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This study attempted to find which factors determine the course of mental growth. The hypotheses were as follows: (1) early growth rates are rapid, chaotic, and uneven; (2) intellectual functions become more complex at age 2; (3) language is of overriding importance in intellectual growth; (4) more developed individuals have a longer infancy period but accelerate later; (5) effects of environment are manifest at age 2; and (6) parental warmth is important for healthy development. A review of the Berkeley Growth Studies and related studies showed that (1) early mental growth rates are uneven but not chaotic; (2) genetic factors are important in determining intellectual capacity, and around age 2 the nature of mental functions become more complex; (3) maternal attitudes affect mental scores differently, before and after age 2; and (4) with retarded children, lack of language (and, therefore, communication) and a nonstimulating environment can retard mental growth. It was concluded that many factors which affect mental growth converge at age 2. Further research, however, is needed to identify and specify the nature of the processes of these factors. Numerous tables and a bibliography are included. (JS)

THE TWO YEAR OLD

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Dr. Nancy Bayley is Research Psychologist at the Institute of Human Development at the University of California at Berkeley. She has held this position since 1964.

Dr. Bayley earned her bachelor's and master's degrees from the University of Washington. She was awarded the doctorate from the State University of Iowa in 1926.

Berkeley has been Dr. Bayley's home since 1928 when she came to the University of California as a Research Associate at the Institute of Child Welfare. She has served the University in a variety of capacities, including Research Psychologist at the Child Study Center of the Institute of Human Development, Lecturer in Psychology, and as Chief of the Section on Early Development in the Laboratory of Psychology where she conducted research in cooperation with the National Institute of Mental Health. In conjunction with her work at the University of California, Dr. Bayley has also served as a Research Associate in Psychology at Stanford University and as Research Associate in Psychiatry at the University of Maryland.

Dr. Bayley participates actively in several national societies. From 1961 to 1963 she was president of the Society for Research in Child Development. She is also a member of the American Educational Research Association, the American Association for the Advancement of Science, the Gerontological Society, the American Psychological Association, the National Education Association, and the Western Psychological Association of which she was president during 1953-54. This year Dr. Bayley received the Distinguished Scientific Contribution Award from the American Psychological Association.

Among Dr. Bayley's major professional interests are: mental and physical development processes in children; development of intelligence; and factors effecting personality and emotional adjustments during development.

Dr. Bayley, a native of Oregon, is married to John R. Reid.

Preface

Across the years child development researchers have sought to sort through the maze of variables impinging upon children and their potency in shaping intellectual and personality patterns.

Time and again they have returned to longitudinal studies to shed some light on the influence of genetics, mothering, deprivation, enrichment, educational settings and family life in determining the behavioral patterns of children. The biggest chasm has been relating and reconciling perceptual and cognitive factors. Language development has appeared to be the bridge over which we might cross. But a simple documenting of language growth has not been enough. Cognition, symbolic logic, discimination, coping and problem solving have appeared to be understandable only when the developmental context within which they arise can be identified and understood.

So the nature of the organism, his surroundings and the rhythm of development contribute to his growth pattern in crucial ways. The predication and shaping of that pattern derives from knowing these things.

In Dr. Bayley's paper, there is a focusing and clarifying of thought around the critical age hypothesis. A finger is pointed at the two-year old. Longitudinal data are brought to bear and the problem seems clearer. She identifies the convergence of factors in the period one to three years and comments on their importance in setting the stage for adequate mental growth. In this paper she has gone beyond theory to combine data to shape her arguments. She offers the experience of the Berkeley Growth Study and the emphasis of today's thinking to move us more

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Donald J. Stedman

The Two-Year-Old:

Is This a Critical Age for Intellectual Development?*

Nancy Bayley+

In longitudinal studies of the growth of intelligence it is found, repeatedly, that scores earned in the first year or two are not related to scores earned at later ages. There appears to be a change in the nature of mental functions, which is reflected both in the stability of scores and in their correlates, a change which is seen at some time between one and three years of age. The increase with age in stability of function is evidenced in the correlations between test scores before and after two years, and also in individual children's trends of relative scores (IQs) over time. The break at or near two years is also found in the changing nature of correlations between mental scores and a variety of behaviors and conditions, not necessarily in themselves measures of intelligence.

This re-alignment of mental functions in the two-year-old is so pervasive that it deserves some close scrutiny. Perhaps an understanding of the etiology and nature of the two-year-old intelligence will not only afford us insight into the nature of early intelligence, but will also give us valuable leads for use in early training and education.

Among the explanatory hypotheses which have been offered for the differences in test scores before and after two years are: (1) that early growth rates are rapid and

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* Paper read at Duke University, Education Improvement Program, Durham, North Carolina, May 5, 1966.

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chaotic, cannot be measured reliably, and only stabilize at about two years; (2) that the nature of developing intellectual functions changes at this age, becoming more complex: e.g., the beginnings of simple generalization from specific concrete perceptions to classifications of similar objects; (3) that the onset of language (a tool that promotes communication, generalization and abstract thinking processes) is of overriding importance for intellectual growth; (4) that, just as among other species, within Homo sapiens the more developed individuals, by contrast with those who will be less able adults, have a longer period of infancy and slower early growth in the first two-year period--a period in which sensorimotor functions and simple object-relations are established--but accelerate later in more complex intellective functions; (5) that the effects of environmental enrichment--or impoverishment--only become manifest at about two years, when the child is increasingly able to discriminate aspects of the environment; (6) that parental "warmth" is important for healthy development, and that perhaps "traumatic" loss of the mother's close, affectionate care may frequently occur at about this time, with weaning, or the birth of a sibling, or with mother's return to work or to other outside demands on her time. Most probably several, if not all, of these factors converge to effect changes in mental growth processes in the period between one and three years. Presumably some factors are more basic or influential than others in determining the course of mental growth.

Although the evidence to date may only point up the general relations, a look at this evidence should afford us some leads for further investigations.

I shall explore here, primarily, the evidence from the Berkeley Growth Study (Jones and Bayley, 1941) as its trends and relationships have emerged in a series of analyses of the records.

The approximately sixty children in this study were given mental tests monthly from one through fifteen months, then trimonthly through three years, annually through eighteen years, and (most of them) again at twenty-one, twenty-six and thirty-six years of age. The first report (Bayley, 1933) on these mental test scores covered the children's first three years. At that time, it was noted that the babies' scores in the first nine months showed no correlation with their scores earned at three years. However, the ten-to-twelve-month and older scores did show positive correlations between tests. The correlations to assess consistency of scores over time were later extended, and in the first figure (from Bayley, 1949) we see a graphic representation of the correlations through eighteen years. Not until the children were two years old was there any clear correlation with scores earned at six years or later. (The scores used in these calculations are based on the average of three consecutive testings, and are therefore highly reliable--in most instances reliability *r*s are well above .90)

The trend in the consistency of mental scores is shown in a different way in Figure 2. Here the average score at sixteen to eighteen years is used as the basis for comparison, and test scores at all earlier ages are correlated with these last (young adult) scores. Computations are for boys and girls separately, and since we have found marked sex differences in the patterns of correlation, our policy now is always to make computations for the sexes separately. Notice here that it is only after two years that the correlations become significant. The boys' correlations are even negative in the first eighteen months.

The correlation coefficients represented here are very general indicators. A look at some individual curves will serve to point up the growth trends in individual children. Figure 3 presents mental scores in Thurstone absolute scale units for the first five years of two boys. The central curve and shaded area represents the Berkeley Growth Study means and $\pm$ one S.D. The two boys made closely similar scores through fifteen months, after which age their curves diverged widely. In this instance the low curve of case 8M may be in part accounted for by the fact that he had severe pneumonia at about two years. There was some recovery at thirty months where he stabilized at about one S. D. below the mean. Boy 9M moved to a plus one S.D. at eighteen months and stayed high thereafter.

In Figure 4 the age changes in intelligence are expressed in two ways, as IQs and as standard scores, for a girl from one month through seventeen years. The solid line represents her standard scores relative to the Berkeley Growth Study means. We see that she developed rapidly from average at one month to plus three S.D.'s at one year, and then her course of growth slowed, until after six years her scores were consistently one S.D. below the group's mean. Her scores were most changeable in the first three years.

By contrast, Figure 5 shows a boy who scores low in the first eighteen months, is somewhat unstable, though mostly above average from two through four years, after which age he ranges between one and one and a half S.D.'s above the mean.

These are extreme cases. However, all of the individual curves show greater instability in scores during the first two or three years. Thus, it is evident that early mental growth rates are unstable, even though the tests at any given time (or even two tests a month apart) are seen, from their intercorrelations, to be stable and reliable.

The frequently reported correlation between parents' socioeconomic status and their children's IQs (usually around .50) has been interpreted to mean either that children inherit their parents' abilities, or that the better circumstanced parents offer their children a more intellectually stimulating environment. Whatever the explanation, we see in Figure 6 that in our Berkeley Growth Study sample the parent-child correlation does not become significant until after three years. The correlations for the boys, again, are negative around four to nine months; for the girls at this period they are zero. By three years the correlations are all positive; by six years they are significant. The boys' highest correlations are with fathers' occupational status. The girls' correlations are usually higher than the boys' and they are highest with both fathers' and mothers' education.

Similar age trends in parent-child correlation have been found by other investigators. For example, Honzik (1940, 1957, 1963), and Hindley (1965) report no correlation before two years between children's scores and parental status but clear correlations after about three years. In her latest report, Honzik (1963) found significant rs for the girls at three years but not for the boys until five years.

If we turn again to individual cases, Figure 7 shows standard score curves for three children in relation to the educational level of their parents. (This level is expressed in standard deviation units from the mean for the Berkeley Growth Study sample.) Scores from cases 8M and 5F approximated their parents' educational level from about three years; case 14F did not settle down to parental level until about six or eight years.

For the Berkeley Growth Study we have two sets of estimates (ratings) of the mothers' IQs: the first as of the times the children were under three, and the second between nine and fourteen years of age. The *r*s of these ratings with their children's scores over time are shown in Figure 8. For the early rating of mothers' IQ there is a change in the direction of correlations for the boys at thirteen to fifteen months, while the mother-daughter *r*s show a marked increase after three years. The later ratings show less clear relations with sons' IQs, but the mother-daughter *r*s are negative at first and change in direction after three years.

With these several patterns of Berkeley Growth Study parent-child correlations in mind, let us look at Figure 9. The children represented here, tested by Skodak and Skeels (1949), were placed in adoptive homes as young infants and therefore any correlation with measures of true parents' ability must be attributed to hereditary factors. The upper half of the chart gives correlations with true parents' education and true mothers' IQ: the lower half relates children's IQs to their adoptive parents' education. Clearly the girls' scores are related to their true parents, and increasingly so from four years. The boys' correlations are lower, but they change from negative to positive sign after the two-year tests.

Here in this last instance we have evidence that mental abilities are hereditary and that the nature of mental functions in the first two years may, on a genetic basis, differ from the more complex mental processes that are developing after three years.

However, all of the correlations we have reviewed are moderate and they obviously do not explain the determiners of mental abilities. What *is* clear is that relationships to intelligence change somewhere around two years, and that some of this change must be genetically determined. What is the evidence for the effectiveness of environmental influences on performance?

The ratings that Schaefer and Bell made on the Berkeley Growth Study mothers' behaviors (Schaefer, Bell, and Bayley, 1959) have been utilized to explore some possible relationships. Figure 10 shows Schaefer's hypothetical circumplex order of maternal behaviors, an order which grew out of the Berkeley Growth Study maternal ratings (Schaefer, 1959.) Notice that there are two orthogonal factors here, labeled Autonomy-Control and Love-Hostility. Along the circumference of the circle connecting the factor poles, intermediate types of behavior are distributed. In actuality, our maternal behaviors are not so evenly placed as this, but they do tend to follow the pattern. For purposes of illustrative comparisons with the children's scores, we have placed the maternal behaviors in a column, starting with autonomy, and moving clockwise, continue through loving, then controlling, hostile and ignoring behaviors.

Figure 11 shows the patterns of correlation between these maternal behaviors and the children's mental scores in the first twelve months. Each maternal scale is correlated with test scores at four age levels.

We see some clear sex differences here. In general, but most clearly between three and ten months, "loving" mothers have sons who tend to score low, daughters who tend to score high; hostile mothers, on the other hand, more often have high-scoring sons and low-scoring daughters. Controlling maternal behavior correlates positively with "IQ" for both sexes.

Our present concern, however, is to see what happens in the next age level which is shown in Figure 12, for ages thirteen-to-fifty-four months. Here we see a changing pattern of correlations: the boys' correlations are becoming more like the girls', and by four years (the solid black bar) the change-over in the *r*s in the maternal love-hostility dimension is complete. At the same time, the mother-daughter correlations are becoming smaller.

The final outcome of this pattern of relations is shown in Figure 13 for five-to-eighteen years. For the boys there is a firmly-established relation that continues through eighteen years, which may be expressed loosely as loving-mother: high IQ; hostile-mother: low IQ. The girls' school-age IQs become almost entirely independent of their mothers' early behaviors toward them.

Here, again, we see that this change in correlational patterns also occurs between one and three years of age. It appears that environment makes a difference in these children's scores: specifically maternal "warmth" or loving-understanding and its opposite. However, the maternal effect on the mental scores is different before and after two years, and it is much more lasting in its relation to the boys' than to the girls' scores.

The fact that the maternal behaviors are meaningfully related to the children's scores in intelligence implies what we have found, that the children's own emotions and attitudes are related to both the maternal behaviors and to their own test scores. Figure 14 shows the correlations between the maternal behaviors and ratings made of the children's happiness between ten and thirty-six months. As one would expect, positively evaluating, equalitarian and affectionate mothers tend to have happy babies while irritable, generally hostile mothers have unhappy babies. As we saw, these are the maternal behaviors which are related (though differently for the sexes) to the children's IQs.

Figure 15 presents the correlations of happiness in infancy with intelligence over time. Girls who are happy in infancy (from ten to thirty-six months) make high scores and, although the correlations attenuate at the later ages, those that are most persistent are the ratings made after two years. Although the happy boy babies do not score high, it is clear that for them being happy between eighteen and thirty-six months is likely to go with high IQs later, especially after three years. The changes in correlation occur around two years, in relation both to the ages at the ratings and the ages of the mental tests.

Another of the children's behavior variables, which shows this age dichotomy even more strongly, is the rating of activity. We see in Figure 16 that, in relation to maternal . behaviors, sons' activity correlates very differently before as compared with after eighteen months. At ten through fifteen months loving mothers have inactive, while hostile mothers have active, sons. After this age the correlations drop to zero and may even reverse in sign. The relations for the girls, not shown here, are lower but the pattern is similar. With these patterns in mind, let us look at Figure 17, which relates the children's activity to their intelligence. For both sexes, activity is correlated positively with IQ through three years. However, after that age, most clearly for the boys, low IQs go with high activity through fifteen months, but the active two-and three-year-old tends to have high IQs late.

Several other of the ratings show patterns of correlation in which there is a break in the direction of correlations with IQ for ratings made before and after eighteen months. Figure 18 shows the rs for a closely related variable, speed (rapidity) of action.

Figure 19 shows the correlations with positive (versus negative) behaviors. It appears here that the two-to three-year-old boys who are not "negativistic" but respond positively to the testing situation, are likely to have high IQs later. Likewise, to a lesser degree, as in Figure 20, the non-irritable, calm two-year-old may fare relatively well in later intelligence. In the ratings of shyness (in the strange testing situation)--Figure 21--it is the two-to three-year-old girls who are not shy who tend to have high IQs later. Again, the ratings before this age are irrelevant to later function, though not-shy girl babies generally score high at the time.

This series of correlational patterns between behavior ratings and intelligence, though the patterns are complex and there are marked sex differences, repeatedly exhibit a change in their relation to test scores, a change which occurs at about two years.

Thus there is evidence for the effects of maternal behaviors in the love-hostility dimension and the children's own related behaviors, on the course of intellectual development. However, these relations are complex and they change over time, with the most marked and abrupt changes most often occurring between one and three years.

The changes may occur at this age for any of several reasons. The nature of the developing mental processes, at this time change from those sensorimotor coordinations involving more considered perceptual differentiation and simple forms of abstraction. The onset of language at this time is relevant to the processes of abstraction and of communication, and these processes become more heavily weighted in the tests after two years. It may also be that the infant who was stirred to active response and rapid behavioral development by a "hostile" mother, may soon, as a two-year-old runabout, come under more restrictive and emotionally disturbing controls when his mobile activity becomes more of an irritant to his irritable, distressed and often punitive mother.

Such a mother-child relation would promote unhappy, negativistic behavior which is inimical to intellectual progress. It may also be true that this type of mother does not afford opportunities for age-appropriate verbal communication.

A further exploration into the nature of intellectual factors and their organization at various ages has some relevance for our second hypothesis that the nature of intelligence before and after two years may be very different. Recently, Norman Livson and James Cameron have collaborated with me (Cameron, Bayley, and Livson, 1966) in a factor analysis of the Berkeley Growth Study scores on my First-Year Mental Scale, my Infant Scale of Motor Development (birth to three years) and Jaffa's Preschool Mental Scale. Because the children were tested so frequently, we were able to use as scores the age at first passing each item and compute product-moment correlations. Cameron employed the Tryon family of cluster and factor analysis programs to extract dimensions of each of these tests. Eighteen factors were derived, six for each of the three tests (the First-Year and Preschool mental and the Infant motor). "Precocity" scores were computed for eighteen scales, each composed of the items in a factor (or dimension). A precocity score is the mean of the ages at first passing the items in a scale. The precocity scores were intercorrelated with each other and with subscale and factor scores for all later tests given, through thirty-six years.

The precocity scales, most clearly in the First-Year scale (from zero to seventeen months) tend to include only items that are close together in their age placements. As they move into the Preschool scale and the two-to-six year range, the items are somewhat more widely spread in difficulty. The six First-Year precocity scales, in the order of their mean age placement, we have called: Visual Following, Social

Responsiveness, Perceptual Interest, Manual Dexterity, Early Vocalizations and Meaningful Object Relations (utilizing Eye-Hand Coordination).

Only one of these factor scales, Early Vocalizations, shows any clear prediction to later scores. It falls in the eight-to-fourteen-month age range. Figure 22 shows the correlations for the total test scores at this age level (ten-to-twelve months) with total test scores at other ages. The variables correlated are for each child's mean score at three consecutive test ages for all ages through eighteen years, and for scores at single test ages at twenty-one, twenty-six and thirty-six years. It is clear that at ten-to-twelve months the scores are unrelated to test scores after three years. When we use only the Vocalization factor scores, however, as shown in Figure 23, there is considerable stability in the girls' relation to total test scores at later ages. Although the mean scores on this factor for the boys and girls are closely similar, the girls' scores, but not the boys', appear to be fairly stable. That is, of six mental scale factors in the First-Year scale only one shows stability of function over time, and this is for one sex only. Some additional checks on this series of correlations have been made, in which several "outlying" cases were eliminated. When this was done, the correlations were reduced somewhat, but the trend of positive _r_s persisted.

