental Education Low	-.197	39.1	.01	.061	.060	-.181	100.2	.01
Sex	-.118	94.9	.01	.074	.073	-.098	99.3	.01
Home Environment High	.189	45.2	.01	.082	.082	.179	92.9	.01
Parental Education High	.167	28.0	.01	.087	.086	.181	84.7	.01
Southeast	-.112	11.9	.01	.091	.090	-.074	77.4	.01
Northeast	.098	10.1	.01	.093	.091	.065	70.4	.01
Type of Community High	.097	6.9	.01	.094	.093	.089	64.3	.01
Type of Community Low	-.093	5.7	.05	.095	.093	-.061	59.0	.01

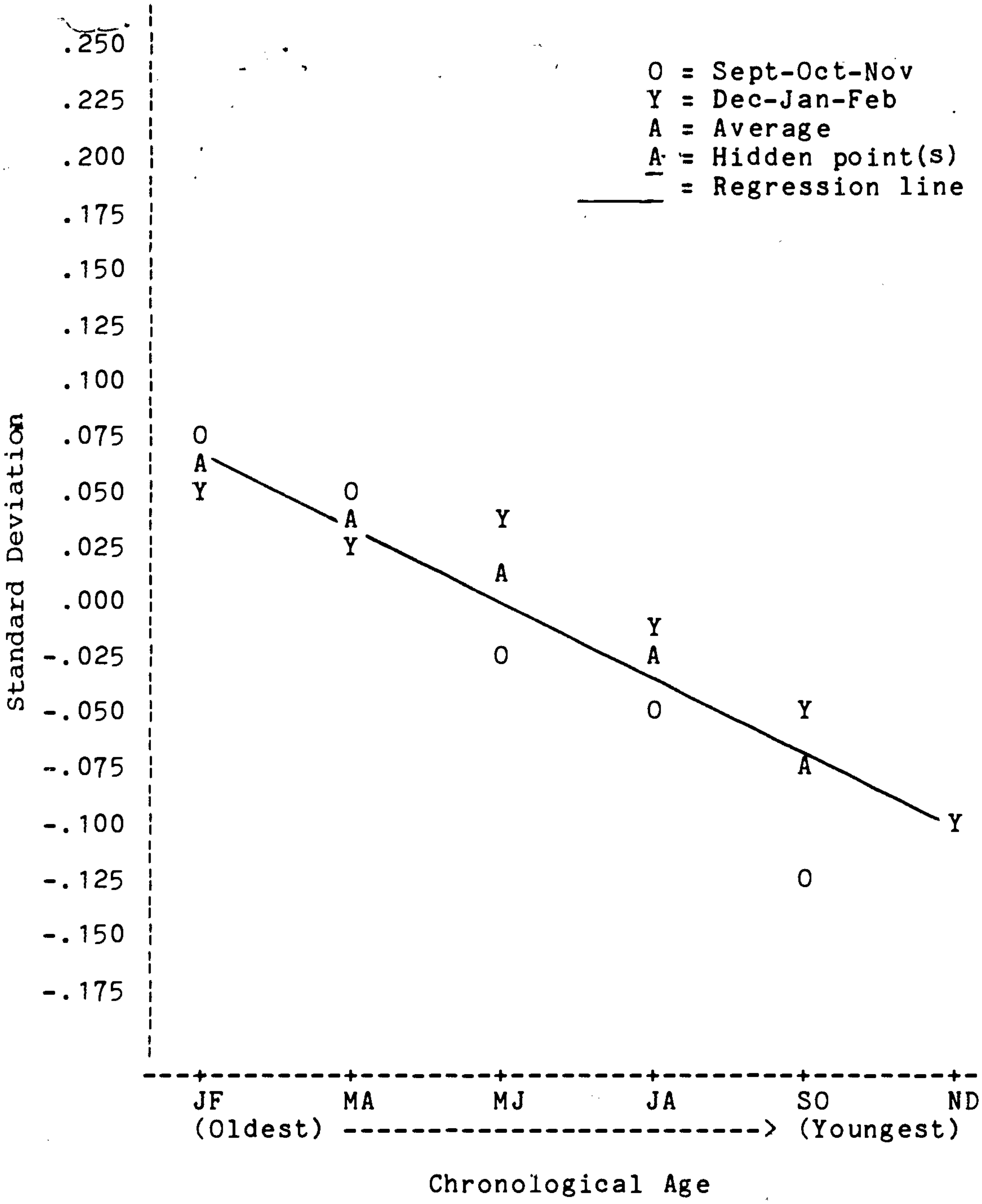

Figure 24. Reading achievement by chronological age among nine-year-olds.

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TABLE 63

Summary of Multiple Regression Using Chronological Age for the Age Thirteen Reading Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	-.016	1.2	ns	.001		-.036	5.8	.05
Chronological Age	-.006	1.8	ns	.002	.002	-.022	5.8	.05
Parental Education High	.300	108.1	.01	.060	.060	.243	117.8	.01
Home Environment High	.262	77.0	.01	.090	.089	.223	136.2	.01
Sex	-.143	129.3	.01	.110	.109	-.140	136.0	.01
Parental Education Low	-.218	35.2	.01	.117	.116	-.198	121.7	.01
Home Environment Low	-.273	33.7	.01	.123	.122	-.189	110.0	.01
Type of Community Low	-.184	20.0	.01	.126	.125	-.094	99.7	.01
Type of Community High	.134	12.5	.01	.129	.127	.110	90.5	.01
Southeast	-.096	7.9	.01	.130	.128	-.063	82.3	.01
Northeast	-.022	.5	ns	.130	.128	.025	74.8	.01

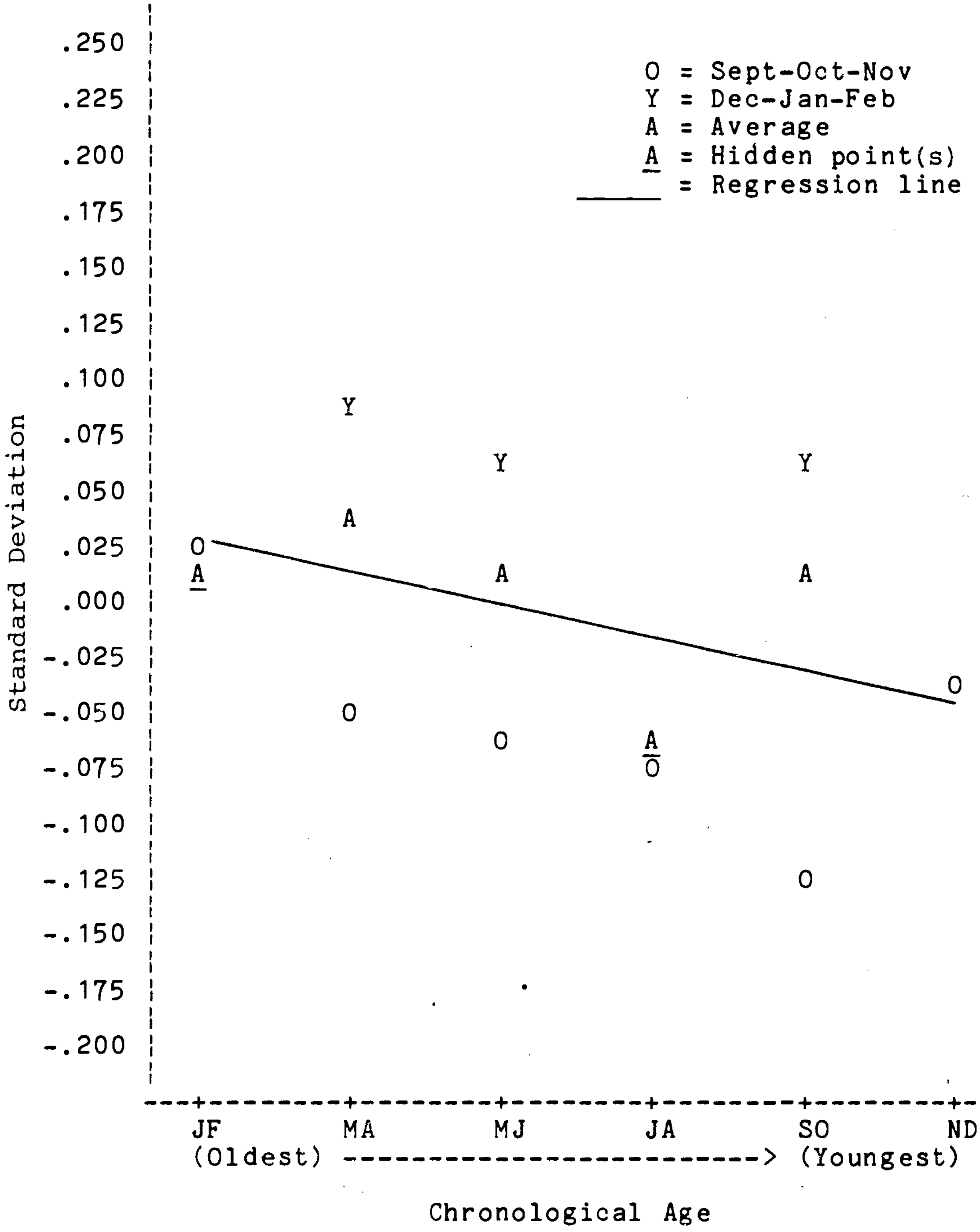

Figure 25. Reading achievement by chronological age among thirteen-year-olds.