The six motor factors for the most part are not predictive of later intelligence. The items in the motor scale predominantly involve large muscle coordinations in body movement and balance. It is not to be expected that they would show much relation to intelligence except in instances of profound defect. However, one of these scales, which seems to measure coordinations in active motion (with items at ages eight-to-thirteen and thirty-seven-to-forty months), is actually _negatively_ correlated with the boys' IQs after five years, and the rs go as high as -.50 with IQ at twenty-six years. It may be that motor precocity of this kind in the two-year-old is found among those males who have little potential for advanced cognitive abstractions.

The Preschool mental scale covers an age period in which we should expect to find some stability of intelligence test scores over time. However, the first two of these precocity scales have no predictive power. They are the easiest in this test (their mean scores are at about nineteen months for Visual Discriminations and twenty-four months for Hand Dexterity (Object Relations). The third Preschool scale, Memory for Forms (in the twenty-to-sixty-month interval), is the first to have some predictive power, but for males only and only to their IQs between five and ten years of age.

The fourth Preschool scale (ranging from two and one-half to six years) is the first scale which "predicts" significantly for both males and females. These correlations are shown in Figure 24. We have called this factor Verbal Knowledge (or Comprehension of Spatial Terms). It is unrelated to total test scores in the first year, but at the later ages appears to be tapping a well-established intellectual function. The correlations over the long range tend to be stronger for the males as compared with the females. From an examination of subscale scores, it appears that the greater male stability in the function tapped by this Preschool verbal factor is clearest in scores on Information subscales of the Terman-McNemar and Wechsler tests.

The fifth Preschool factor is similar to, and correlated with, the fourth factor, although the items are more complex and occur at later ages (fifty-four to eighty-four months). It has some predictive power but definitely less than the fourth factor. The sixth factor, Definitions (sixty to seventy-three months), is not predictive of later scores.

The results of the analysis of these factor precocity scores makes it clear that the mental functions tested (perhaps testable) in the first year are almost if not entirely independent of later mental functions. The only exception is the (eight to fourteen month) Vocalization factor which has some predictive power for the girls only. It is not until after two and one-half years that a clearly predictive factor for both sexes emerges. This is a factor which involves both word knowledge and spatial relations. It is also moderately correlated (.33, P = .05) with both the First-Year verbal factor, and the First-Year Meaningful Object Relations factor.

A comparison of the factors found in the First-Year scale (zero to seventeen months) and the Preschool scale (fifteen to eighty-four months) shows most strikingly a difference in the complexity of the functions tapped. In the order of their mean age placement, the First-Year scale factors are: Visual Following, Social Responsiveness, Perceptual Interest, Manual Dexterity, Vocalizations (involving rudiments of communication) and Meaningful Object Relations (e.g., puts cube in cup, round block in form board, and builds tower of two cubes).

The Preschool scale builds on these simple functions, but the factors are more complex. The Preschool scale first factor is Visual Discrimination and it is correlated somewhat with both the First-Year Perceptual Interest and Meaningful Object Relations. The second Preschool factor is Manual Dexterity (Object Relations). It is also correlated with the First-Year Meaningful Object Relations, and differs from it primarily in that it requires more discrimination in the interrelations of the objects involved.

Preschool factor three, Memory for Forms, again correlates with First-Year Meaningful Object Relations. However, it includes the additional element of memory.

Preschool factors five and six, Complex Spatial Relations and Definitions, are entirely unrelated to the First-Year factors.

Thus, there is a shift during the second and third years, from the early simple sensory discriminations, eye-hand coordinations and vocalizations, toward more complex organizations and combinations of the simpler functions. Factors from the two scales which correlate with each other are also usually similar in difficulty. We find also that around two years factors involving simple memory and recognition of forms enter into the tests, as well as the ability to classify objects and to use verbal identifying tags in these classifications.

This factor analysis gives evidence that there is a real change in the second year in the nature of the developing intellectual processes. However, the break does not appear to be abrupt, and scores on factors of similar difficulty around two years are often, but by no means always, significantly intercorrelated.

This shift in the nature of intellectual factors at least leaves the way open for change in individual children's mental growth processes. As the simpler functions mature and no longer play a role in differentiating scores, more complex functions emerge; there are independent functions which appear to have as their elements, in varying combinations, the earlier, simpler factors.

It stands to reason, if this is true, that as compared with the First-Year factors different aspects of the environment may serve to enhance or retard the growth of these more complex functions. The changing patterns of correlation with maternal behaviors and of the children's own behaviors to their intelligence may very well reflect such shifts in environmental relevancies.

If we assume the hypothesis that before and after the second to third year of life somewhat different environments are optimal for intellectual growth, then it will be relevant for us to try to find out what the important environmental differences are. This opens up a large unexplored field.

However, there are indications from a number of studies that for the preschool child basic language (i.e., verbal communication and comprehension) may be most crucial for mental growth. Several indicators from the Berkeley Growth Study are relevant. In this age period the babies begin to talk and to understand words. The factorial study shows that precocity in early vocal communication toward the end of the first year and in preschool comprehension of complex spatial terms are among the best predictors of later intelligence. If we turn to the maternal behaviors, we recall that higher IQs tend to be found among children whose mothers evaluate them positively and tend to treat them as equals. On the latter trait, these mothers are rated as playing games with their children, talking to them as equals, reducing age differences between them, avoiding a directing and commanding role and enjoying spending time with them. In general such a mother may be characterized as interacting with and communicating with her child on a level which he can comprehend. She is also likely to be a mother who appreciates her child's achievements, and who can express this appreciation in a way that is gratifying to the child.

There may, at this age, be much to gain in specific programs of training. It is on such an hypothesis as this that Earl Schaefer at the National Institute of Mental

Health is now engaged in a program of language stimulation of young children from impoverished homes. He is starting the training at fifteen months, in an effort to make the most of this emerging capacity before poor habits of communication are established.

I should like to report here another relevant study in language stimulation. It is a study of mongoloid children, a study in which Dr. Stedman participated several years ago (Stedman and Eichorn, 1964). Ten relatively healthy mongoloids had been admitted to Sonoma State Hospital between the ages of one and a half and four months, for a Special Projects Study. Among other tests and observations, these babies were given the Bayley mental and motor scales at monthly intervals in the first fifteen months and then at less frequent intervals. Although the mongoloid infants had extra care, and extra stimulation which was inherent in the fact that they enjoyed a variety of tests and measures, and a better than usual ratio of caretaker per child, it was still true that they were being reared in an institution. To test the effects of this environment, Drs. Stedman and Eichorn selected a matched set of ten home-reared mongoloids, whom they tested and measured on the same developmental scales as the hospital group. They found (1964) that the hospital-reared babies did significantly less well than the home-reared babies on both the mental scale and the Vineland Social Maturity Scale. The children were most deficient in items involving language, and manipulatory skills with small objects.

Two years ago we were able again to pick up these two samples and to obtain a comparable series of recent tests on them. Our hospital sample of ten was intact. However, three of the home cases were no longer available and they were replaced with three others from the same sample pool, using the same criteria of selection. Both sets of children were tested in the fall of 1964 (at about five years of age) and again one year later. At the 1964 testing the hospital children had started nursery school, and eight of the ten home babies were attending nursery schools for retarded children. In the fall of 1965 all twenty children were attending nursery schools, though two of the home children had been in school for only two or three months.

In 1964 the IQs of both groups had fallen somewhat, as is to be expected in mongoloids, but the hospital children were even further behind, and their deficiencies were in the same areas as at the first comparison study. It was clear that the hospital did not afford the kind of stimulation that could make these children as capable and as sufficient in self-care as were the children who were reared at home.

In July, 1965, a period of intensive training of the hospital children was instituted and is still in effect. This is a ward program designed to increase the children's receptive and expressive language abilities. A consultant was brought in to set up a language training program. She gave instructions on techniques and procedures to the ward nursing personnel and to research personnel who worked with the Special Projects' children.

This program is supplementary to the two hours per day, Monday through Friday, that the children spend in classes at the hospital school. It includes approximately three hours per day on the ward in a group instructional situation. The materials and activities utilized include books, puzzles, pictures, songs, finger plays and group games. One to two hours each day are spent in large muscle activity, with toys such as tricycles and rocking boats in the playroom, and larger equipment such as slides, swings and jungle gyms (during good weather) in an enclosed yard. In addition to the group activities each child recieves an average of fifteen minutes daily instruction with a technician on a one-to-one basis.

In all of the children's living situations the major emphasis has been on the need continually to talk to and with the children about what is going on around them, what they and others are doing. Thus in every way possible they are encouraged to develop receptive language and verbalize individual wants and needs. Stress has been placed on always asking of the child, in every situation, a little bit more than the adult anticipates he will be able to give, thus encouraging a more mature response from the child. This program has operated with the same staff-child ratio (1:5) as has always been in effect.

This entire ward program is based on the assumption that the retarded child absorbs, in any given situation or environment, less than would the normal child of comparable chronological age. If, therefore, he is to learn from his experiences, he needs far more and more frequent structured exposure to environmental stimulation. The response of the children thus far bears out these assumptions, both in increases in test scores and in a continuing and mounting demand on their part for more and varied experiences.

We have just completed an analysis of the findings, which may be summarized in Figures 25 to 28. The first of these (Figure 25) shows the relative status on the mental tests, expressed in ratio IQs for the three testings. The first two bars represent the IQs of all ten children for each group, the cross-hatched bars are composed of the seven sets of matched pairs who were included at all three testings. There is about a two-and-a-half-year interval between the first and the second tests, and a one-year interval between the second and third tests. The results are essentially the same, whether seven or ten pairs are used.

At the second testing when the children were five years old, the differences between the two groups had increased. Again, the differences were predominantly in items directly concerned with language. For example, seven of the control group used single words effectively to make their wants known, but only one of the hospital-reared children did so. Seven of the home-reared children were able to name three of five test objects presented, to identify by naming five of eight pictures, and to combine two words to form a simple sentence; none of the hospital children passed any of these items. Communication within this experimental group was limited to bodily and facial gestures and to inarticulate sounds. Stedman and Eichorn in the report of the first comparison study had noted that the project children had not had "the active coaxing and coaching for performance which was observed in the home and verbalized by the mothers; nor did they have the stimulation and example of normal siblings or peers" (1964, page 400). This observation was equally relevant at the five-year testing.

However, after the third comparative study, with the intervening training, the difference between the two groups in level of mental functioning had been greatly reduced. The mean difference of 10.6 IQ points (significant at the .001 level) obtained at the time of the second comparison study had shrunk to 6.3 IQ points (not statistically significant) at the time of the third comparison study. The fact that IQs increased also in the home children may reflect the continued nursery school experience, as well as additional parental stimulation induced by the knowledge that other children were included in this study.

At the third testing all children were given the Stanford-Binet Form L-M as well as the Bayley scales. There was not enough top on the Bayley scales for the brighter children. On the other hand, two of the children, both in the hospital sample, were unable to pass all six items at two years on the Stanford-Binet. We have therefore made the comparisons in two ways. To obtain Binet IQs, we assigned a basal age of eighteen months to the two who did not earn a two-year basal age. We also obtained "Bayley plus Binet" scores by adding one point for each Binet item passed to the Bayley scale raw point scores. These were compared with a similarly scored normal sample to obtain mental age-equivalents from which IQs were computed. The difference between the two groups is essentially the same by either method.

Item analysis of these six-year tests on the Bayley and Binet scales yields a total of six items which differentiate between the two groups of children. Success on these items depends all or in part on the ability to understand spoken directions and (in the case of the Stanford-Binet) to use expressive speech in an appropriate manner. The nature of these items reflects the continued superiority of the home-reared group in the area of language development, but the smaller number of significant items is indicative of the increased functioning level of the hospital- reared children and the less striking overall difference between the two groups of children.

In Figure 26 we see the comparison for scores on the motor scale.

At five years the home children were functioning at a higher (though not significantly higher) motor level than the hospital children. (The difference between the two groups had increased over that found for the two and one-half year olds. The tests at six years show the two groups to be functioning at approximately the same motor level.

The three motor scale items which differentiated at five years in favor of the home group, and also those items which tended toward significance, depend largely on the ability to maintain balance. These differences probably reflect a lack of experience on the part of the hospital group with playground equipment and toys which elicit development of the large muscles of the body. This conclusion is supported, at least in part, by the results of the item analysis of the motor scale results of the third comparative study, after the children had been given additional experience in large muscle activities. At this time only one item, "catches ball in arms," differentiated between the two groups of children.

In Figure 27, comparisons are shown for Vineland Social Maturity Quotients. The groups differ significantly at all ages, although the gap is somewhat smaller at the third comparison. The superior language facility of the home-reared group which was reflected in the item analysis of the second comparison study mental scale is also reflected in the item analysis of the social scale. Of the nine significant items in the social scale, two ("talks in short sentences" and "asks to go to the toilet") are specific instances of the ability to use language.

The failure of the Special Projects' group to function at the level of the control group on the remaining items is the result, at least in part, of a relative (sometimes complete) lack of occasions to learn the behaviors being measured. For example, the nursing personnel must give extra thought and time to creating situations which are a normal part of home routines. These include opportunities to help with household tasks, such as setting the table, cleaning up after a meal, putting toys away. Similarly, self-care in such tasks as washing one's hands and face, and toileting are more easily done by the caretakers than to take time (and patience) to let the child help himself. Other conditions which relate to the caretaker-child ratio, and specific hospital ward living situations tend to restrict the children's experiences. Scissors and forks had not been allowed because of the potential danger inherent in their use. Knives for cutting or spreading were not required for the semi-pureed consistency of the food that was being served to the children. Those two items on the Vineland Scale which approached significance ("washes hands unaided" and "walks upstairs unassisted") reflect this lack of opportunity to learn.

Of the four social scale items which differentiated between the two groups on the third comparison study, one, "relates experiences," is an indication that, even with the training program, the hospital children have not yet caught up with the home-reared children in language development.

These charts present average trends. For so small a sample, it is useful to test these trends by looking at individual cases. Figure 28 presents the IQs of three of the hospital subjects. Case A earned the highest scores. In the three-month period before he started to school, his IQs were thirty-four and thirty-seven. At the end of nine months of nursery school, his IQ was 39. At this time he entered the intensive language program, and now, nine months later, his IQ is 52. The curve for Case B is representative of most of the children, whose IQs might increase moderately with school, but definitely improve with language training. Even the poorest subject, Case C, held his own in IQ, at an age range when mongoloids are reported characteristically to have dropping IQs.

Not only have these children's vocabularies and IQs increased, but also their self-sufficiency, their general social behavior, and their evident pleasure in their new-found self-identities. Previous to the training program, the five-year-old hospital children had little or no expressive speech. Their vocabularies averaged about four words per child; and ranged from several children with no words, to the most verbal child with a vocabulary of about ten to twelve words. They could not tell their own or each other's names. With the exception of one youngster, the childrens' expressive and receptive vocabularies have grown impressively. All but two of the children are combining words. They know and can tell their own and the other children's names.

The improvement, moreover, is seen in other respects which are not specifically linguistic, but appear to result from better verbal communication. Formerly, they could not be trusted not to run away in the corridors or on the grounds if their hands were not held. None were able to go to the bathroom unattended; and to enter the dayhall with the children was to subject one's person to a thorough mauling with little hands reaching, tugging, poking, pulling, and grabbing everywhere.

As of now, the run-away problem has decreased appreciably. One child has become so trustworthy that he can be given a dime, allowed to walk to the candy machine, get a candy bar and return to the ward unattended. The candy machine is located approximately fifty yards and two corners down the corridor from the ward; there are several doors along the way, including two which open directly to the outside through which this youngster could pass if he so wished. About half of the children can be trusted to leave the dayhall, use the bathroom facilities, and return to the dayhall unattended and without incident (assistance from ward personnel is still required should a bowel movement occur). The incidence of socially unacceptable behavior when research personnel or strangers join the children has been appreciably reduced," (Bayley, Rhodes, and Gooch, 1966).

This study of the children with a diagnosed defect which is known drastically to limit intellectual potential, gives us clear evidence for the importance to intelligence of the right kind of environment. In this instance the effective environmental instrument has been emphasis on meaningful verbal communication and interactions with the persons and in the situations which are the continuing and significant aspects of their daily life.

These children now at six years of age are functioning at mental ages of about two and one-half years. Perhaps this experiment was instituted at a crucial period in the development of their potential for language comprehension and use. Among the many questions this study raises, we may ask whether the stage of mental development (when language is just emerging) is crucial. At what age or at what level of retardation will one find a "point of no return?" If such improvement occurs in these biologically damaged children, will it not be much greater in biologically normal but environmentally impoverished children?

When we look back to the half-dozen hypotheses offered, at the start of this talk, in explanation of the lack of consistency in mental scores before and after two years, we find that none of them is completely ruled out.

Early mental growth is rapid, though not chaotic. The nature of developing intellectual functions does change from simple processes to more complex ones after two years. Language does appear to be a very important aspect of mental growth. There is evidence that genetic factors are important in determining intellectual capacity. There is evidence that appropriate training can, within genetic or other biological limits, improve intellectual functioning. And there is evidence that parental attitudes and emotions which enhance or reduce the child's happiness and feelings of security may affect his mental growth.

Given this complex of causative factors, we may find ourselves immobilized with confusion and uncertainty as to where to turn. However, what we can do, is work to identify and specify more exactly the nature of all of the processes involved. As our knowledge of these processes increases we may hope to be increasingly effective in setting conditions and employing educational procedures that will enhance each child's mental adequacy within the limits of his own biological capacities. In particular we may find that we will be paid off richly if we explore extensively into the mental processes of that most difficult child to study--the "two-year-old."

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11. Correlations between ratings of maternal behavior in the first three years and intelligence scores of boys and of girls at four age levels, 1 to 12 months. The *rs* for all four sets of mental scores are opposite each maternal behavior item. (From N. Bayley and E. S. Schaefer, *op. cit.*, p. 20.)

12. Correlations between ratings of maternal behavior in the first three years and intelligence scores of boys and of girls at four age levels, 13 to 54 months. (*Ibid.*, p. 22.)

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14. Correlations between maternal behavior (0 to 3 years) and children's happiness at four age levels (10 to 36 months). (From N. Bayley. Developmental . . ., in press.)

15. Correlations between ratings of happiness, boys and girls, 10 to 36 months, and intelligence, 1 month to 18 years. (From N. Bayley and E. S. Schaefer, *op. cit.*, p. 39.)

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17. Correlations between ratings of activity, boys and girls, 10 to 36 months, and intelligence, 1 month to 18 years. (From N. Bayley and E. S. Schaefer, *op. cit.*, p. 38.)

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23. Correlations of vocalization factor scores (8 to 13 months) with IQs at all ages. (Ibid., in press.)

24. Correlations of preschool verbal knowledge factor scores (25 to 72 months) with IQs at all ages. (Ibid., in press.)

25. Mean IQs at 2 1/2, 5 and 6 years of 10 hospital-reared and 10 home-reared mongoloids. (From N. Bayley, L. Rhodes and B. Gooch. A comparison of the growth and development of institutionalized and home-reared mongoloids: A follow-up study. Pre-publication copy no. 356, State of California, Department of Mental Hygiene, 1966.)