TABLE 64

Summary of Multiple Regression Using Chronological Age for the Age Seventeen Reading Assessment

Variable	B	F	p	R Square	Adj. R Sq.	Simple r	Over-all F	p
Class Age	.003	.0	ns	.000		-.017	2.8	ns
Chronological Age	.007	2.8	ns	.001	.001	.031	2.8	ns
Parental Education High	.336	131.9	.01	.055	.054	.232	100.6	.01
Home Environment High	.243	52.8	.01	.074	.073	.178	103.8	.01
Sex	-.085	40.9	.01	.080	.079	-.074	91.4	.01
Parental Education Low	-.207	23.9	.01	.085	.084	-.173	81.2	.01
Type of Community High	.134	10.0	.01	.088	.086	.091	71.8	.01
Home Environment Low	-.193	10.8	.01	.090	.088	-.132	64.3	.01
Southeast	-.081	4.7	.05	.091	.090	-.046	57.8	.01
Type of Community Low	-.084	5.3	.05	.092	.090	-.064	52.7	.01
Northeast	.031	.8	ns	.092	.090	.030	47.9	.01

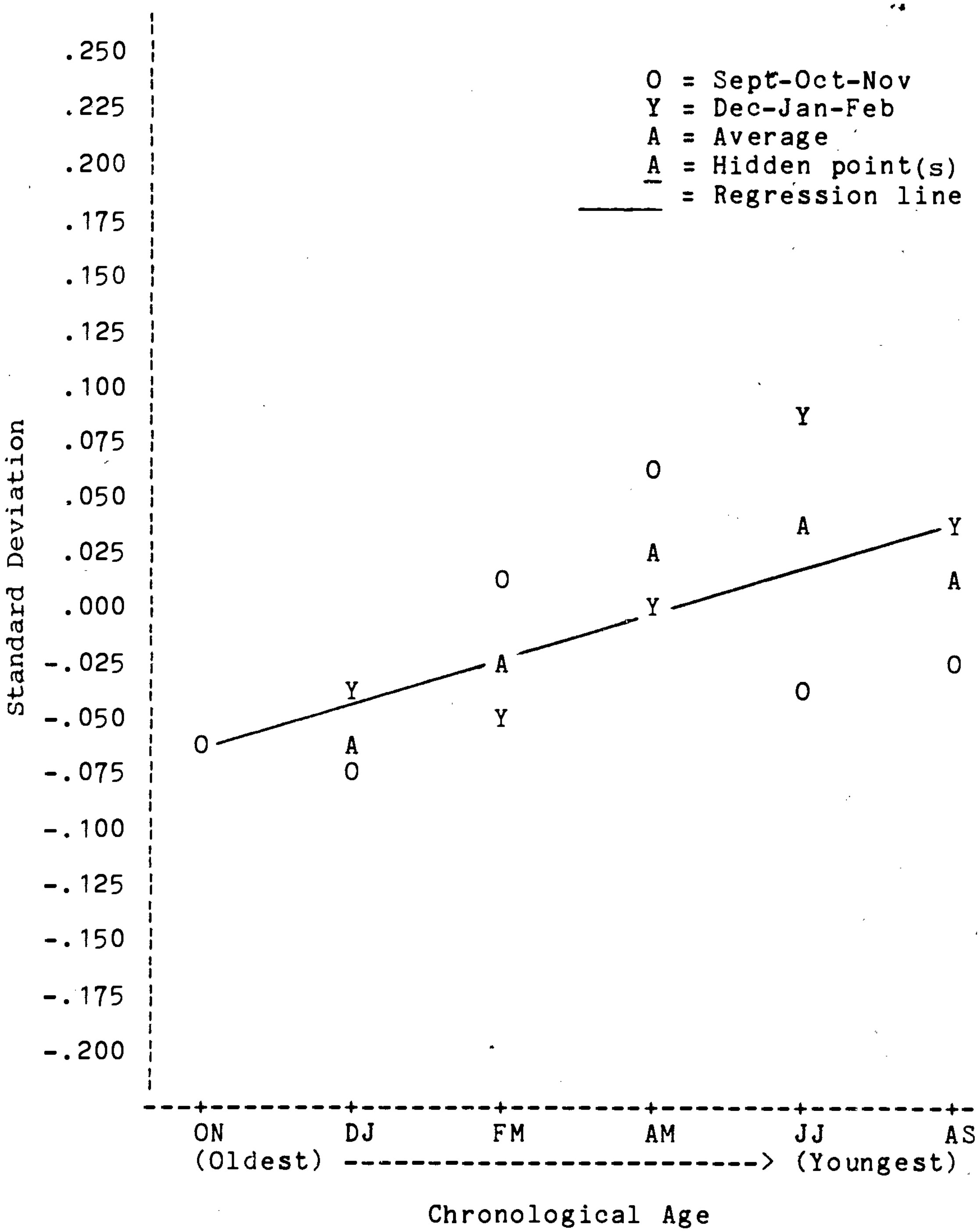

Figure 26. Reading achievement by chronological age among seventeen-year-olds.

Appendix D

GRAPHIC DISPLAY OF THE RELATIONSHIP OF RELATIVE AGE WITH HOME ENVIRONMENT, PARENTAL EDUCATION AND TYPE OF COMMUNITY

This appendix contains figures graphically displaying the relationship of academic achievement with relative age and home environment, parental education or type of community information. Figures exist for the nine, thirteen and seventeen-year-old samples combined at each age for the mathematics, science and reading assessments. Any questions about the descriptions of these tables and figures is answered in Chapter Four.

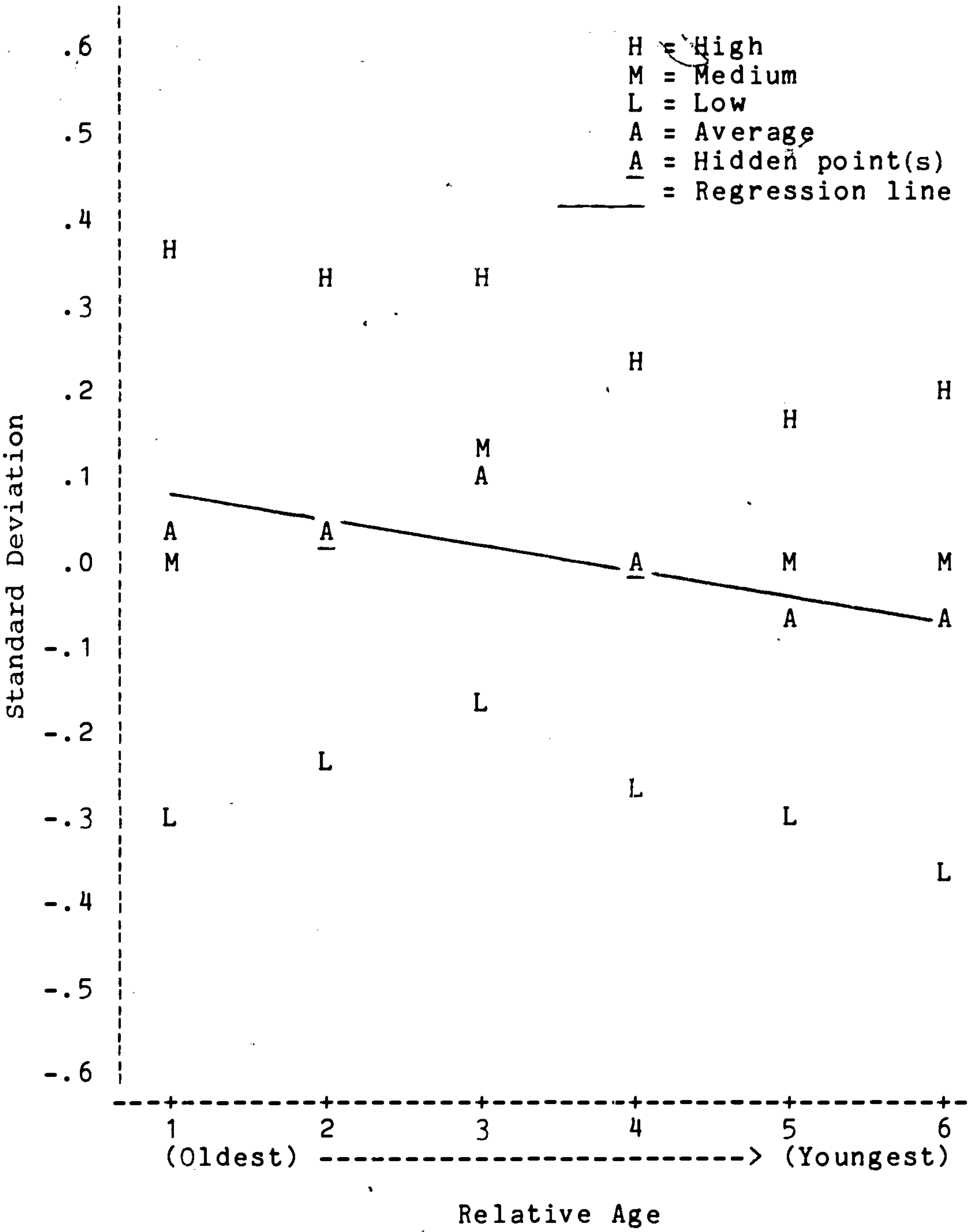

Figure 27. Combined mathematics, science and reading achievement by relative age and parental education among nine-year-olds.

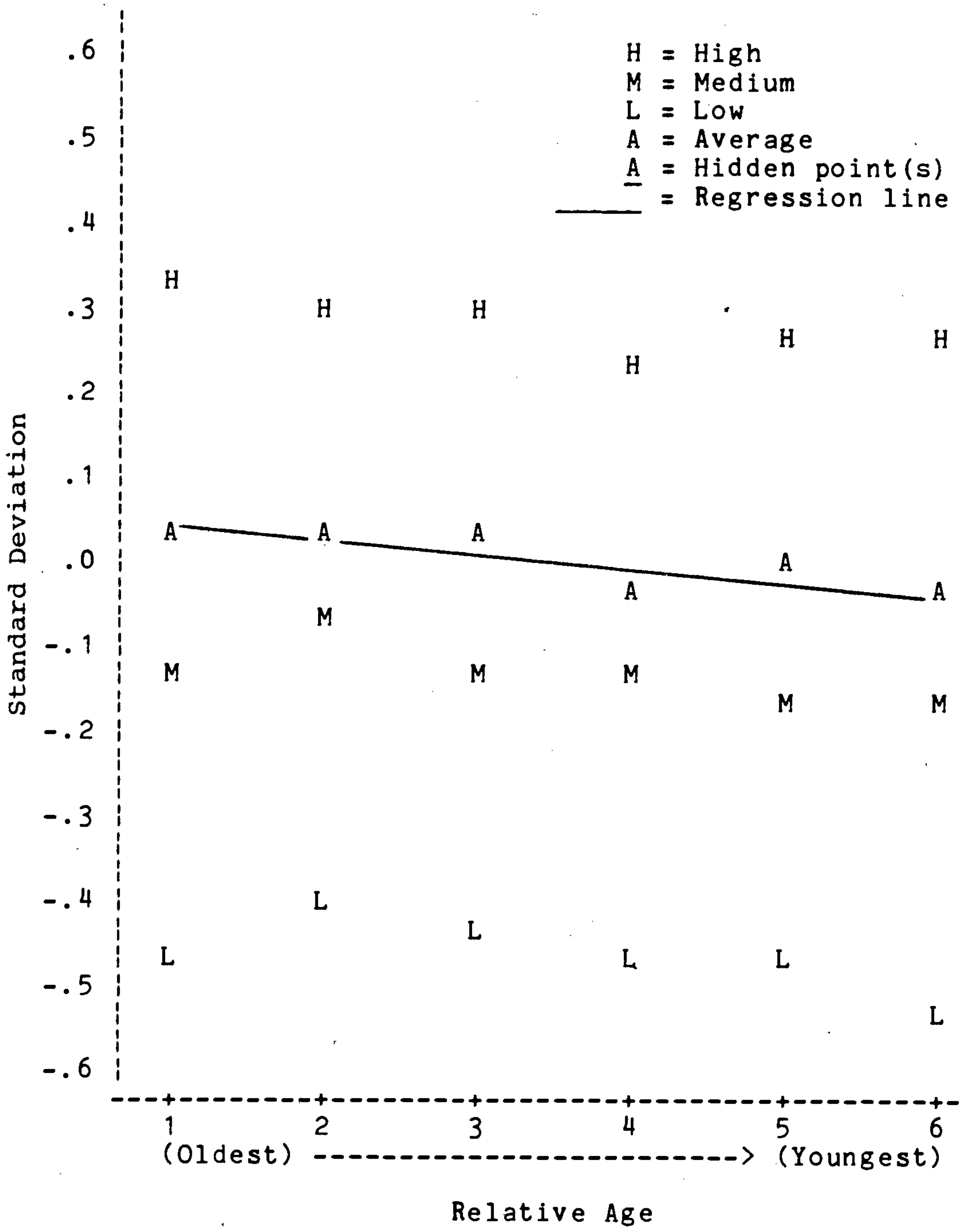

Figure 28. Combined mathematics, science and reading achievement by relative age and parental education among thirteen-year-olds.