26. Mean motor quotients at 2 1/2, 5, and 6 years of 10 hospital-reared and 10 home-reared mongoloids. (Ibid.)

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28. Individual curves of IQs earned by hospital-reared mongoloids showing relation of scores to schooling and to a language training program: A, the best scorer; B, a representative child; and C, the poorest scorer. (Ibid.)

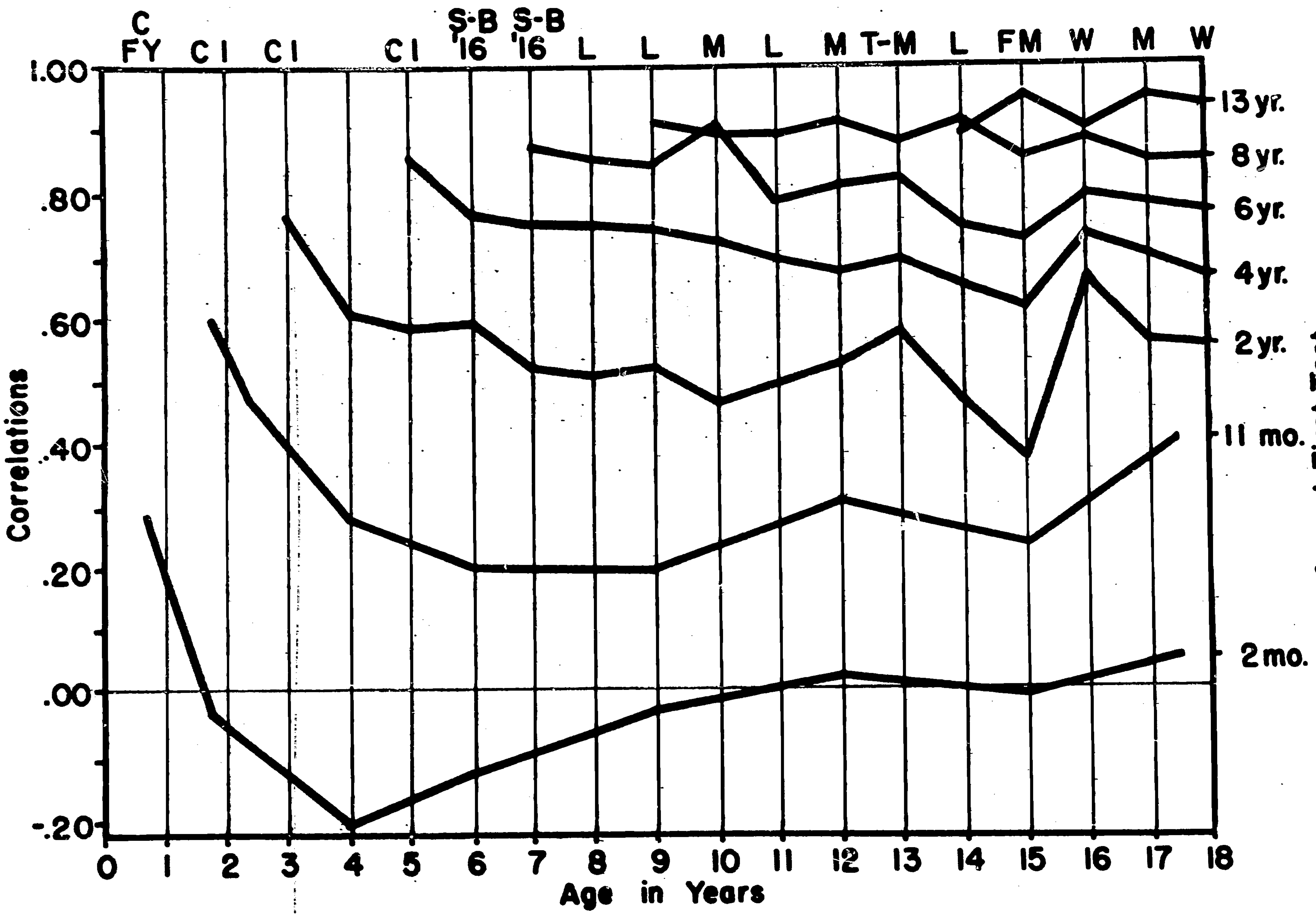

C FY
CI
CI
CI
S-B '16
S-B '16
L
L
M
L
M
T-M
L
FM
W
M
W
1.00
.80
.60
.40
.20
.00
-.20
Correlations
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Age in Years
13 yr.
8 yr.
6 yr.
4 yr.
2 yr.
11 mo.
2 mo.
Age at First Test

Fig. 1

MENTAL CORRELATIONS OF EARLIER TEST SCORES WITH 16-18 YEAR SCORES

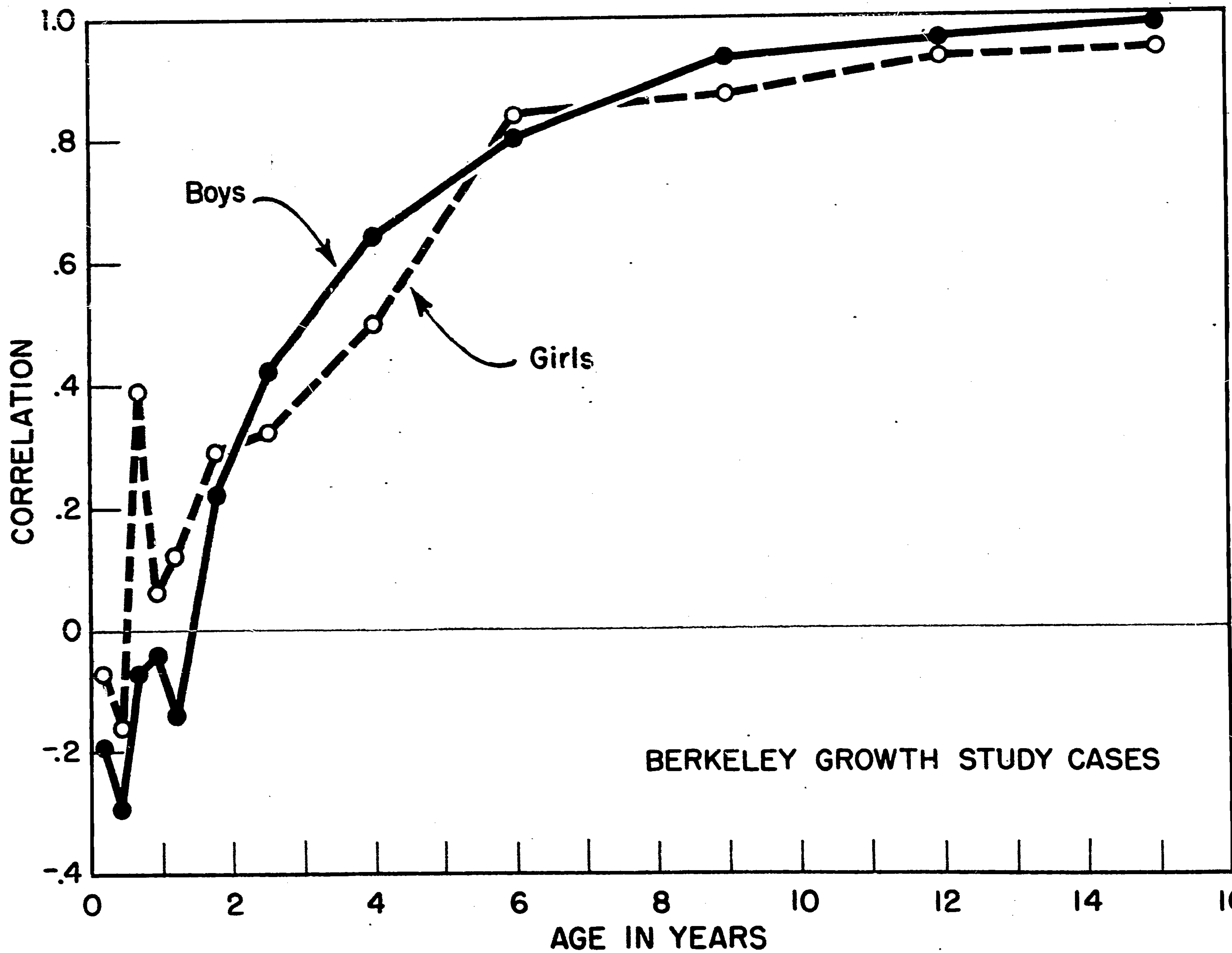
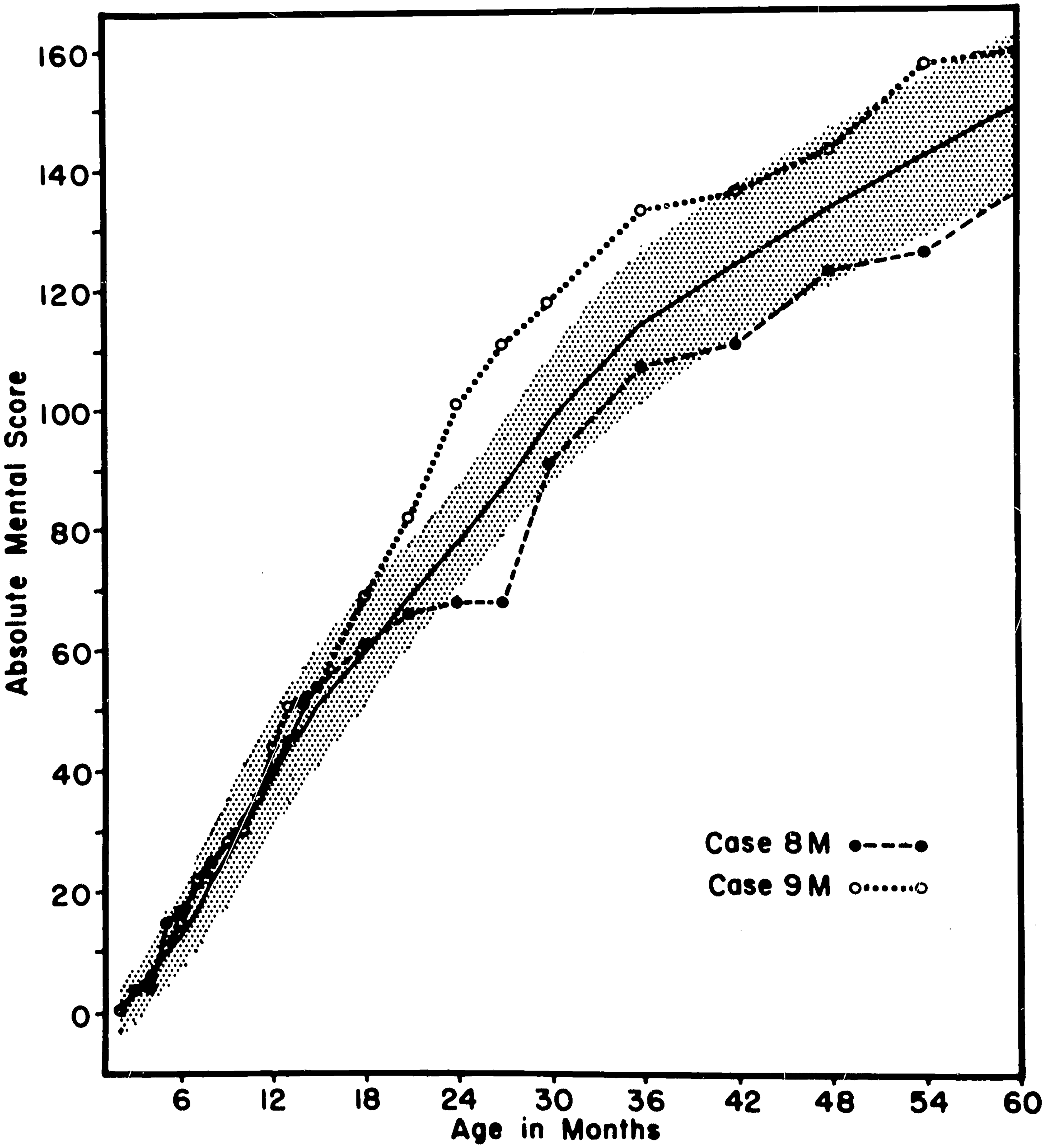


Fig. 2

Fig. 3



160
140
120
100
80
60
40
20
0
Absolute Mental Score
6
12
18
24
30
36
42
48
54
60
Age in Months
Case 8M
Case 9M

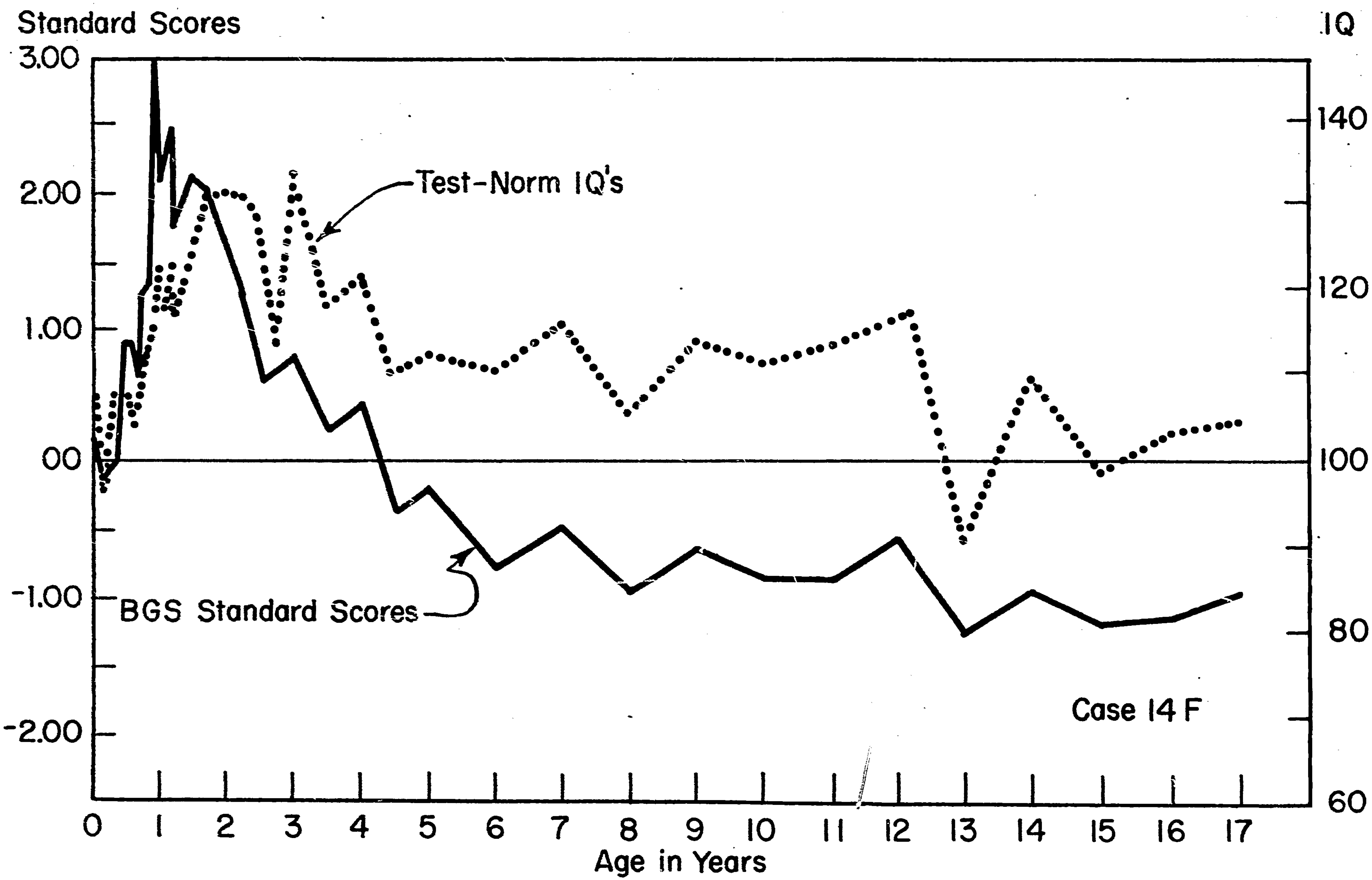
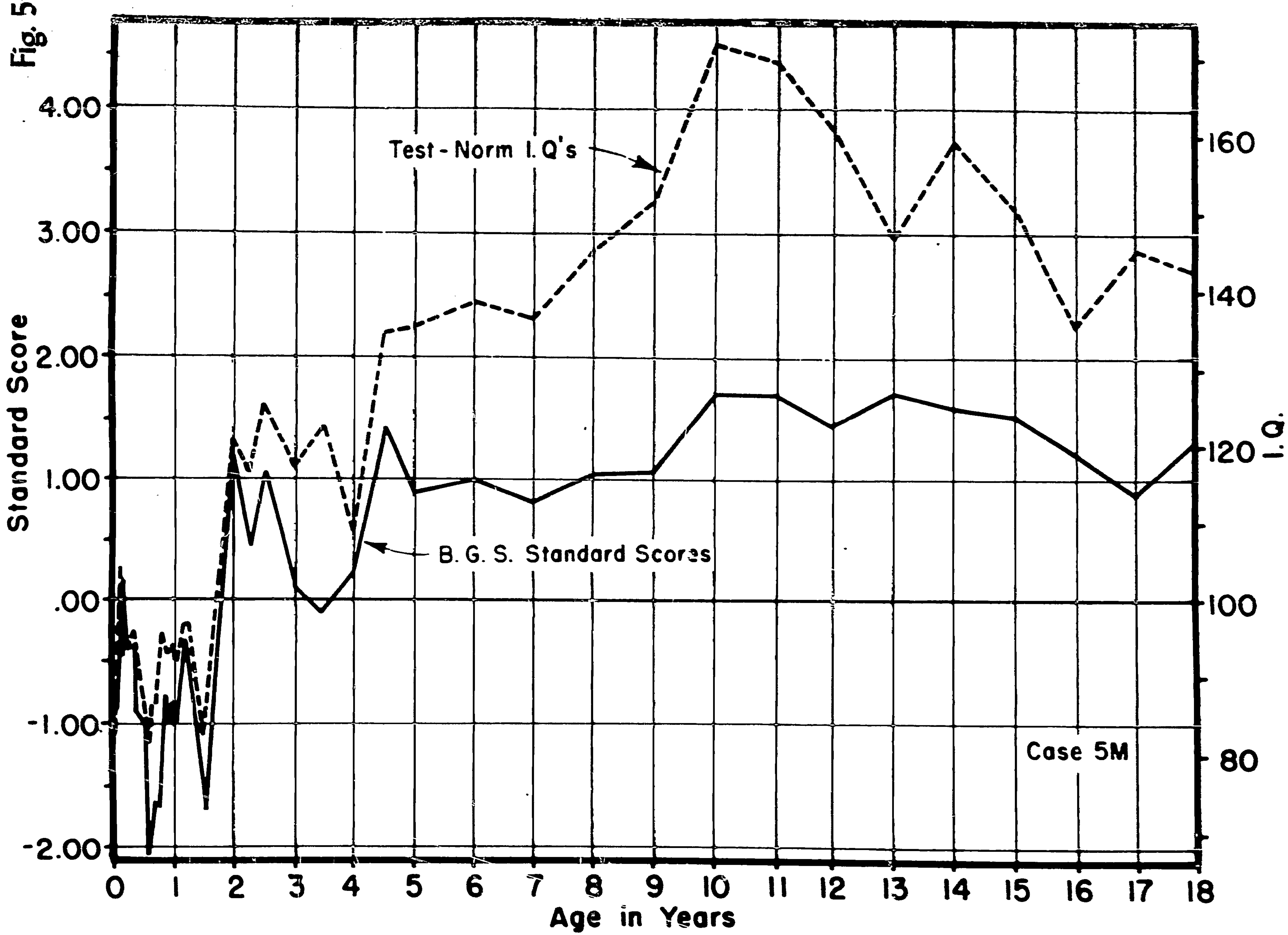

Standard Scores
3.00
2.00
1.00
00
-1.00
-2.00
IQ
140
120
100
80
60
Test-Norm IQ's
BGS Standard Scores
Case 14 F
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Age in Years

Fig. 4

Fig. 5



Standard Score
4.00
3.00
2.00
1.00
.00
-1.00
-2.00
Test - Norm I. Q's
B. G. S. Standard Scores
Case 5M
160
140
120
100
80
I. Q.
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18
Age in Years

Fig. 6

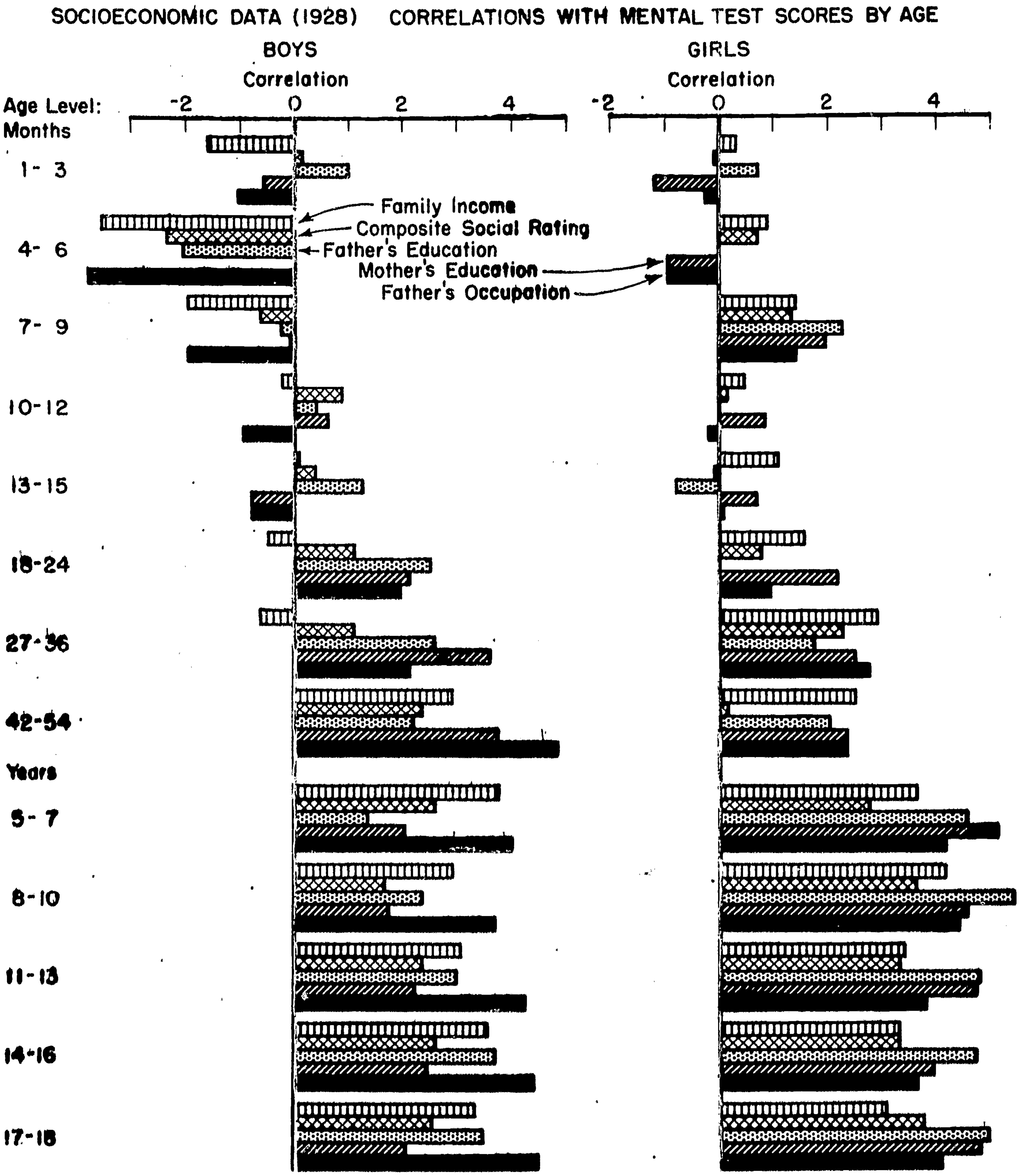
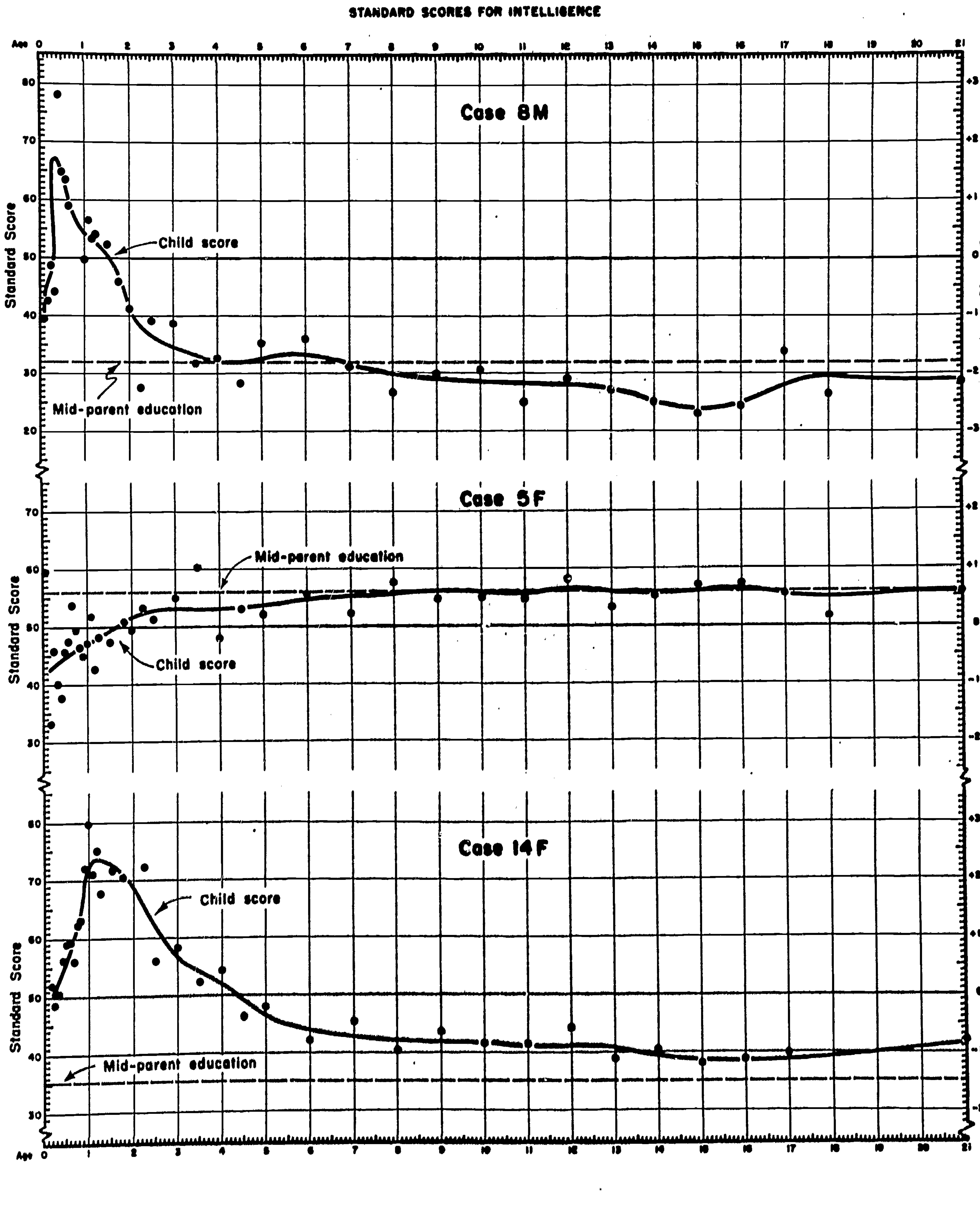

SOCIOECONOMIC DATA (1928) CORRELATIONS WITH MENTAL TEST SCORES BY AGE
BOYS
Correlation
GIRLS
Correlation
Age Level:
Months
-2
0
2
4
1- 3
4- 6
7- 9
10-12
13-15
18-24
27-36
42-54
Years
5- 7
8-10
11-13
14-16
17-18
Family Income
Composite Social Rating
Father's Education
Mother's Education
Father's Occupation

Fig. 7


STANDARD SCORES FOR INTELLIGENCE
Case 8M
Child score
Mid-parent education
Case 5F
Mid-parent education
Child score
Case 14F
Child score
Mid-parent education
Standard Score
Sigma Score
Age

BERKLEY GROWTH STUDY. CORRELATIONS OF CHILDS IQ WITH ESTIMATES OF MOTHER'S IQ MADE FROM NOTES ON MATERNAL BEHAVIOR AT TWO AGE LEVELS

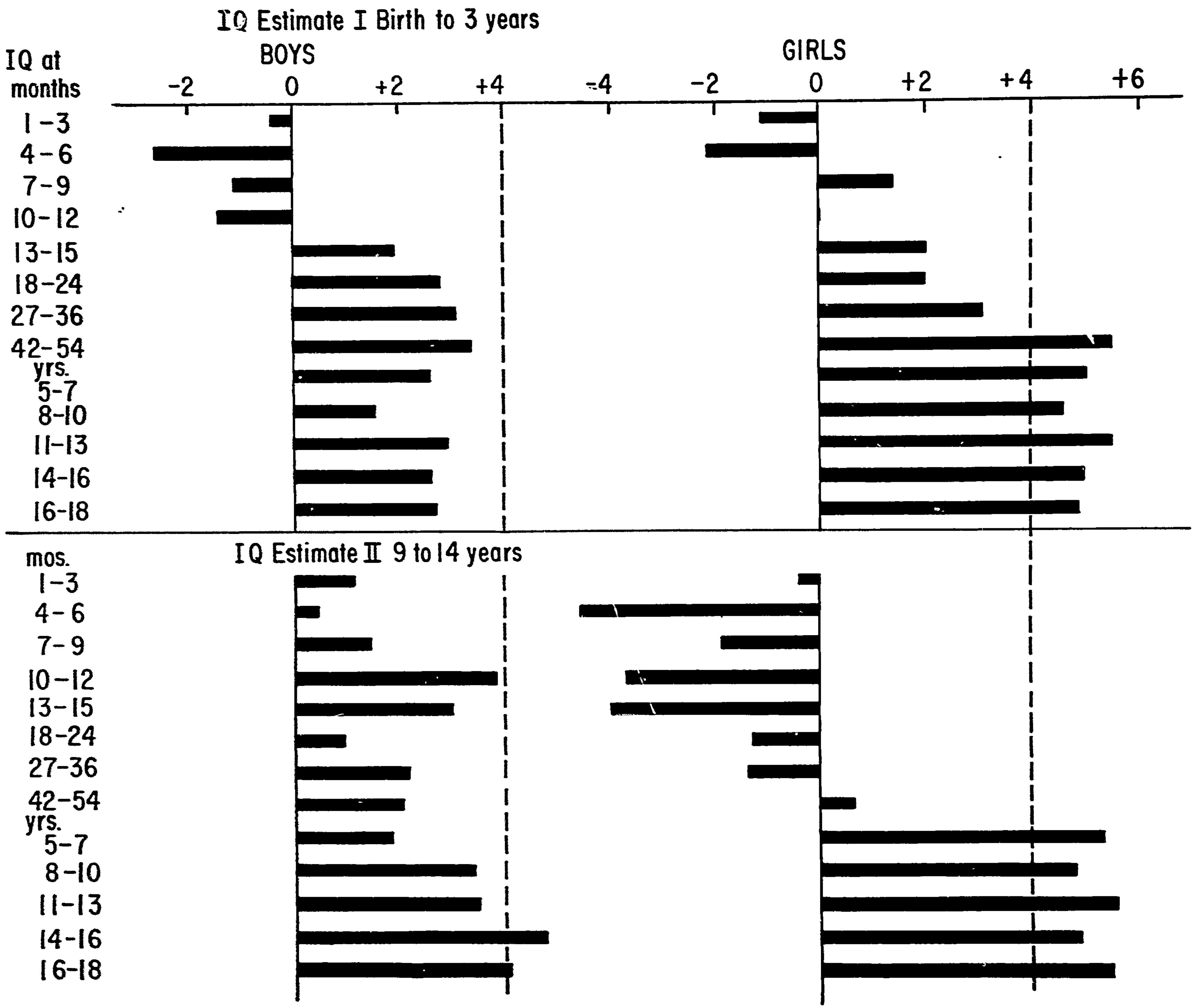


Fig 8

CORRELATIONS: BOYS' AND GIRLS' IQS WITH EDUCATION OF TRUE AND ADOPTIVE PARENTS AND IQ OF TRUE MOTHERS
(FROM SKODAK AND SKEELS, 1949)

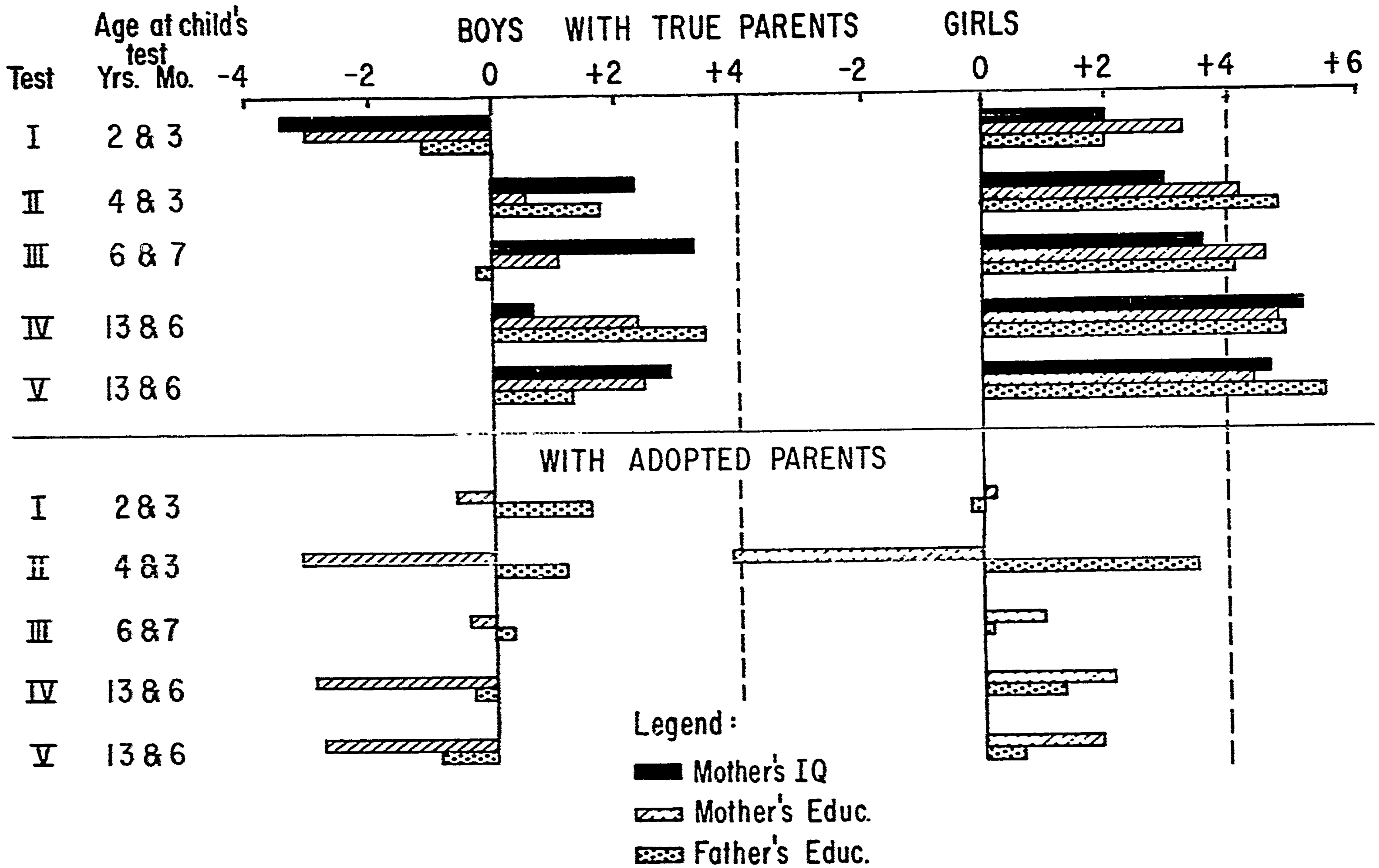
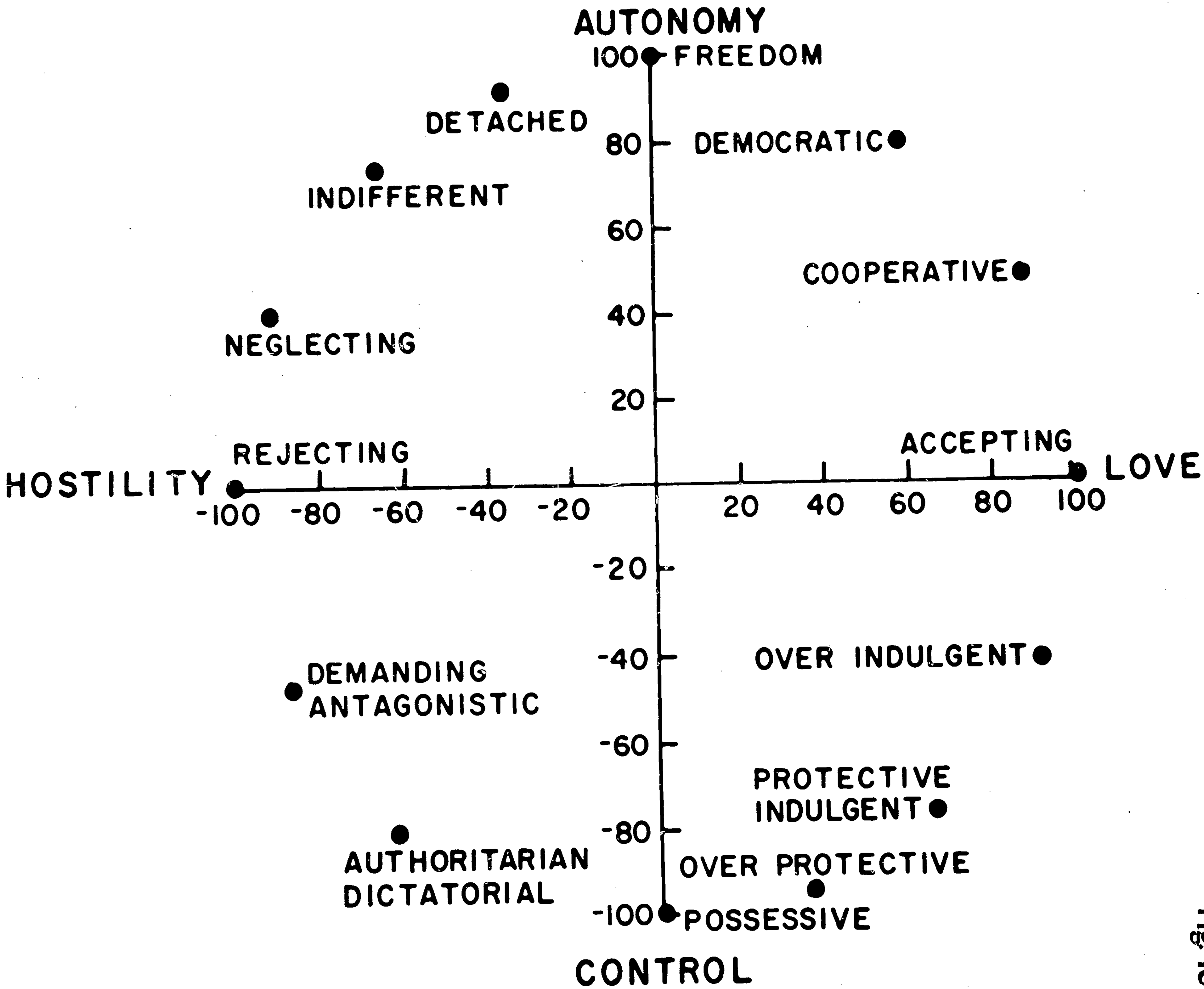