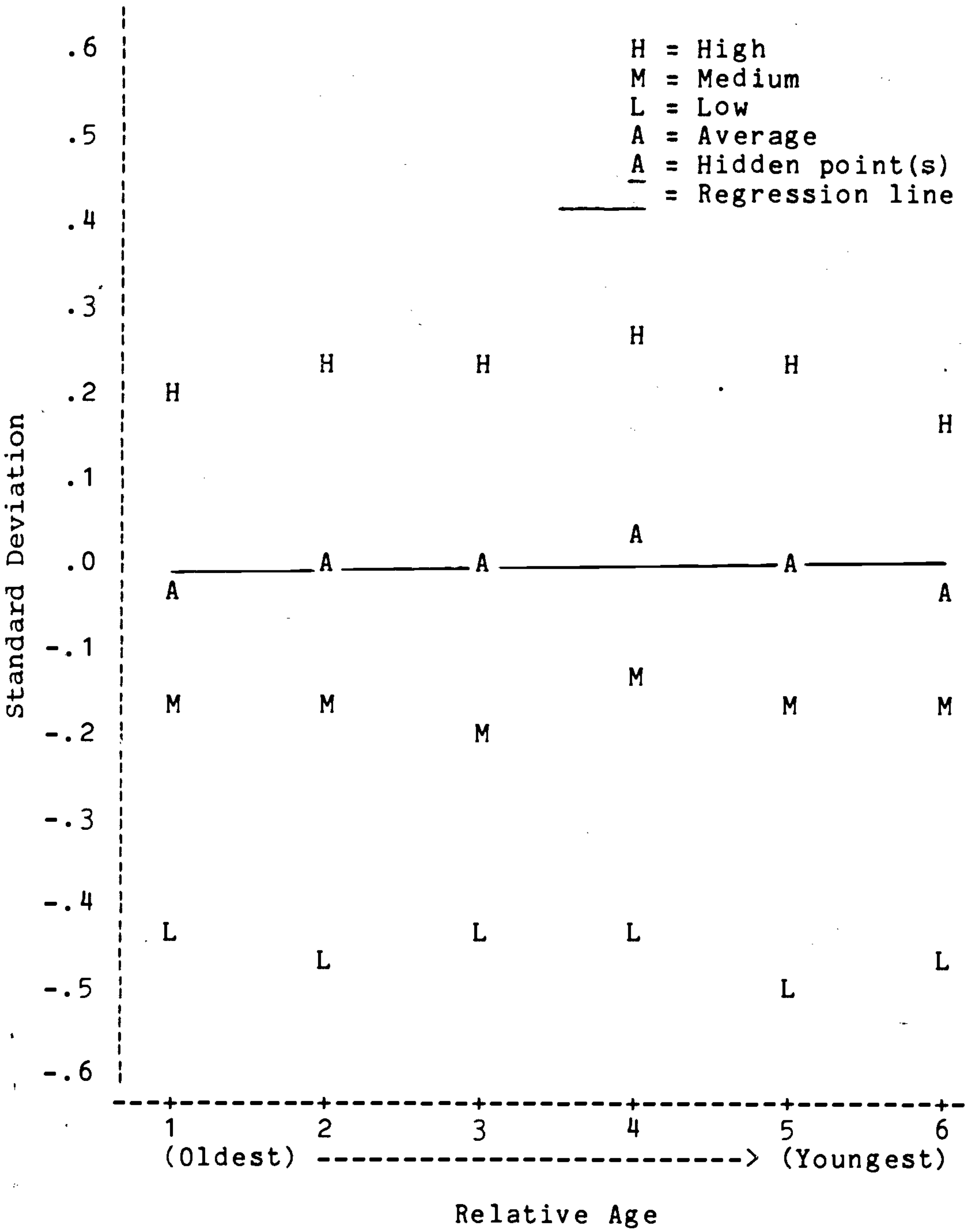

Figure 29. Combined mathematics, science and reading achievement by relative age and parental education among seventeen-year-olds.

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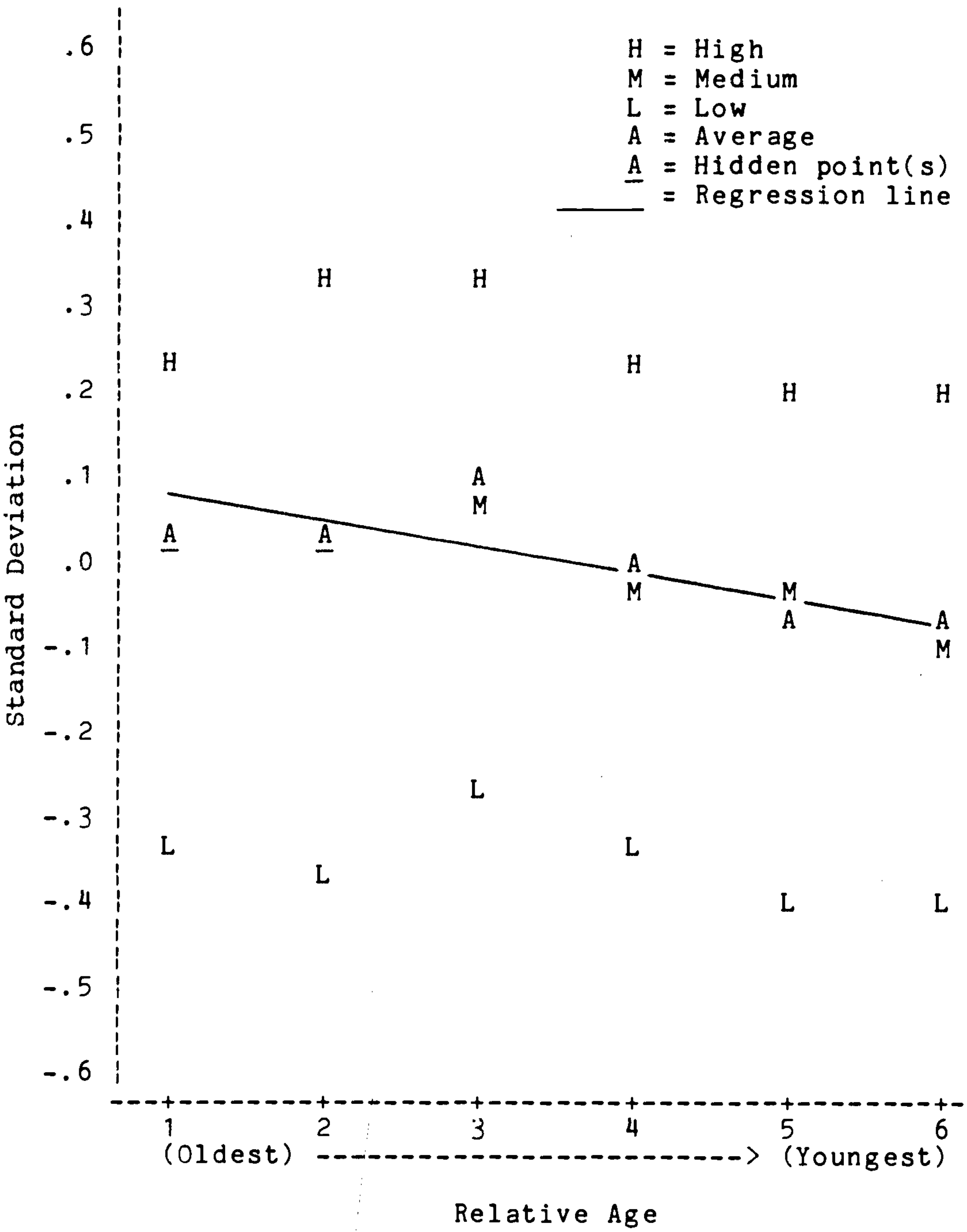

Figure 30. Combined mathematics, science and reading achievement by relative age and home environment among nine-year-olds.

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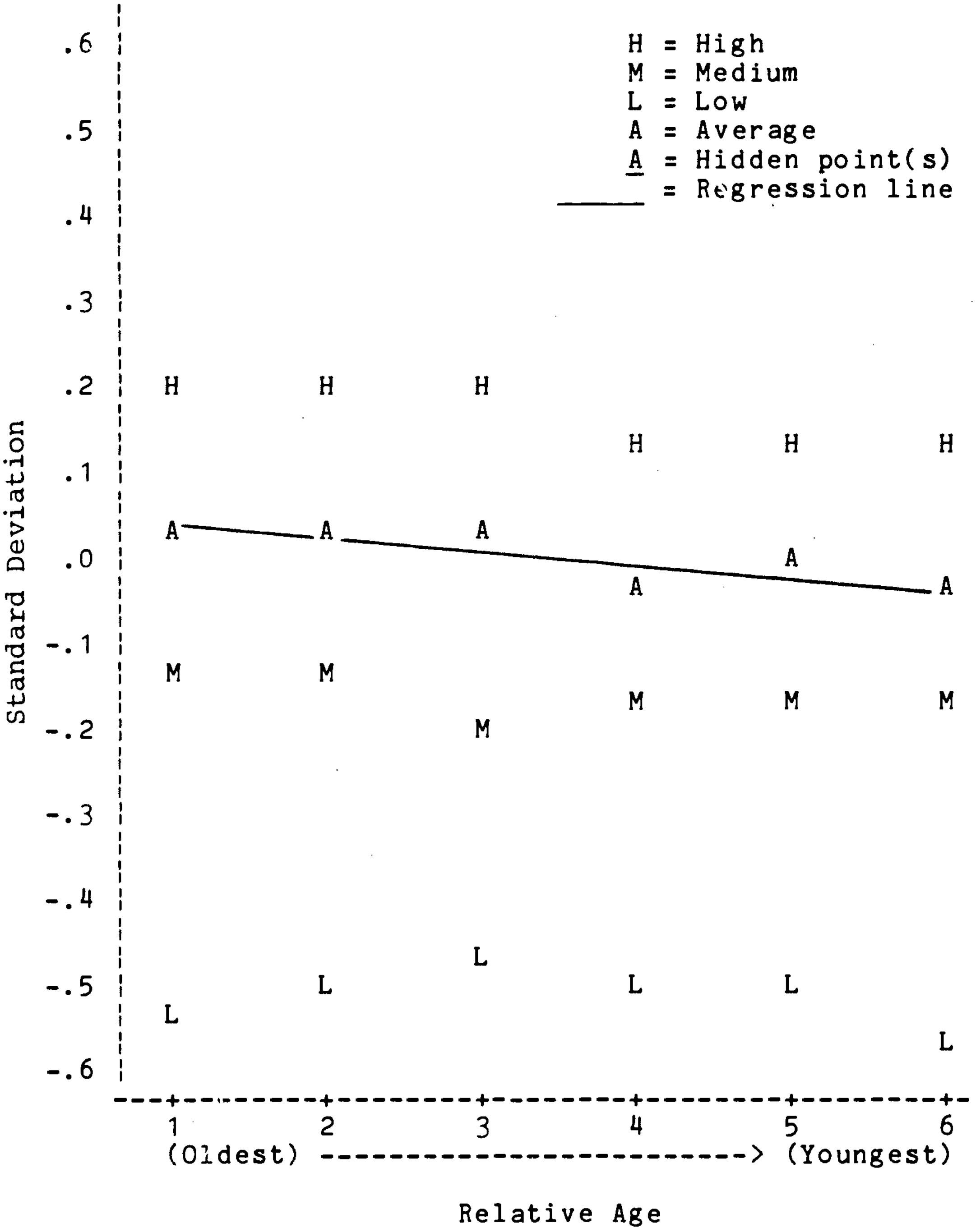

Figure 31. Combined mathematics, science and reading achievement by relative age and home environment among thirteen-year-olds.

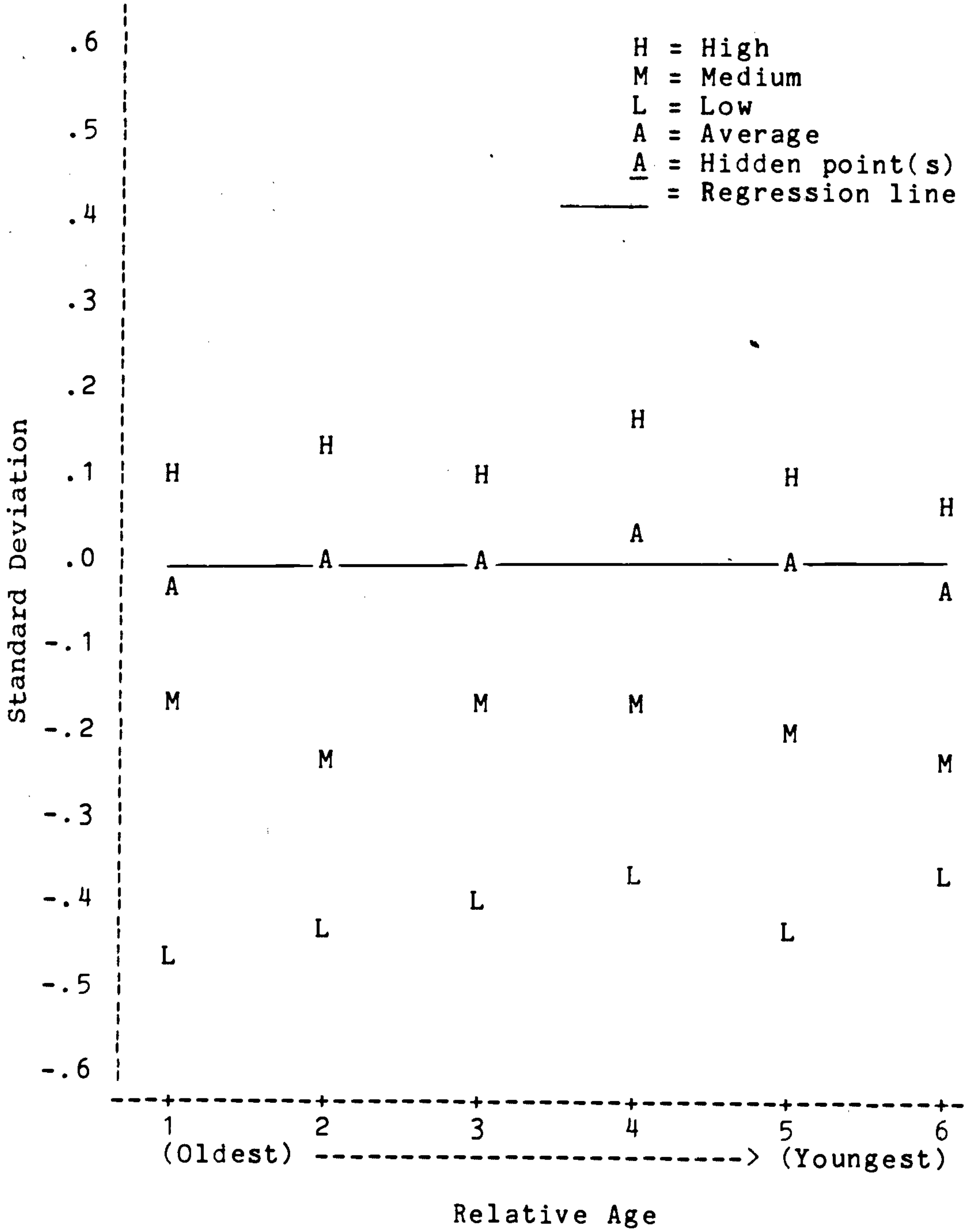

Figure 32. Combined mathematics, science and reading achievement by relative age and home environment among seventeen-year-olds.

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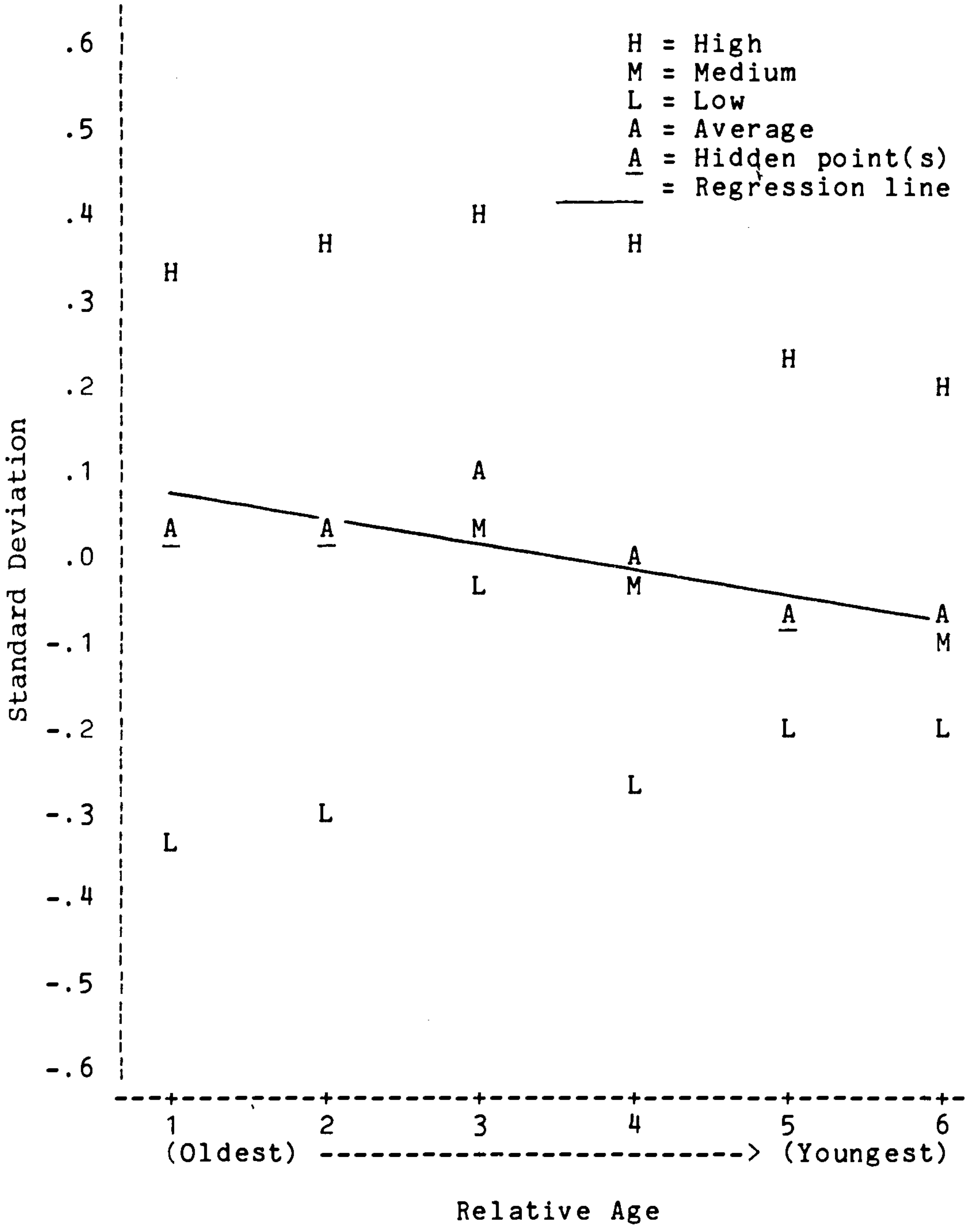

Figure 33. Combined mathematics, science and reading achievement by relative age and type of community among nine-year-olds.