Fig. 9



AUTONOMY
FREEDOM
DETACHED
DEMOCRATIC
INDIFFERENT
COOPERATIVE
NEGLECTING
REJECTING
ACCEPTING
HOSTILITY
LOVE
DEMANDING
ANTAGONISTIC
OVER INDULGENT
PROTECTIVE
INDULGENT
AUTHORITARIAN
DICTATORIAL
OVER PROTECTIVE
POSSESSIVE
CONTROL
100
80
60
40
20
-20
-40
-60
-80
-100

Fig. 10

CORRELATIONS BETWEEN MATERNAL BEHAVIOR (0-3 YRS.) x INTELLIGENCE (4 AGE LEVELS, 1-12 MOS.)

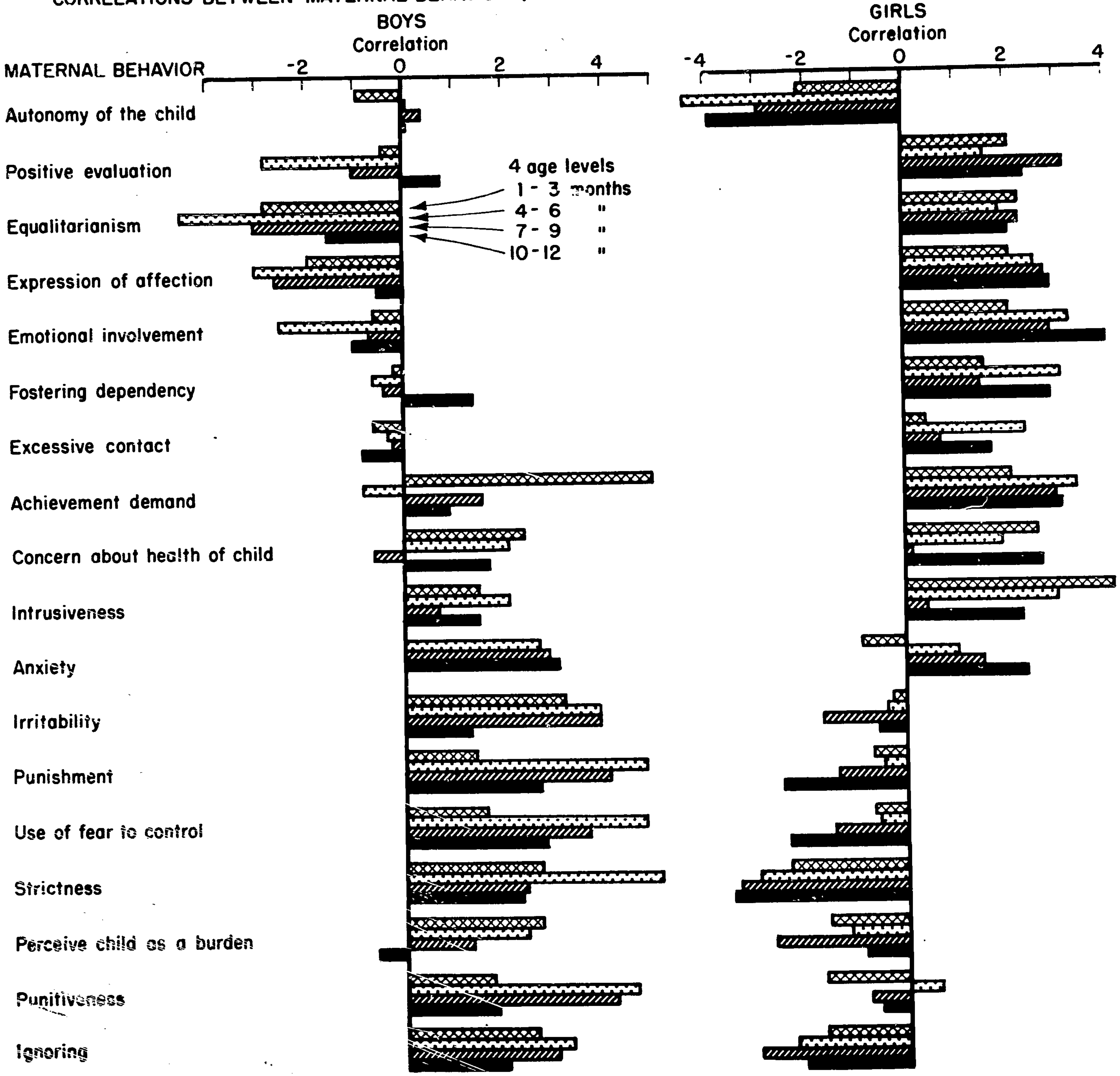


Fig. II

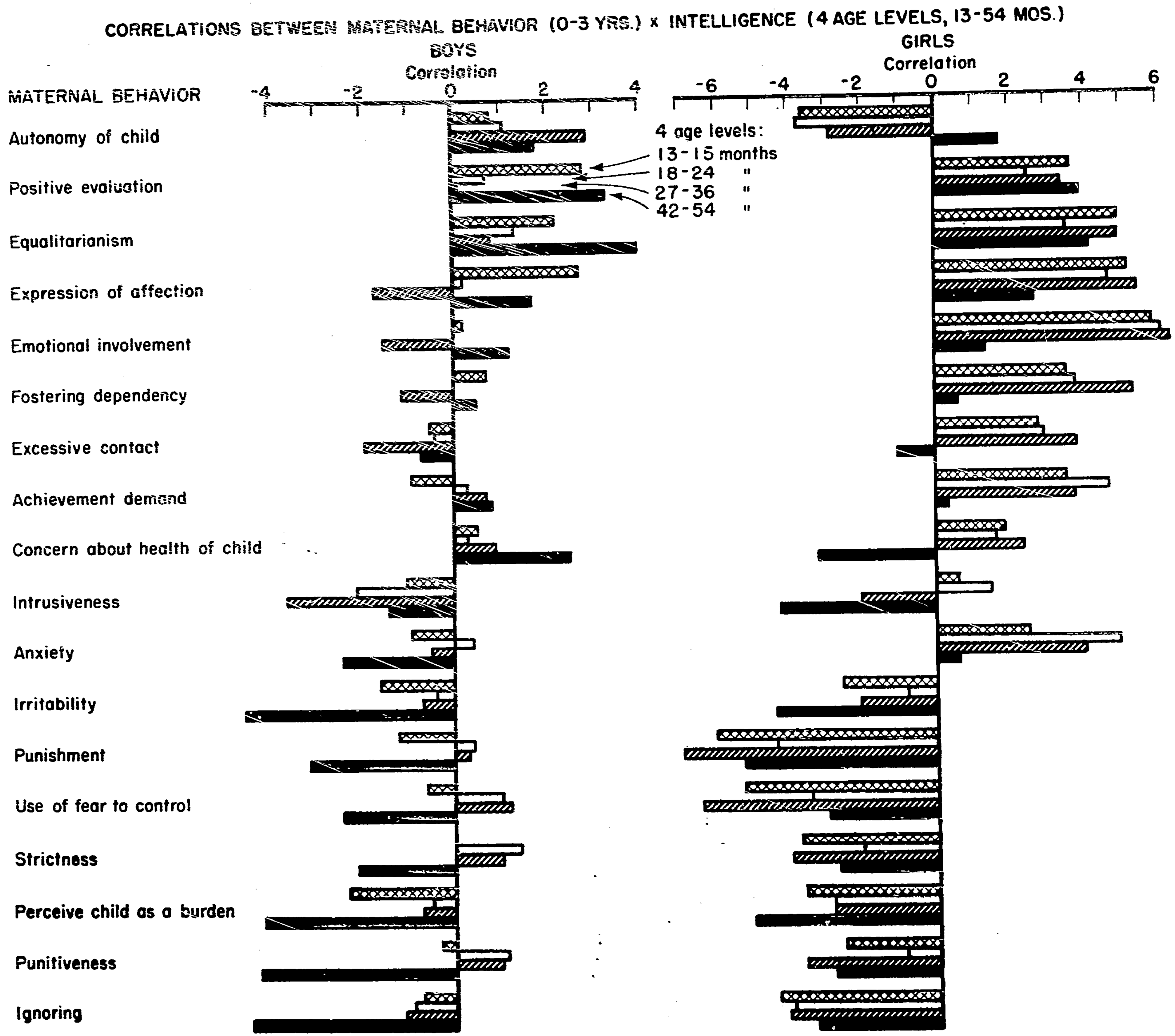
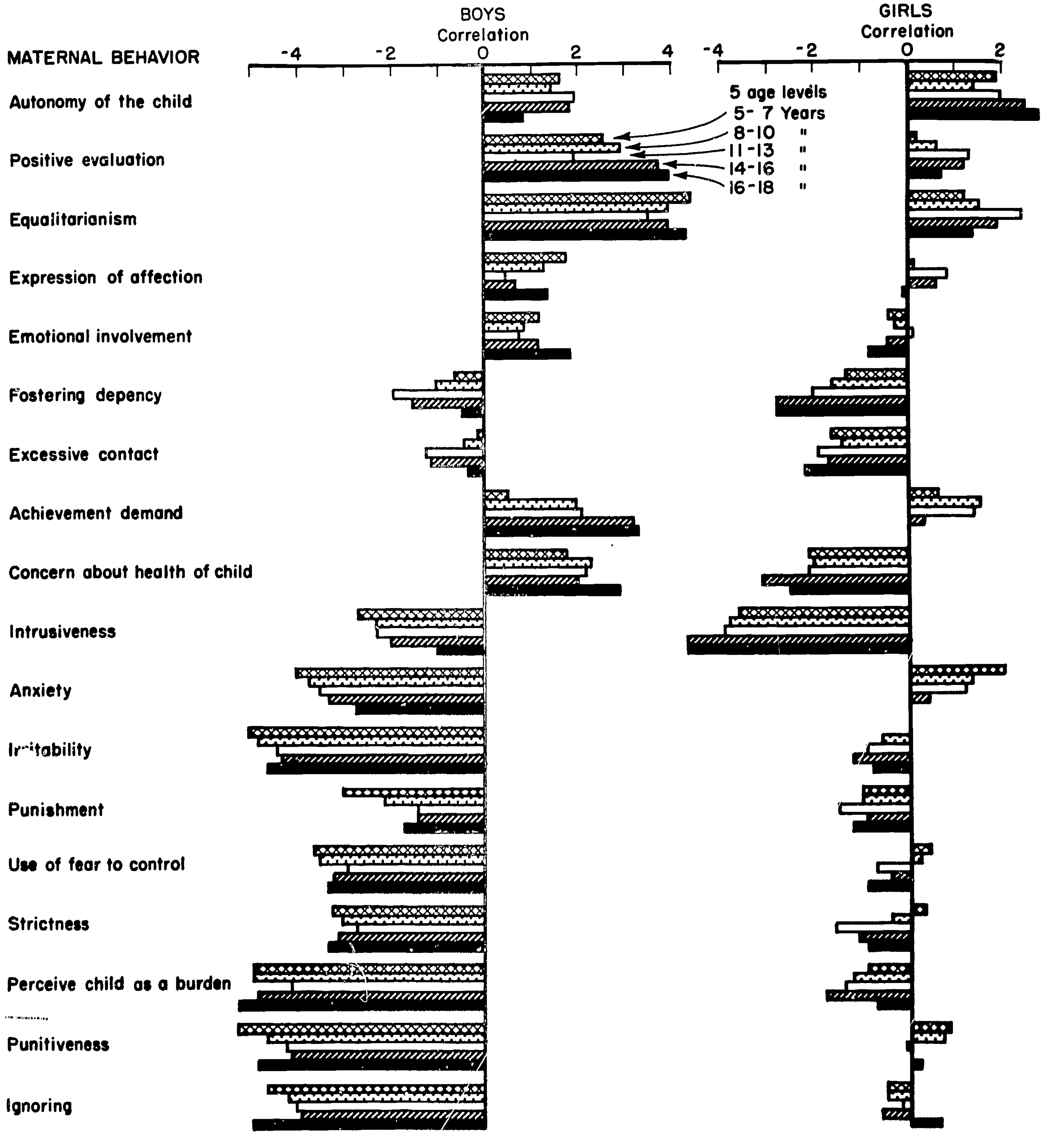

CORRELATIONS BETWEEN MATERNAL BEHAVIOR (0-3 YRS.) x INTELLIGENCE (4 AGE LEVELS, 13-54 MOS.)
BOYS
Correlation
GIRLS
Correlation
MATERNAL BEHAVIOR
-4
-2
0
2
4
-6
-4
-2
0
2
4
6
4 age levels:
13-15 months
18-24 "
27-36 "
42-54 "
Autonomy of child
Positive evaluation
Equalitarianism
Expression of affection
Emotional involvement
Fostering dependency
Excessive contact
Achievement demand
Concern about health of child
Intrusiveness
Anxiety
Irritability
Punishment
Use of fear to control
Strictness
Perceive child as a burden
Punitiveness
Ignoring

Fig. 12

Fig. 13

CORRELATIONS BETWEEN MATERNAL BEHAVIOR (0-3 YRS.) x INTELLIGENCE (5 AGE LEVELS, 5-18 YEARS)



CORRELATIONS BETWEEN MATERNAL BEHAVIOR (0-3 Yrs.) AND CHILDREN'S HAPPINESS AT FOUR AGE LEVELS (10-36 Mos.)

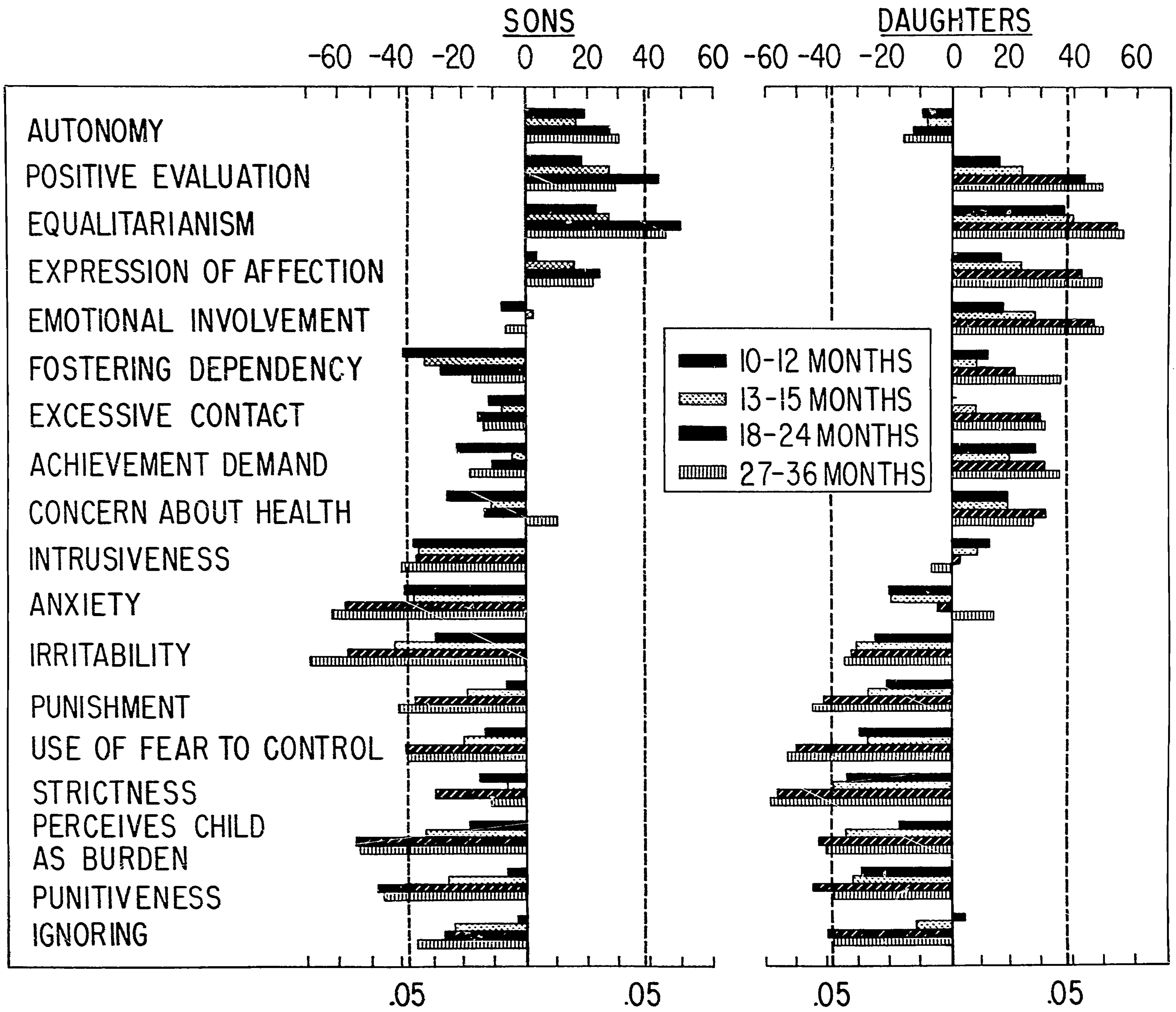


Fig. 14

Fig. 15

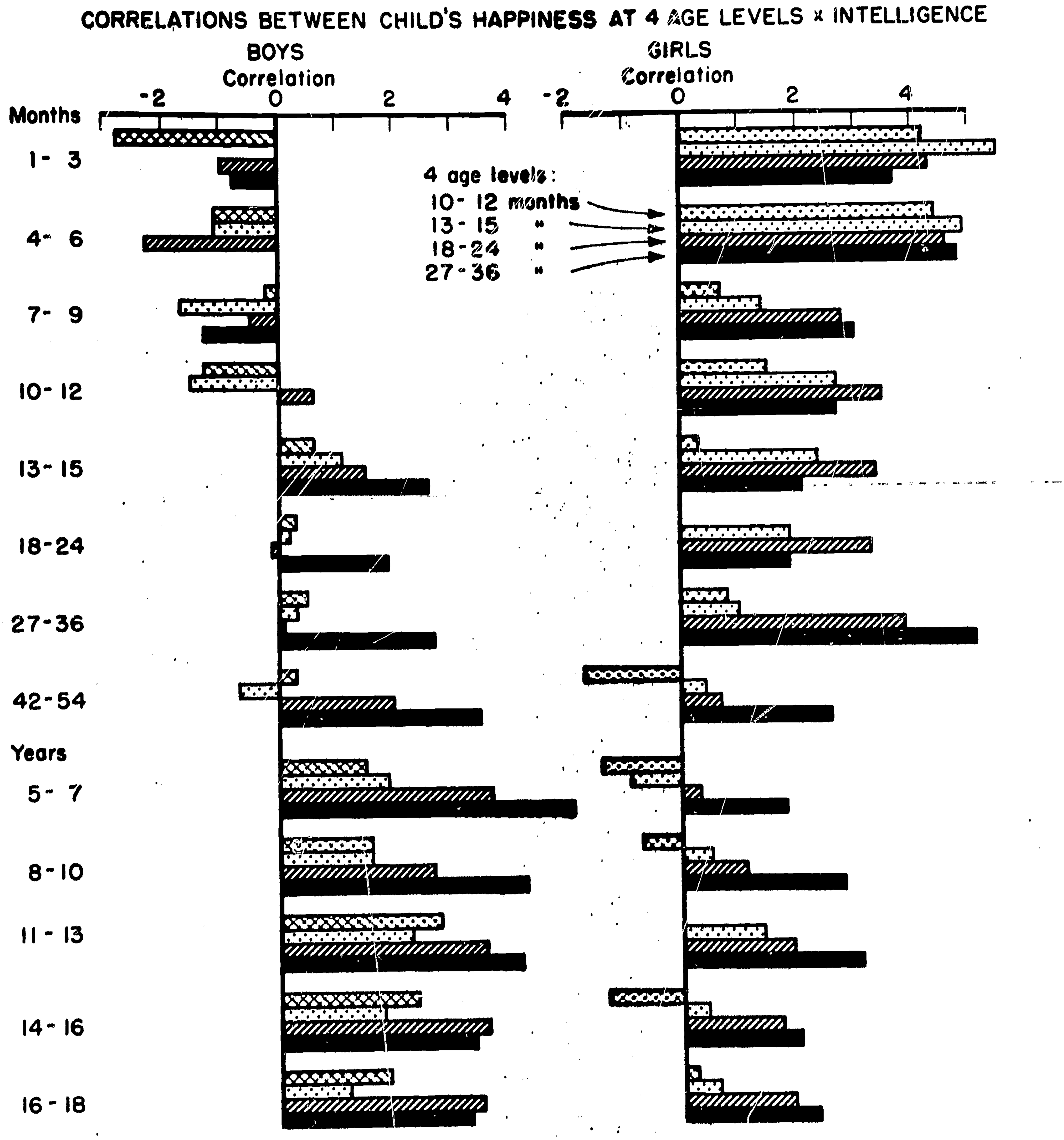
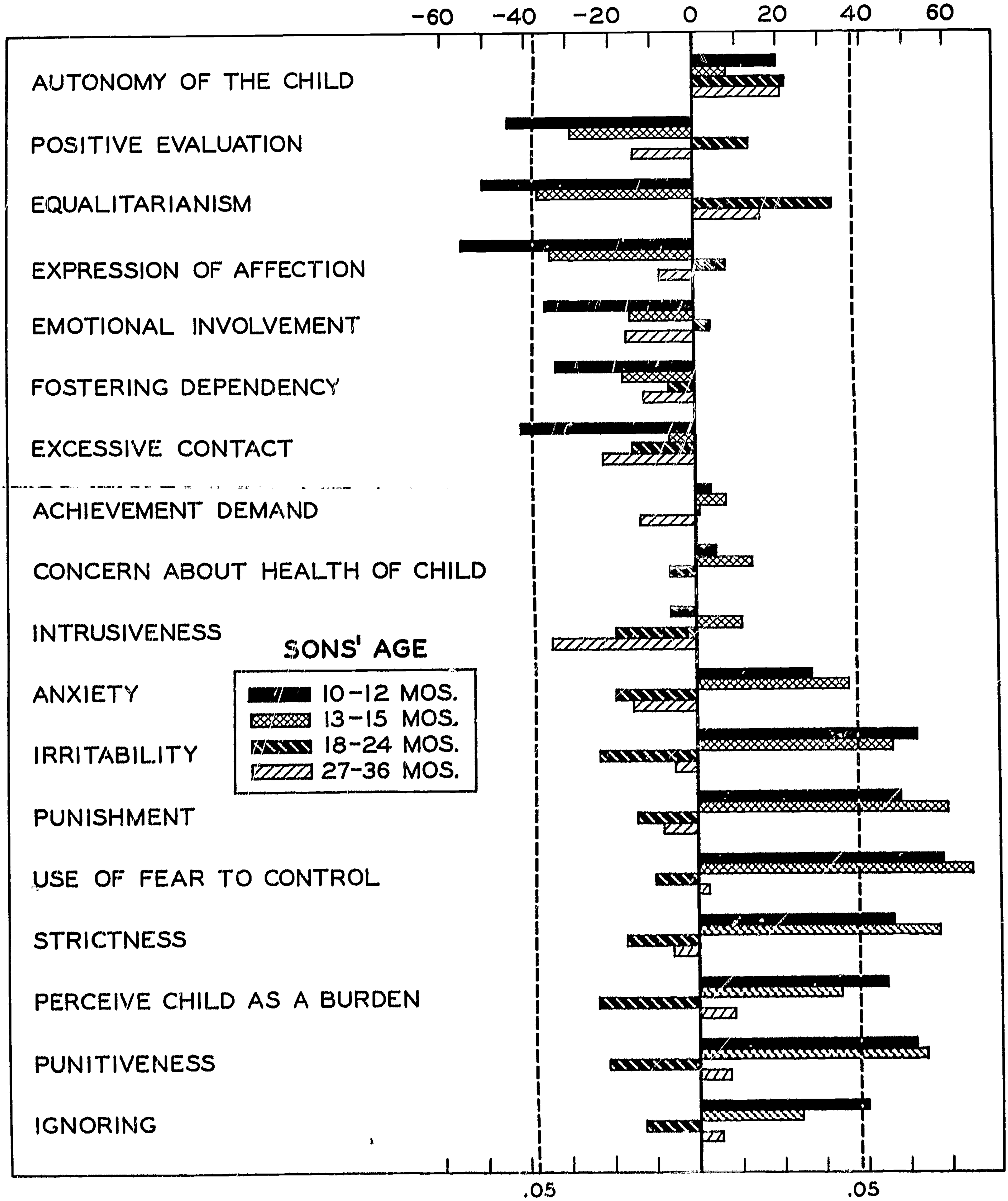

CORRELATIONS BETWEEN CHILD'S HAPPINESS AT 4 AGE LEVELS x INTELLIGENCE
BOYS
Correlation
GIRLS
Correlation
-2
0
2
4
Months
1- 3
4- 6
7- 9
10- 12
13- 15
18-24
27-36
42-54
Years
5- 7
8-10
11 - 13
14- 16
16 - 18
4 age levels:
10- 12 months
13- 15 "
18-24 "
27-36 "

Fig. 16

CORRELATIONS BETWEEN MATERNAL BEHAVIOR (0-3 YRS.) AND SONS' ACTIVITY AT FOUR AGE LEVELS (10-36 MOS.)