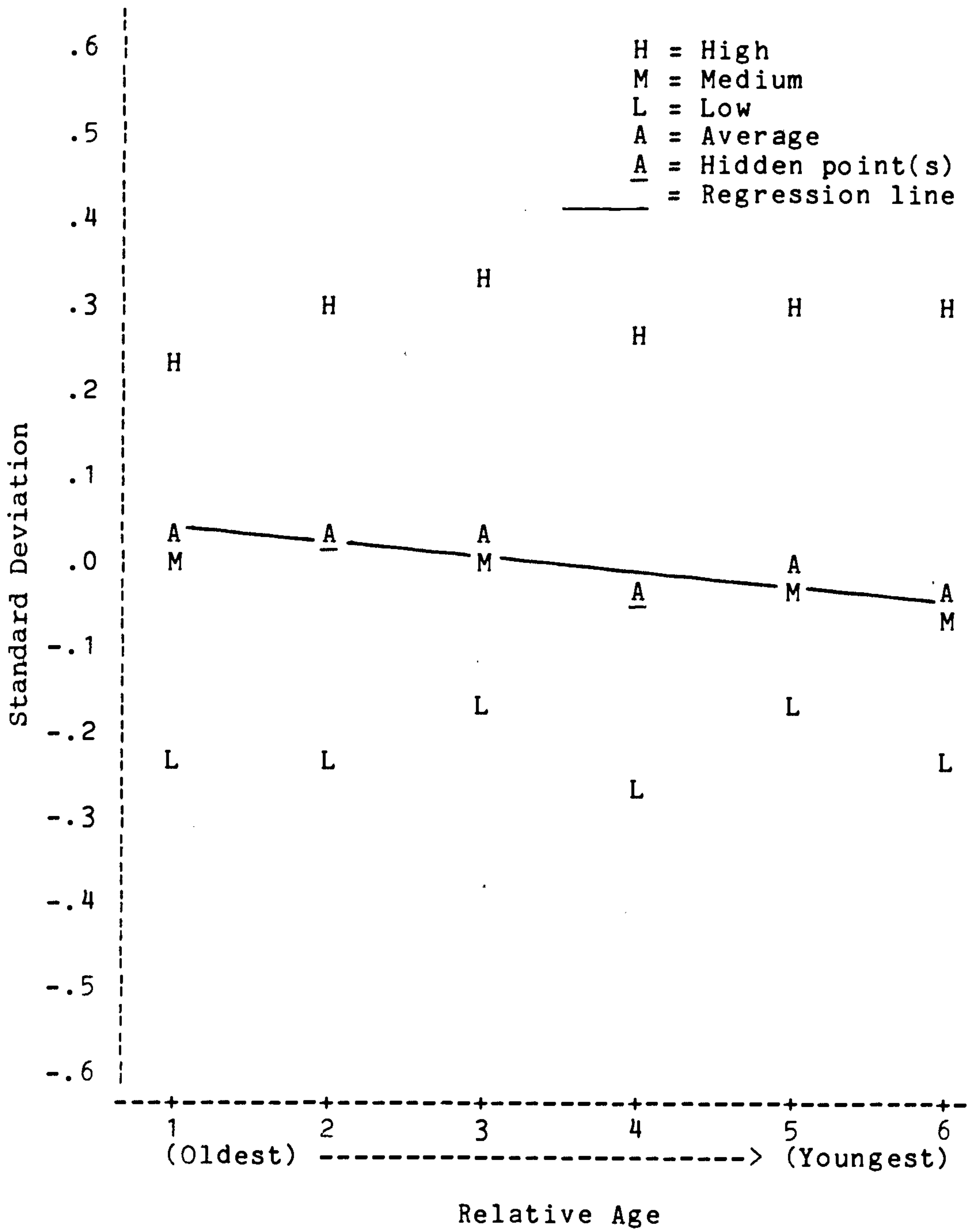

Figure 34. Combined mathematics, science and reading achievement by relative age and type of community among thirteen-year-olds.

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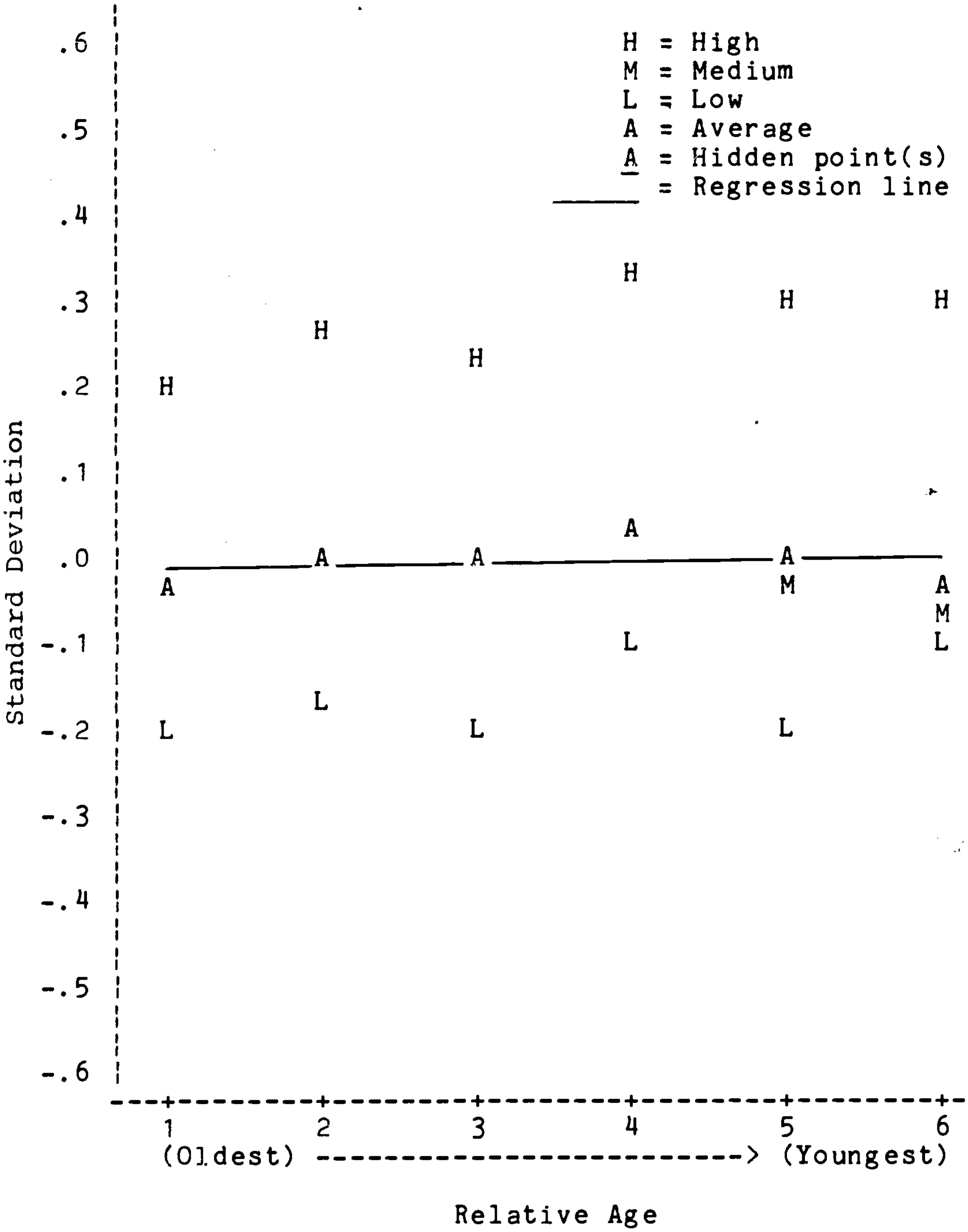

Figure 35. Combined mathematics, science and reading achievement by relative age and type of community among seventeen-year-olds.

Appendix E

GRAPHIC DISPLAY OF THE RELATIONSHIP OF RELATIVE AGE WITH SEX

This appendix contains figures graphically displaying the relationship of academic achievement with relative seventeen-year-old samples for the mathematics, science and reading assessments. Any questions about the descriptions of these tables and figures is answered in Chapter Four.

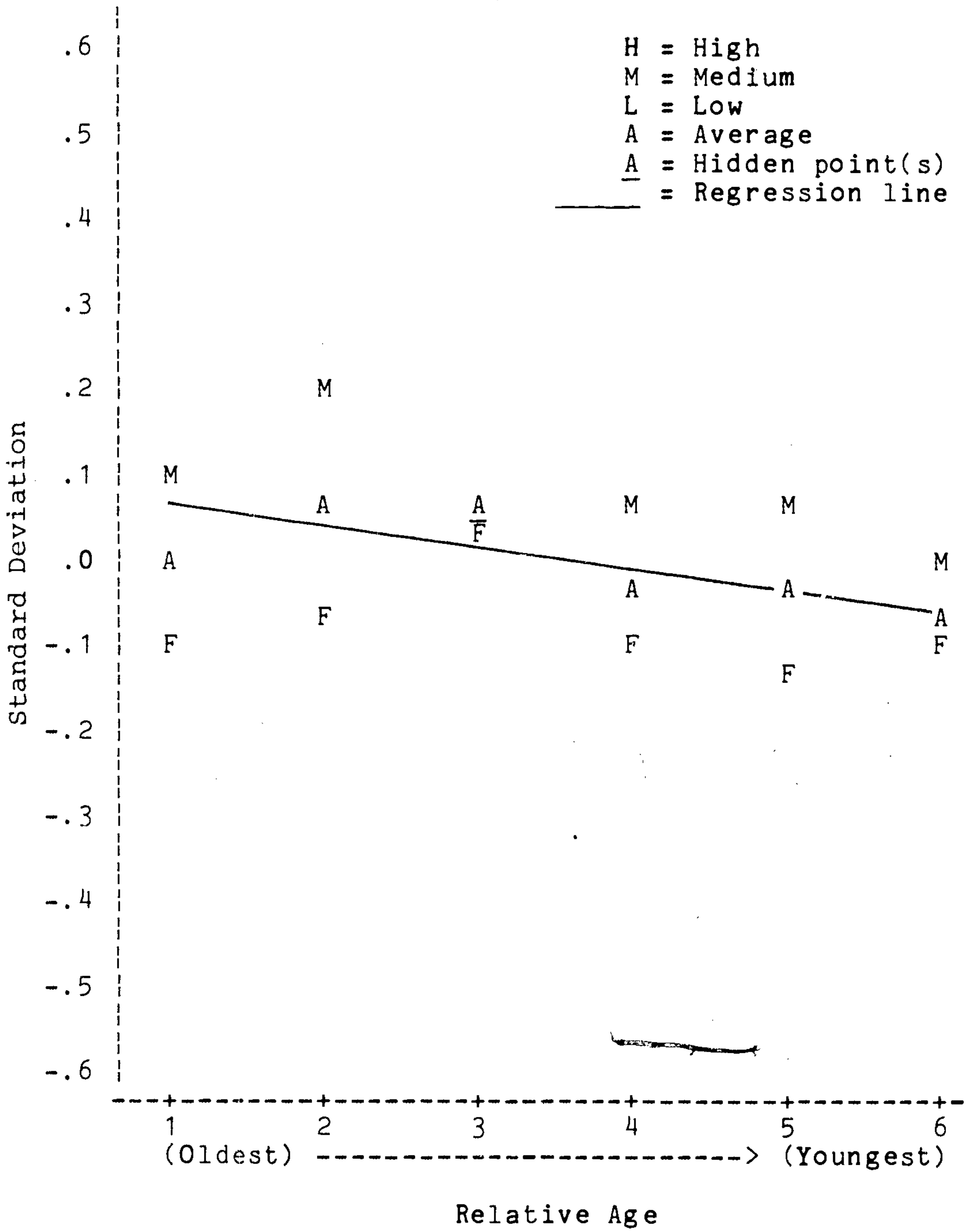

Figure 36. Mathematics achievement by relative age and sex among nine-year-olds.