CORRELATIONS BETWEEN CHILD'S ACTIVITY AT 4 AGE LEVELS x INTELLIGENCE

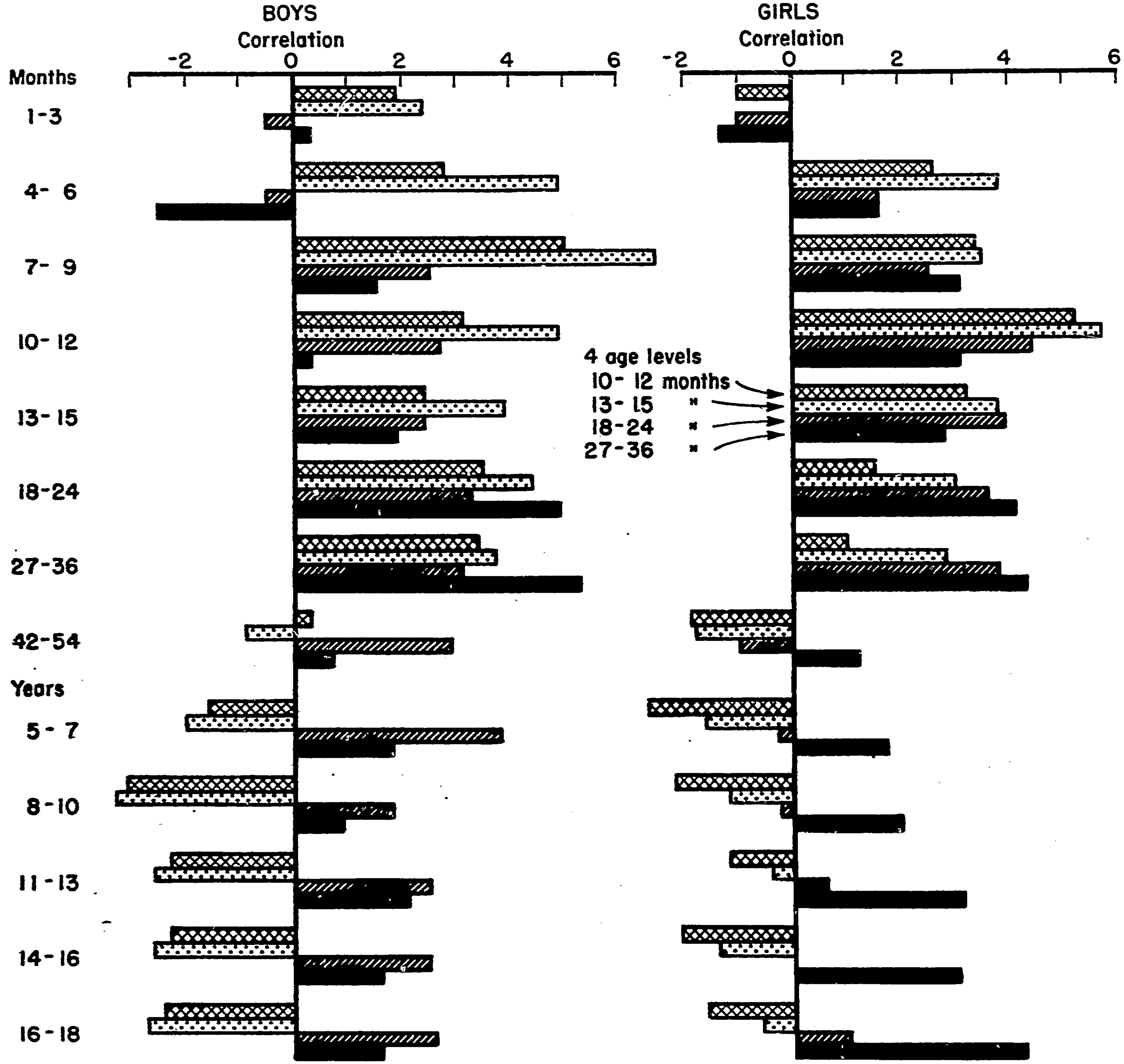


Fig. 17

CORRELATIONS BETWEEN CHILD'S RAPIDITY AT 4 AGE LEVELS x INTELLIGENCE

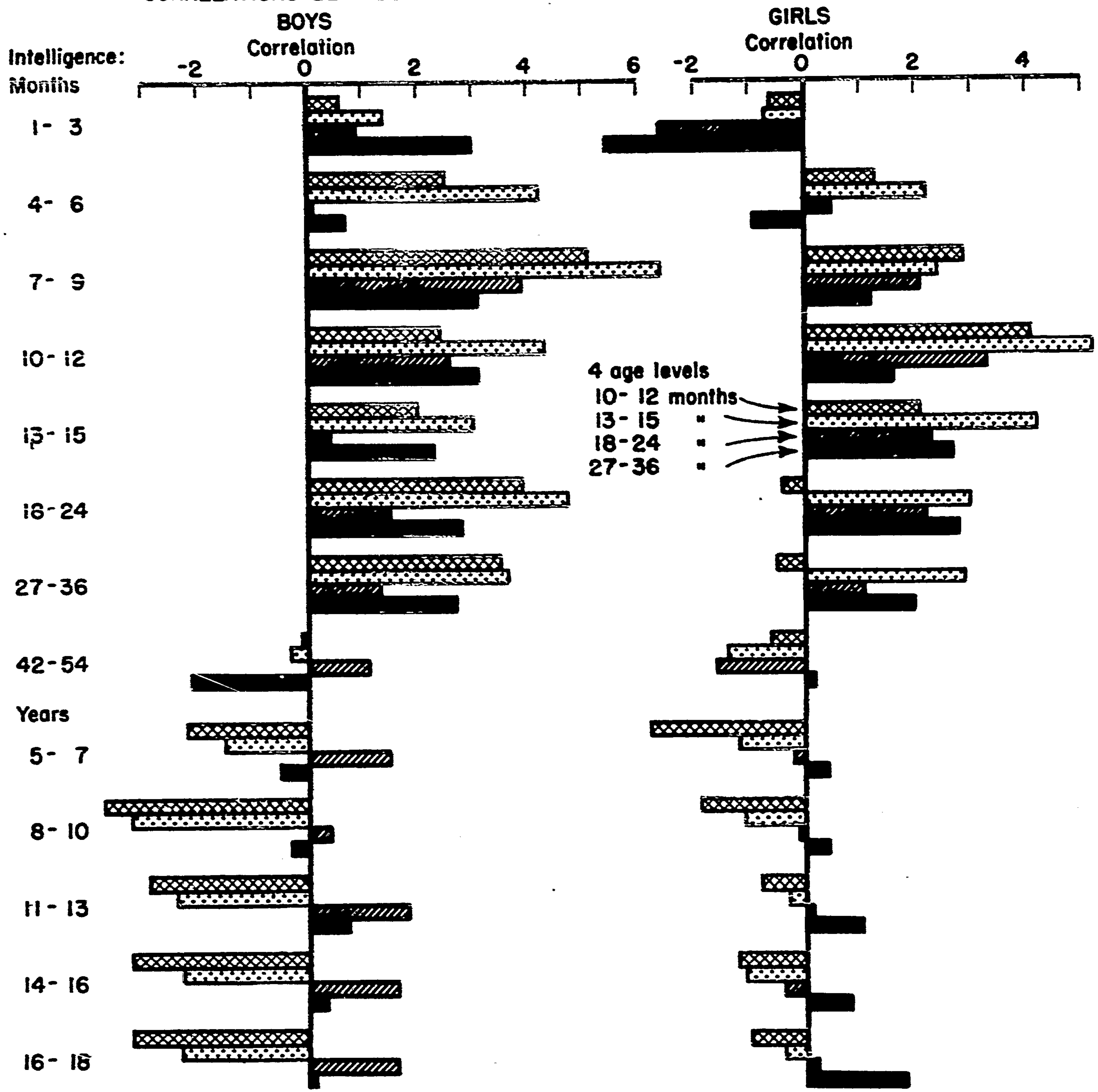


Fig. 18

CORRELATIONS BETWEEN CHILD'S POSITIVE BEHAVIOR AT 4 AGE LEVELS x INTELLIGENCE

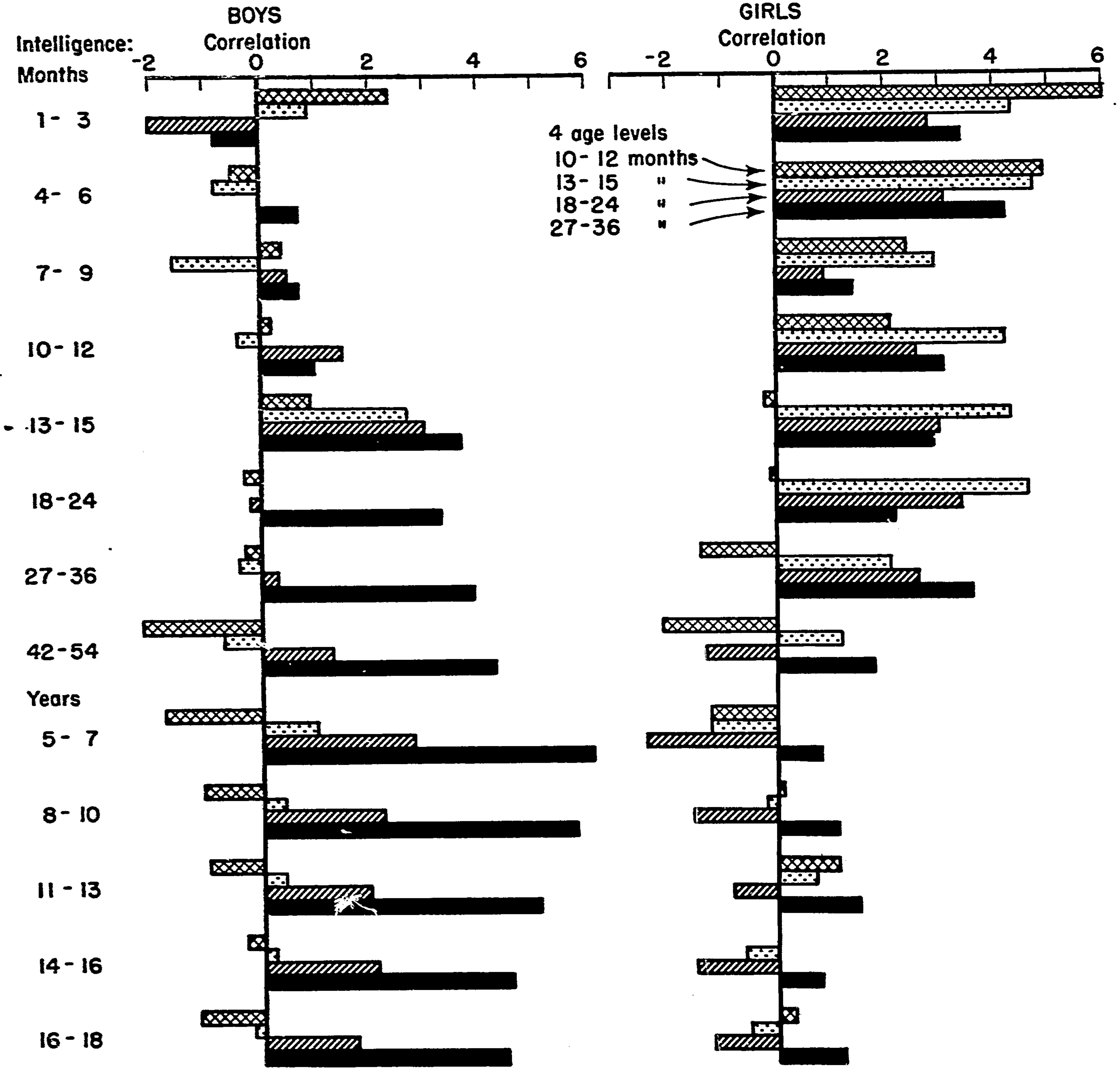
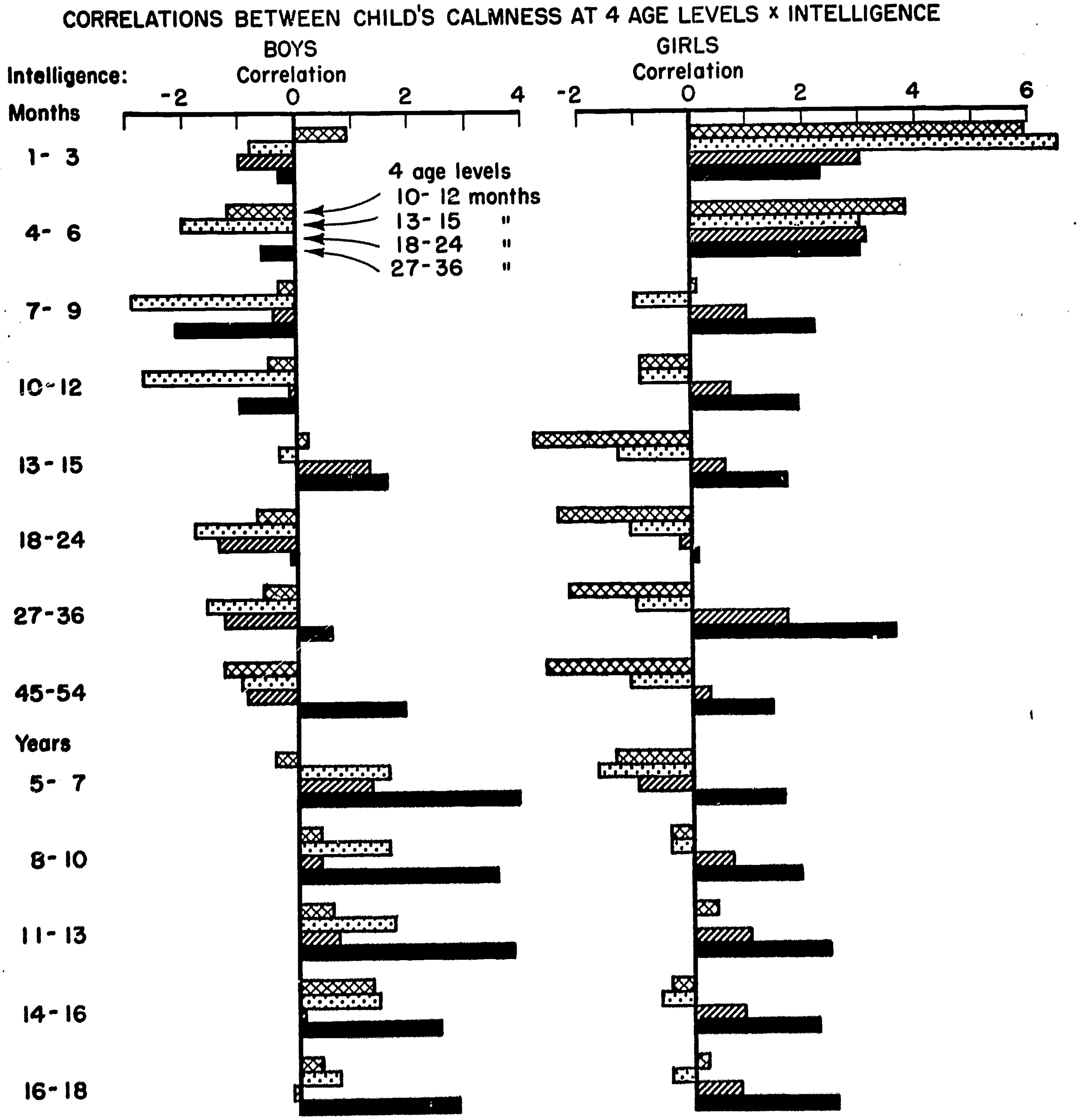


Fig. 19

Fig. 20


CORRELATIONS BETWEEN CHILD'S CALMNESS AT 4 AGE LEVELS x INTELLIGENCE
BOYS
Correlation
GIRLS
Correlation
Intelligence:
Months
-2
0
2
4
6
1- 3
4- 6
7- 9
10-12
13-15
18-24
27-36
45-54
Years
5- 7
8-10
11-13
14-16
16-18
4 age levels
10- 12 months
13- 15 "
18-24 "
27-36 "