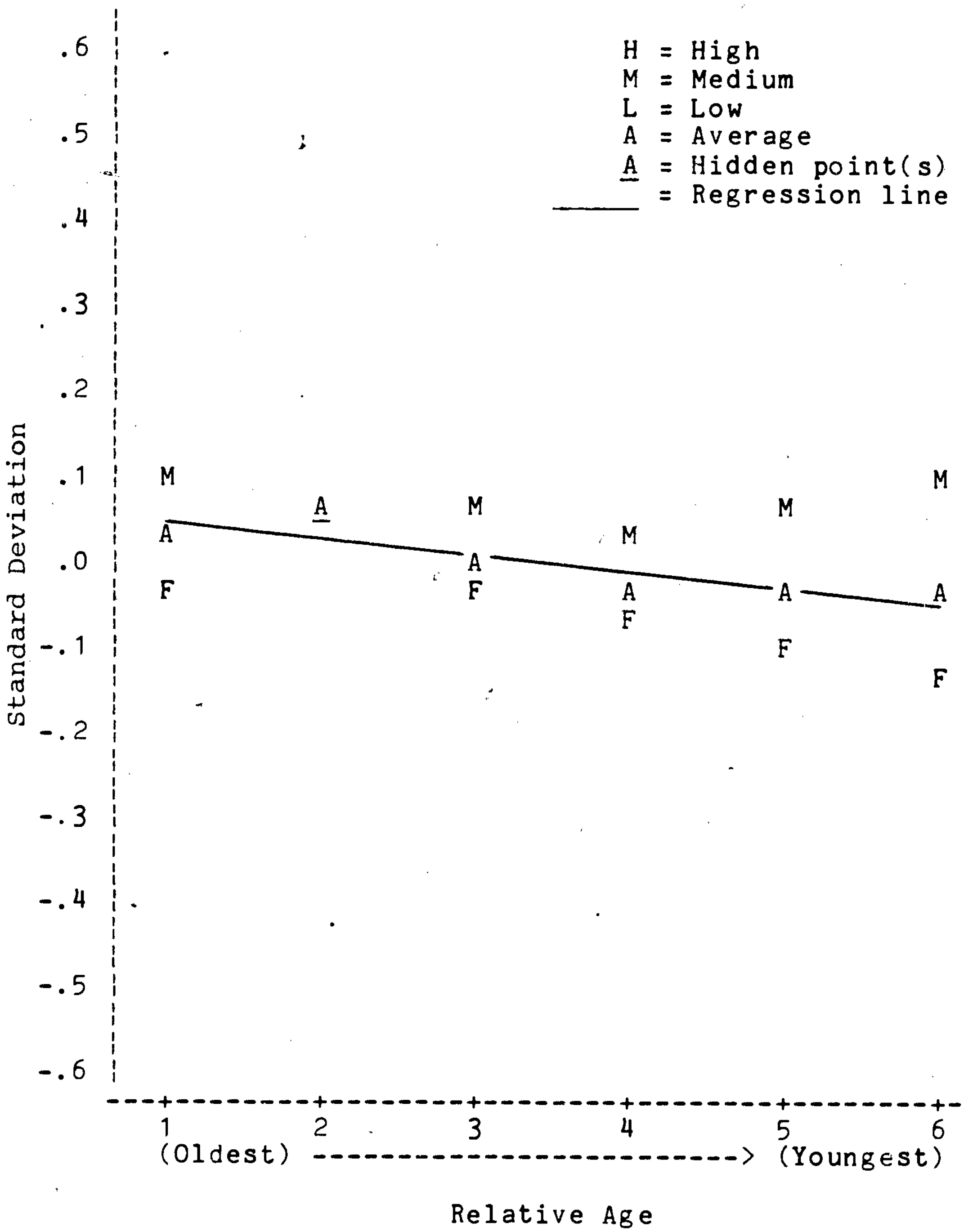

Figure 37. Mathematics achievement by relative age and sex among thirteen-year-olds.

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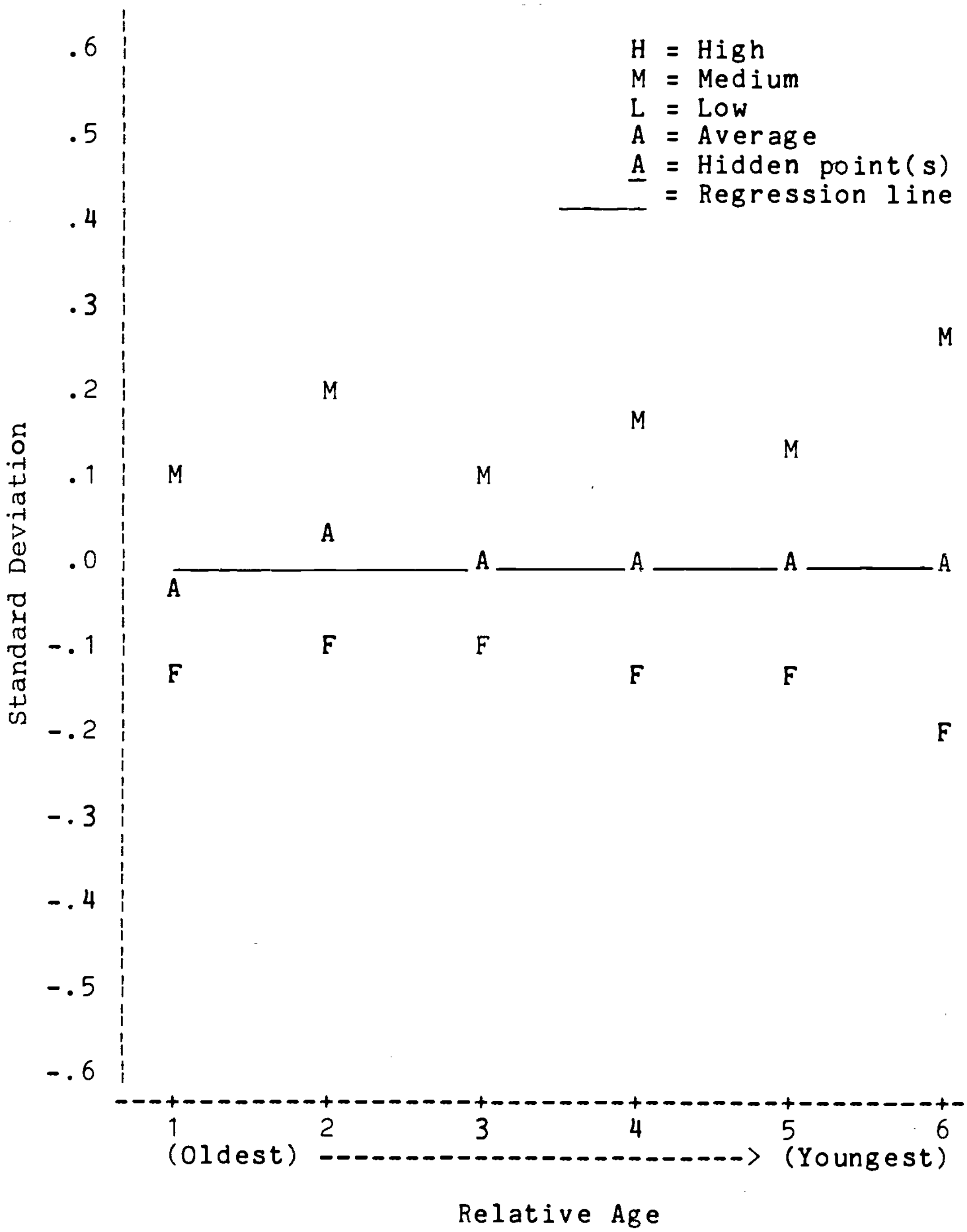

Figure 38. Mathematics achievement by relative age and sex among seventeen-year-olds.