CORRELATIONS BETWEEN CHILD'S SHYNESS AT 4 AGE LEVELS x INTELLIGENCE

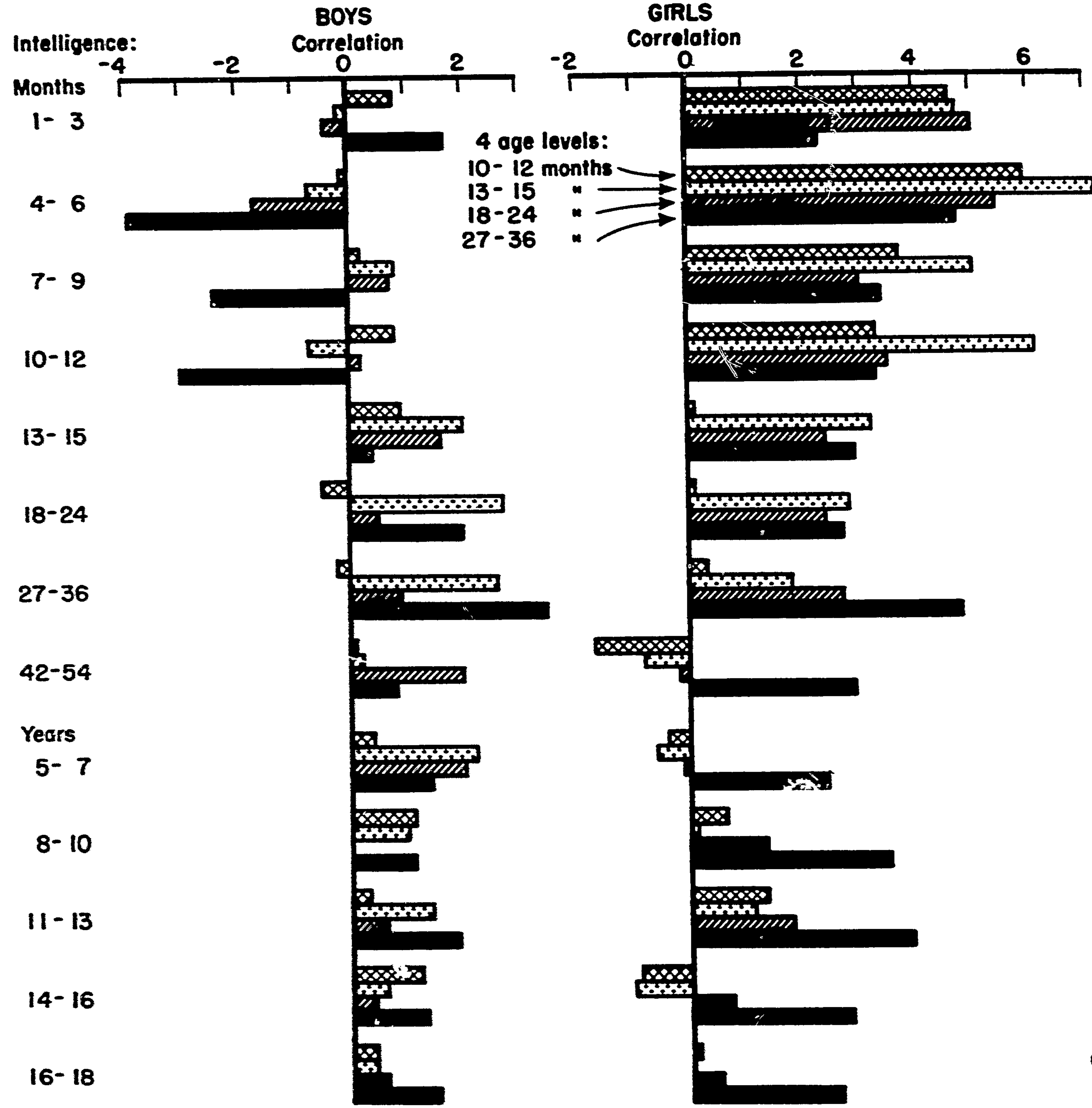


Fig. 21

CORRELATIONS OF TOTAL MENTAL SCORES (10-12 mo.) WITH IQ's AT ALL AGES

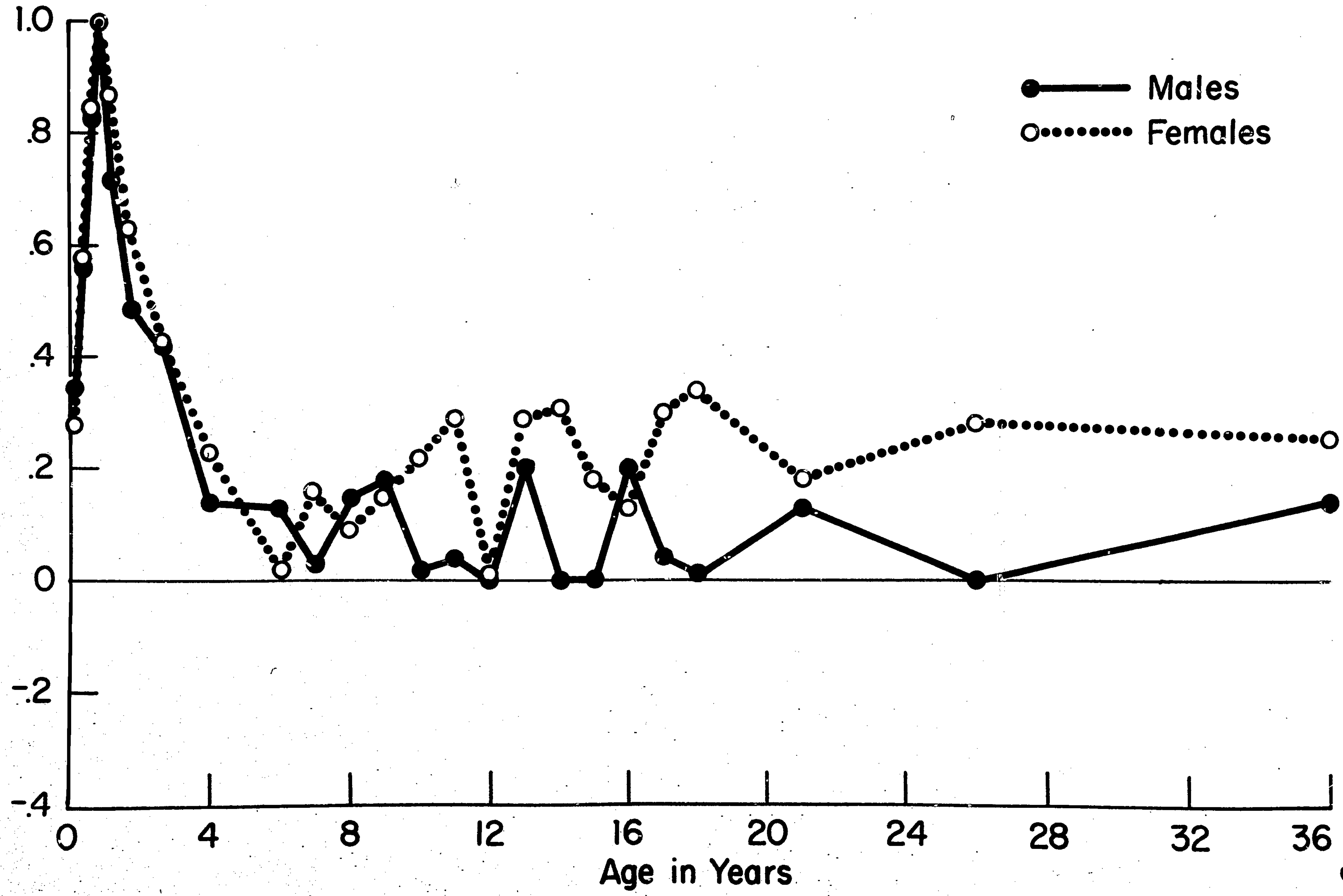


Fig. 22

CORRELATIONS OF VOCALIZATION FACTOR SCORES (8–13 mo) WITH IQ's AT ALL AGES

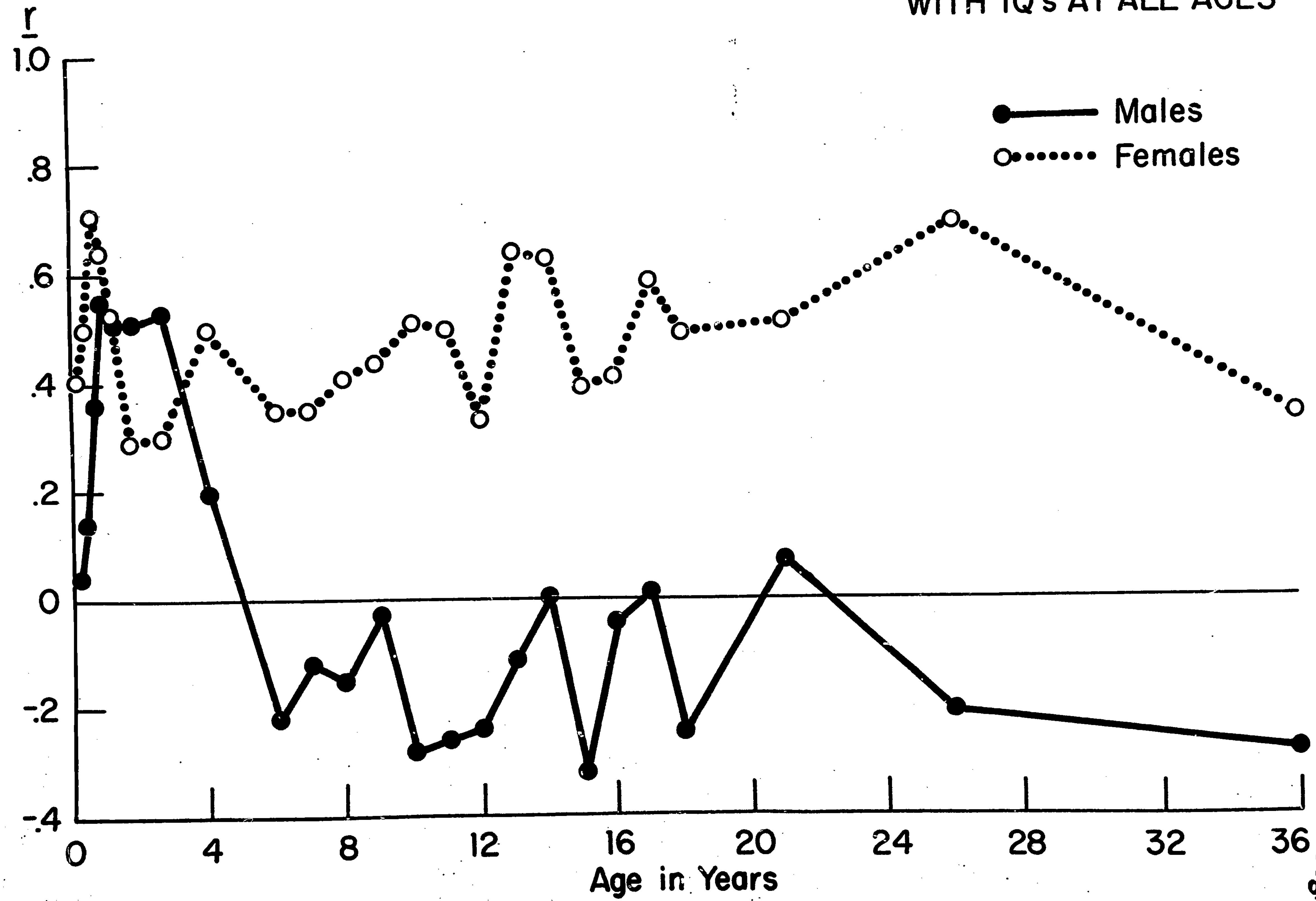


Fig. 23

CORRELATIONS OF PRESCHOOL VERBAL KNOWLEDGE FACTOR SCORES (25-72 mo) WITH IQ's AT ALL AGES

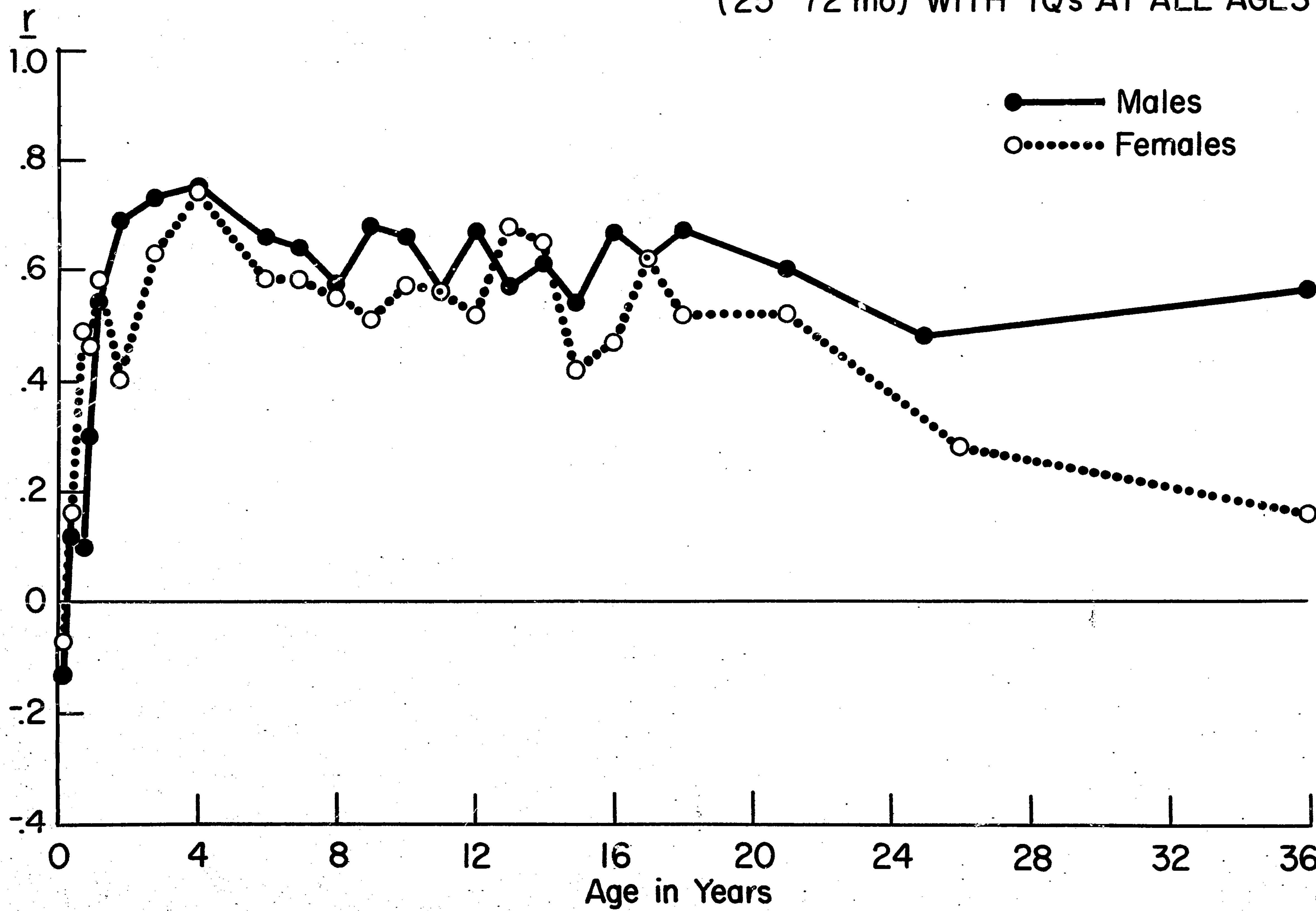
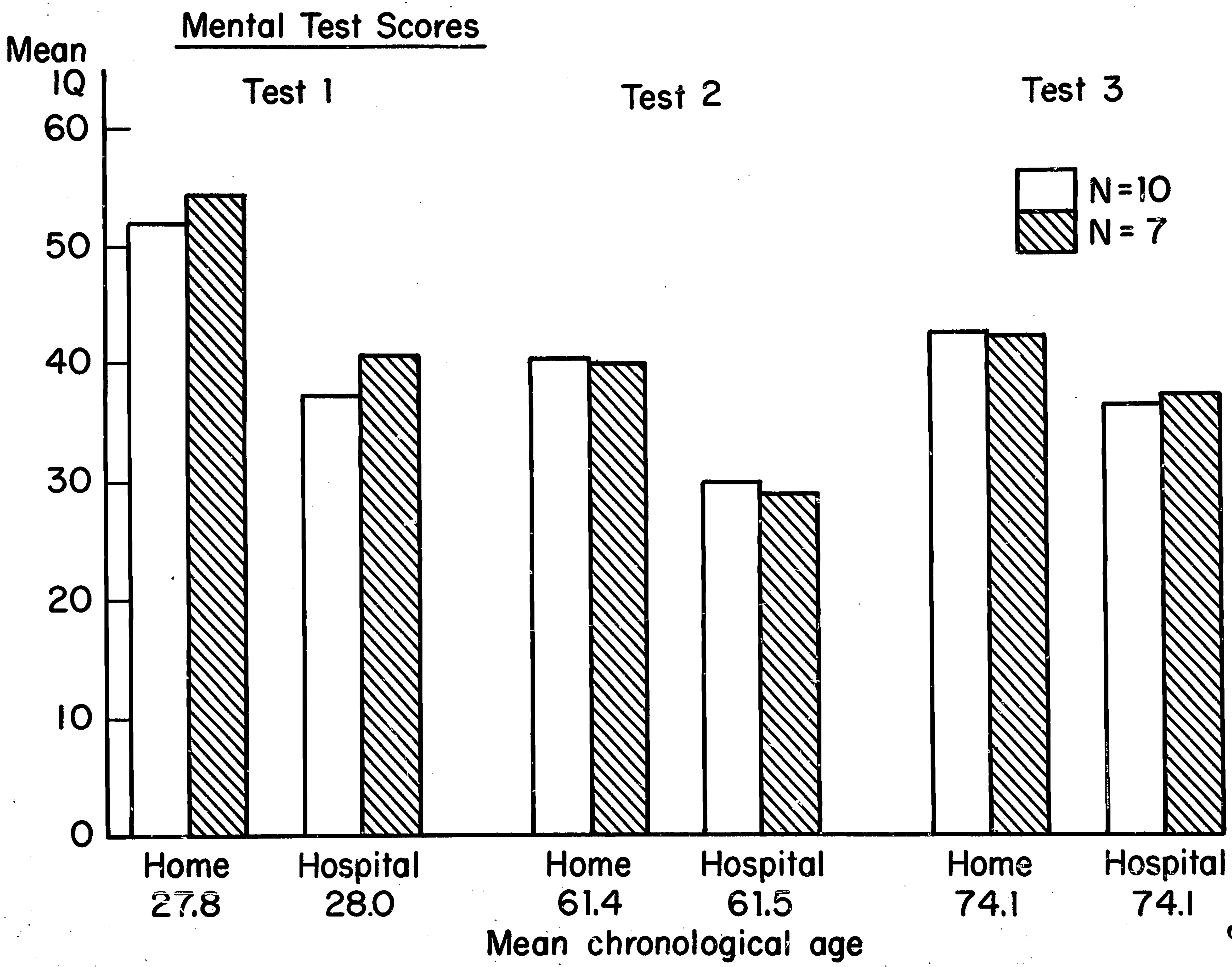
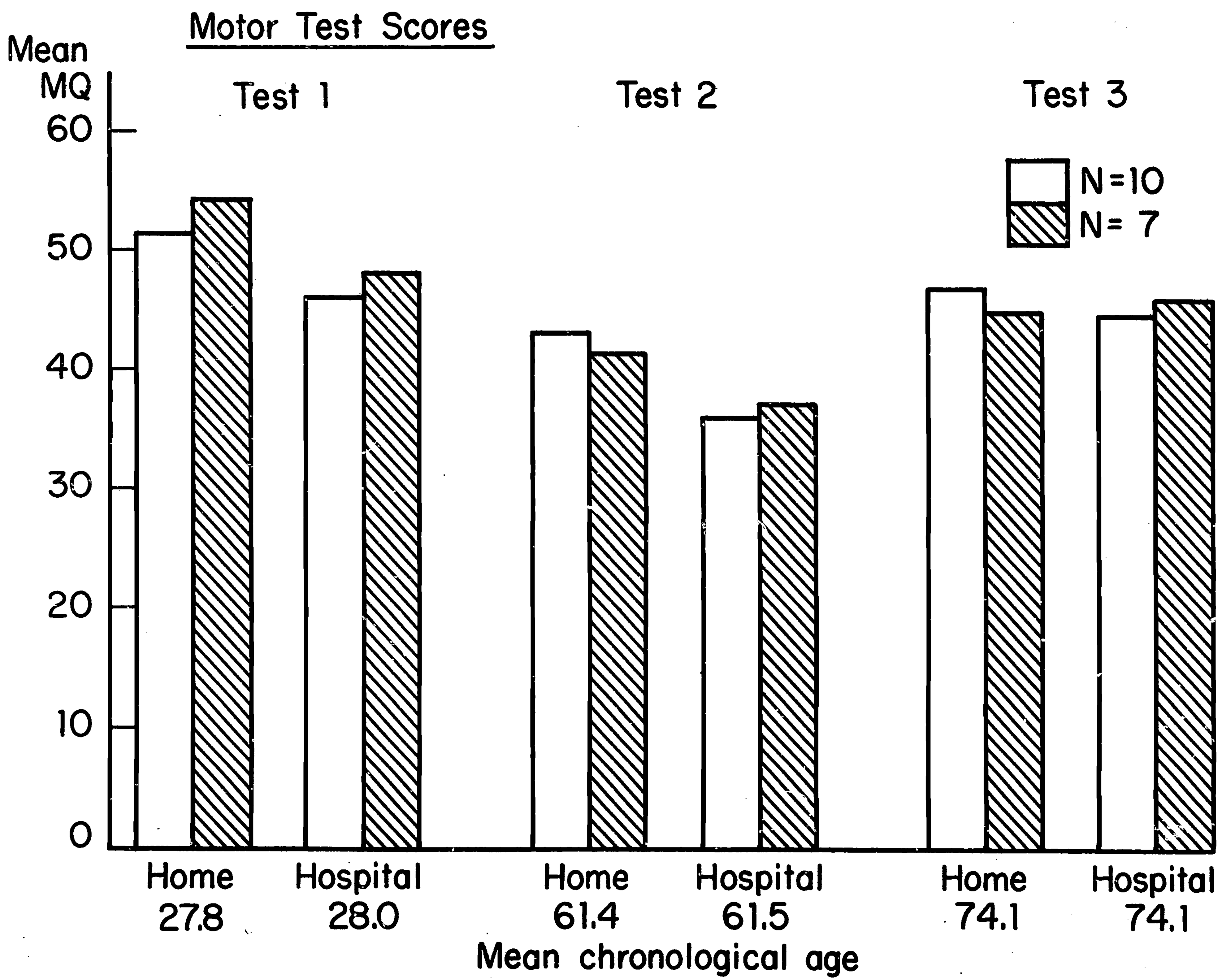


Fig. 24



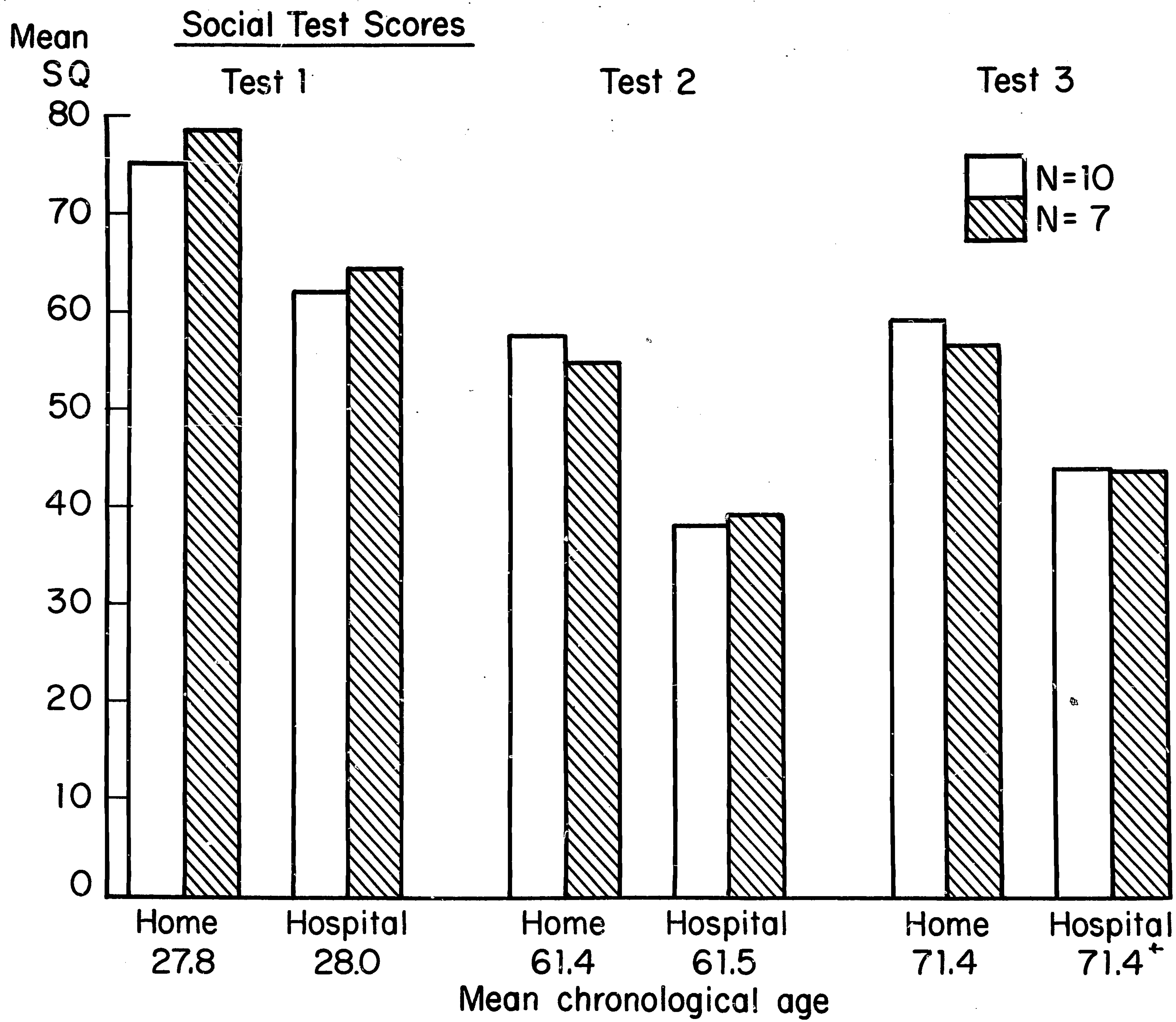
Mental Test Scores
Mean IQ
60
50
40
30
20
10
0
Test 1
Test 2
Test 3
N=10
N = 7
Home 27.8
Hospital 28.0
Home 61.4
Hospital 61.5
Home 74.1
Hospital 74.1
Mean chronological age

Fig. 25



Motor Test Scores
Mean MQ
60
50
40
30
20
10
0
Test 1
Test 2
Test 3
N=10
N= 7
Home 27.8
Hospital 28.0
Home 61.4
Hospital 61.5
Home 74.1
Hospital 74.1
Mean chronological age

Fig. 26



Social Test Scores
Mean SQ
Test 1
Test 2
Test 3
N=10
N= 7
80
70
60
50
40
30
20
10
0
Home 27.8
Hospital 28.0
Home 61.4
Hospital 61.5
Home 71.4
Hospital 71.4+
Mean chronological age

Fig. 27

Individual Curves of IQ for Subjects of Differing Abilities

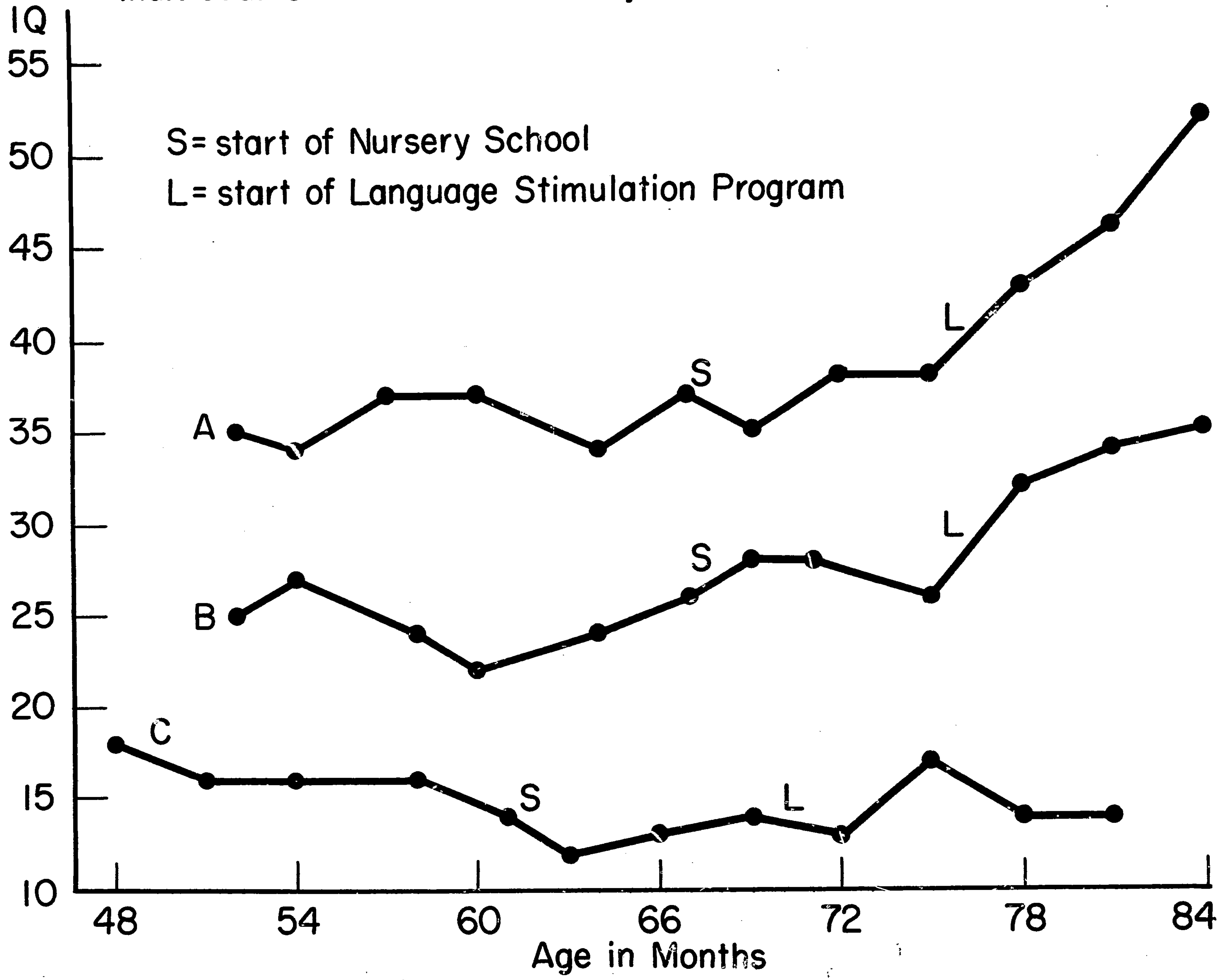


Fig. 28

ACKNOWLEDGEMENTS

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