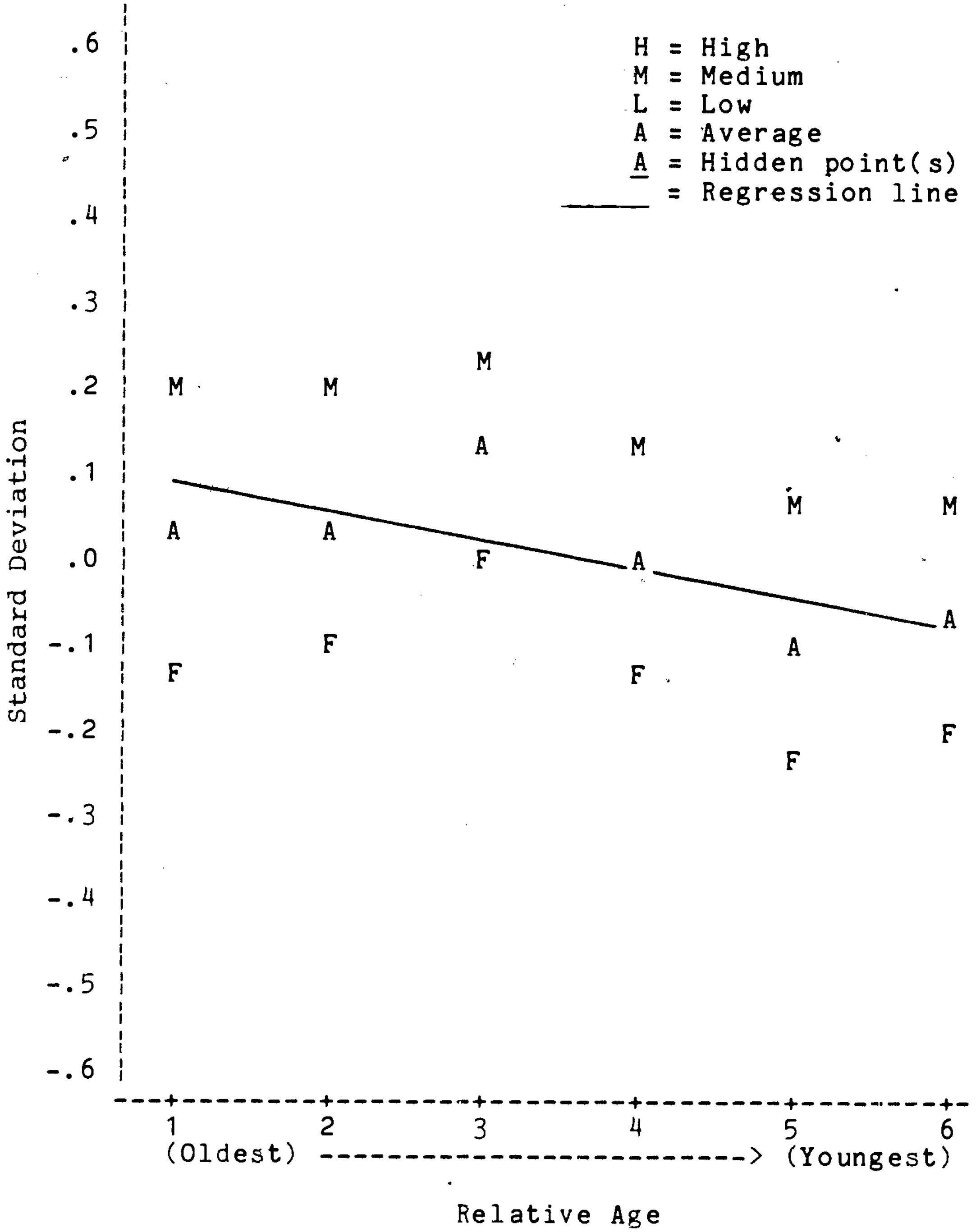

Figure 39. Science achievement by relative age and sex among nine-year-olds.

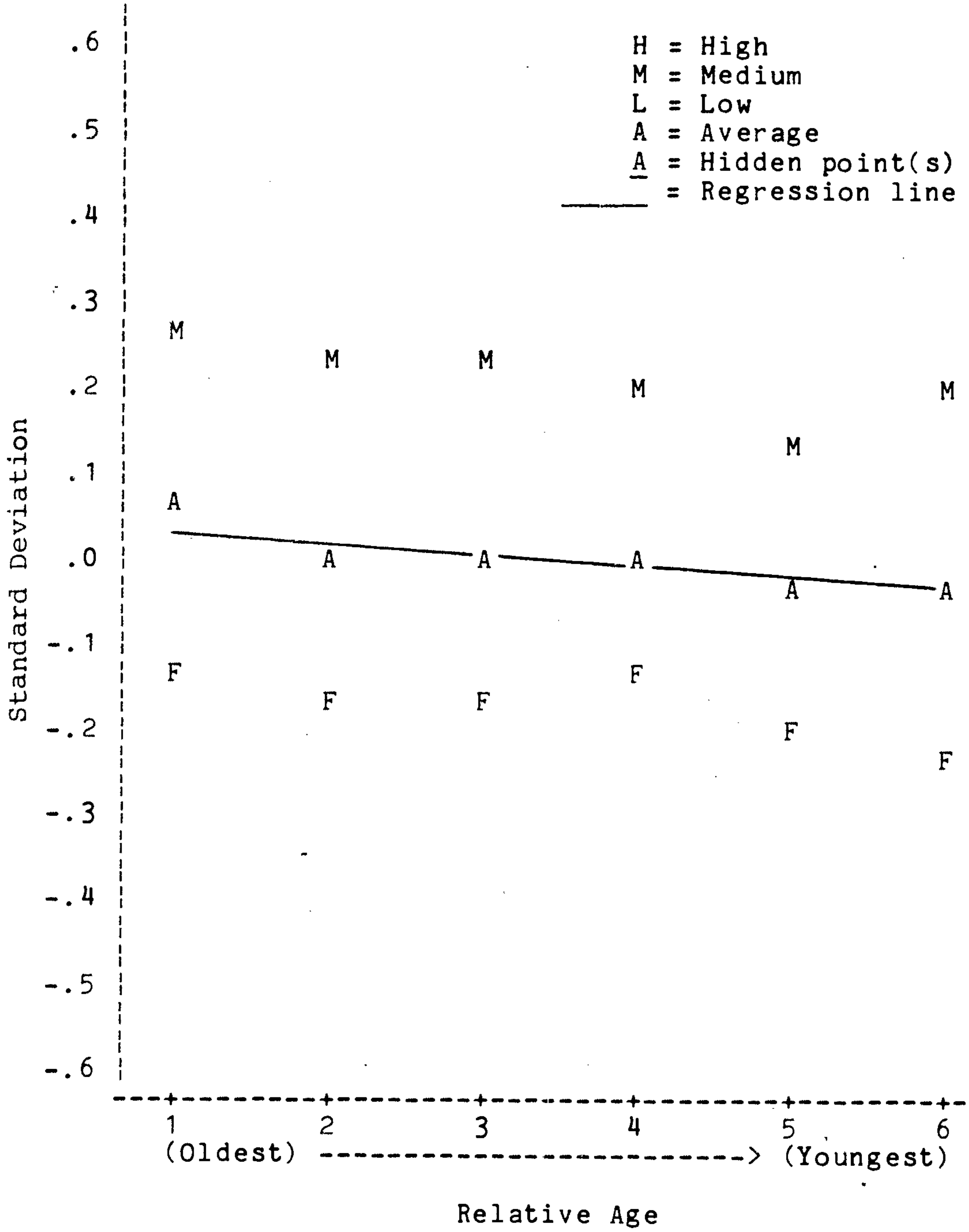

Figure 40. Science achievement by relative age and sex among thirteen-year-olds.

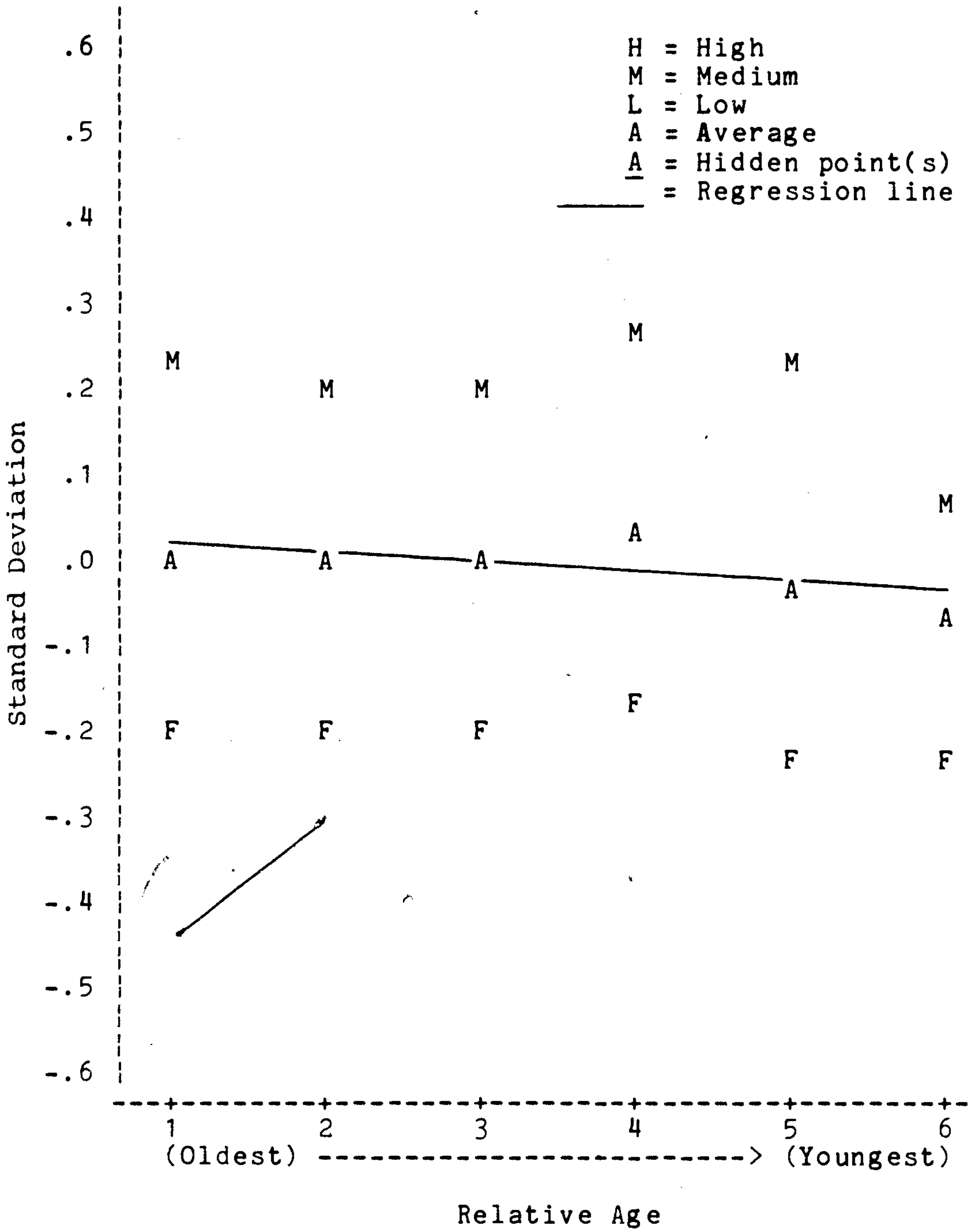

Figure 41. Science achievement by relative age and sex among seventeen-year-olds.

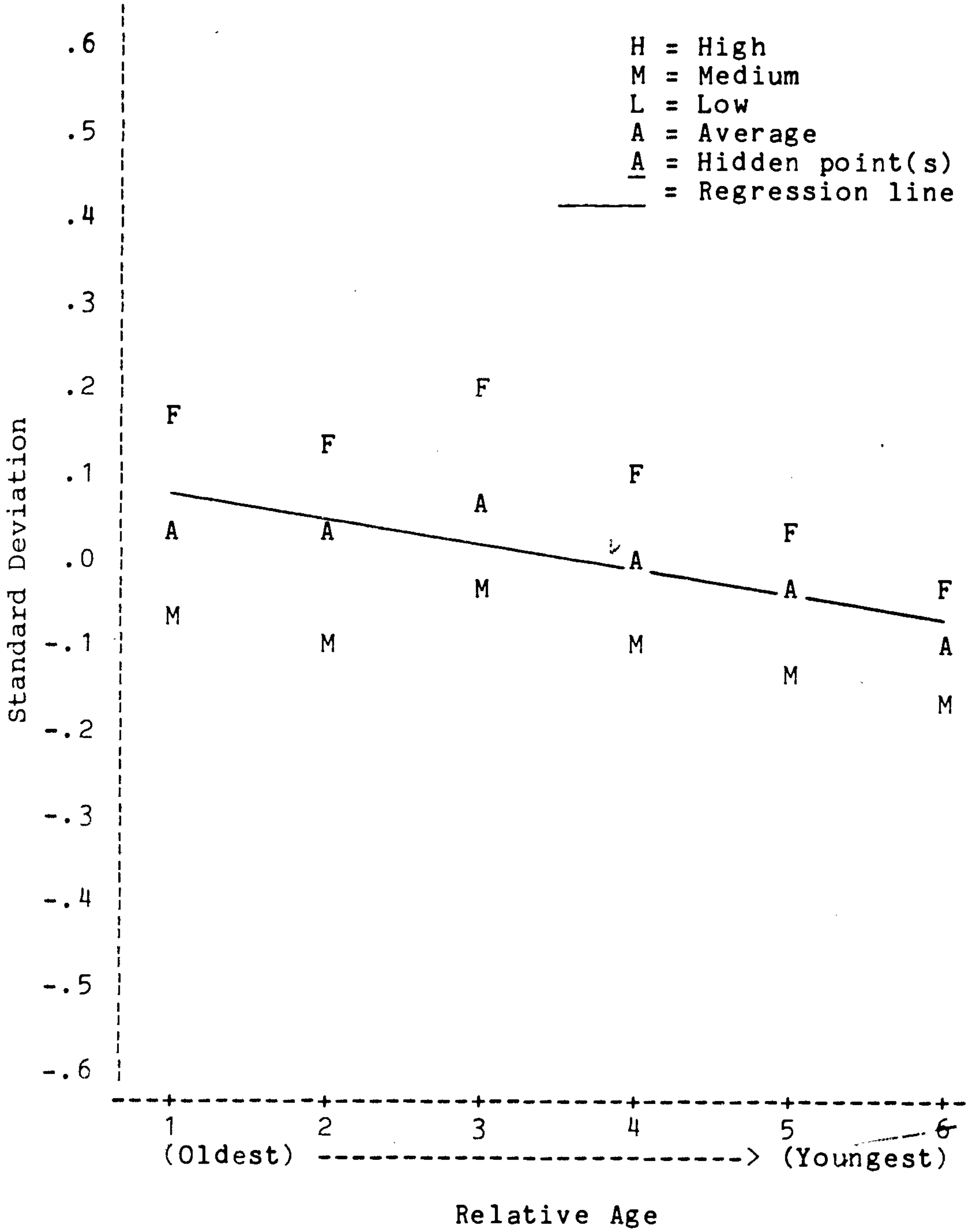

Figure 42. Reading achievement by relative age and sex among nine-year-olds.

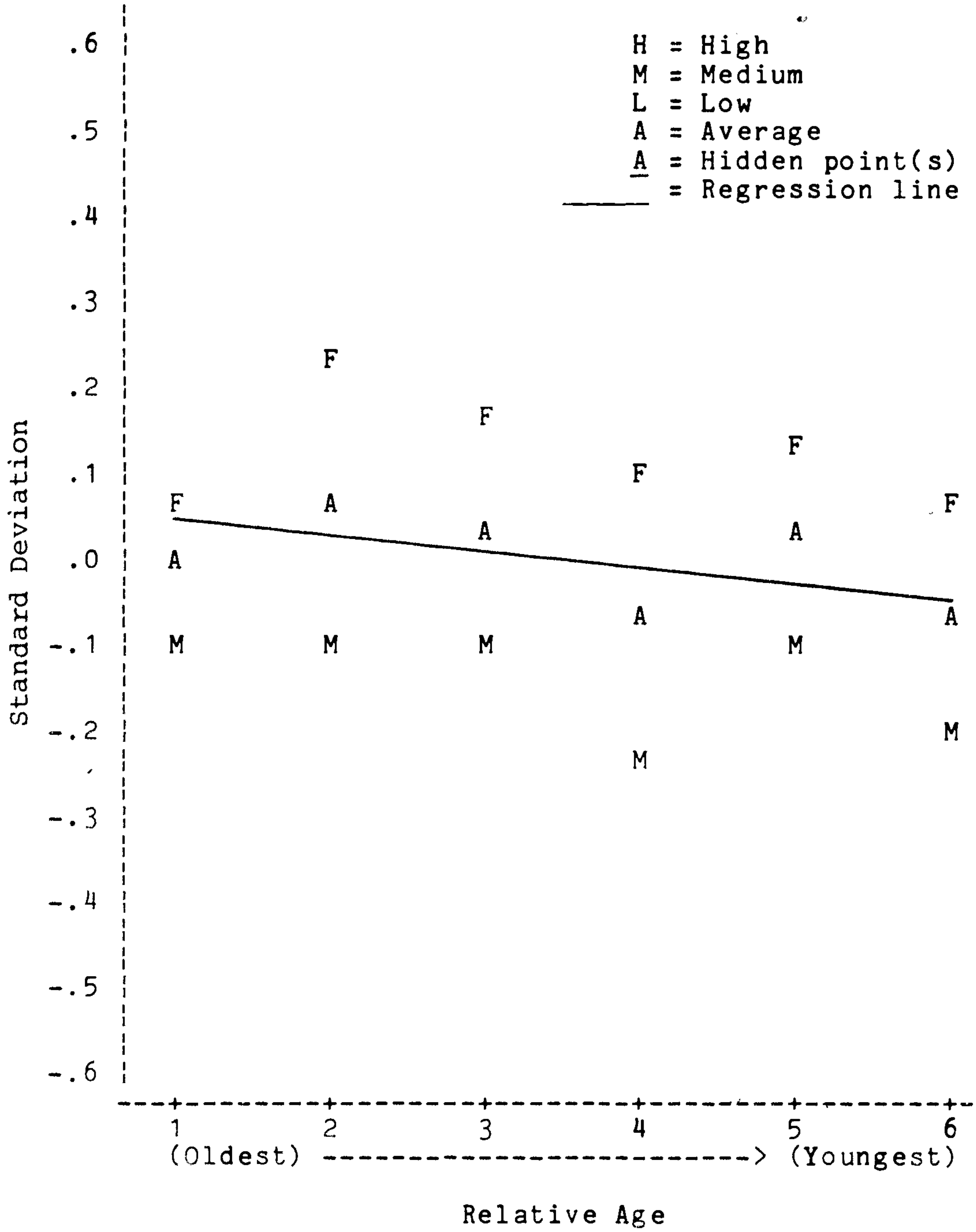

Figure 43. Reading achievement by relative age and sex among thirteen-year-olds.

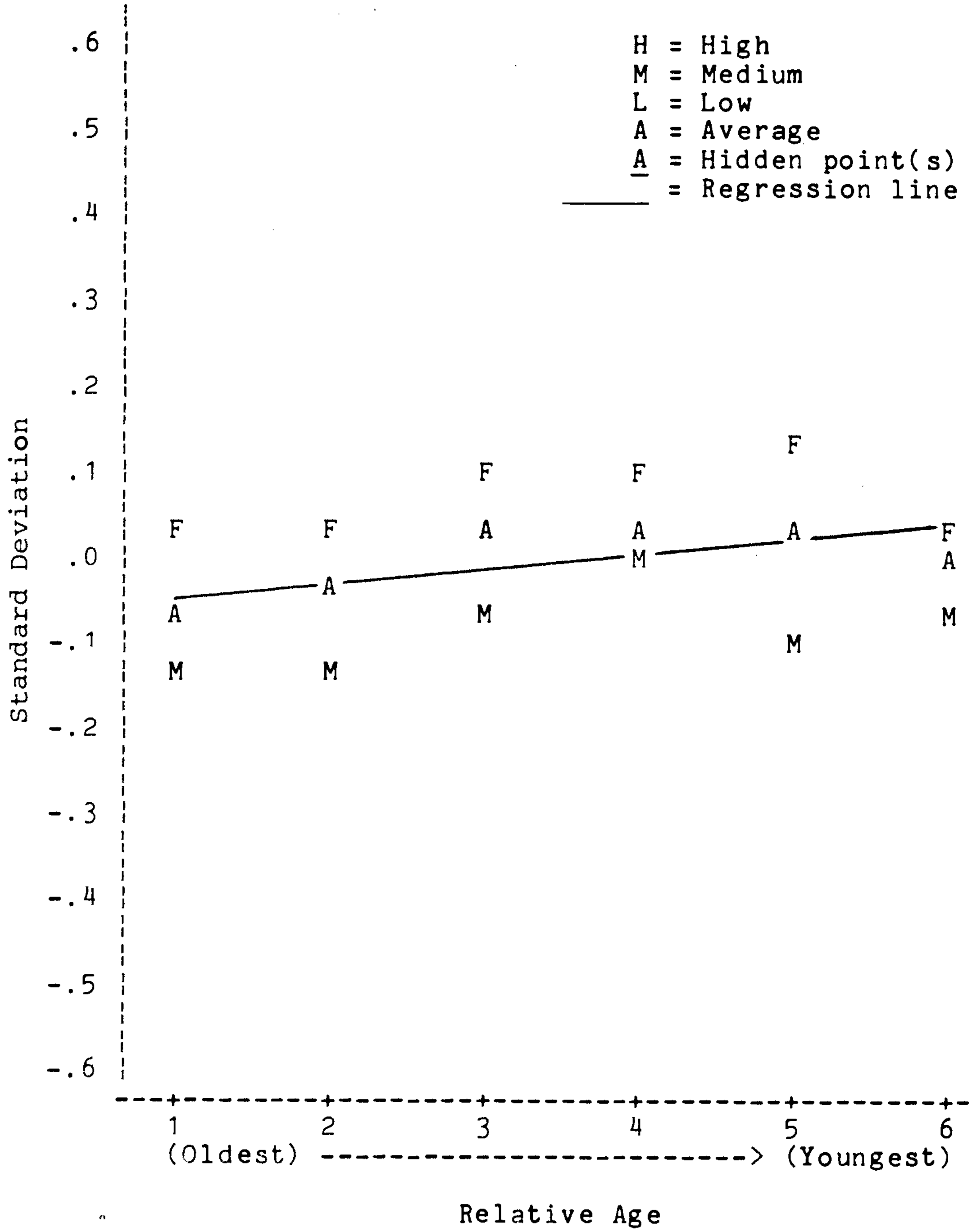

Figure 44. Reading achievement by relative age and sex among seventeen-year-olds.