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ABSTRACT

Two samples of National Merit Scholarship participants tested in 1962 and the entire population of almost 800,000 participants tested in 1965 were examined. Consistent effects in all three groups were observed with respect to both birth order and family size (firstborn and those of smaller families scoring higher). Control of both socioeconomic variables and mother's age (by analysis of variance as well as by analysis of covariance) failed to alter the relationships. Step-down analyses suggested that the effects were due to a verbal component and that no differences were attributable to non-verbal factors. Detailed sibship configurations based on birth order, family size, sibling spacing, and sibling sex were developed for both sexes. The resulting 82 different sibship configurations were ranked by test score means. A rank-order correlation between sexes yielded a very high value of .96, and a high correlation was shown to persist within family sizes. References and tables are included. (Author)

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RESEARCH BULLETIN

BIRTH ORDER, FAMILY CONFIGURATION AND VERBAL ACHIEVEMENT

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BIRTH ORDER, FAMILY CONFIGURATION AND VERBAL ACHIEVEMENT

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Abstract

Two samples of National Merit Scholarship participants tested in 1968 and the entire population of almost 800,000 participants tested in 1969 were examined. Consistent effects in all three groups were observed with respect to both birth order and family size (firstborn and those of smaller families scoring higher). Control of both socioeconomic variables and mother's age (by analysis of variance as well as by analysis of covariance) failed to alter the relationships. Step-down analyses suggested that the effects were due to a verbal component and that no differences were attributable to non-verbal factors. Detailed sibship configurations based on birth order, family size, sibling spacing, and sibling sex were developed for both sexes. The resulting 82 different sibship configurations were ranked by test score means. A rank-order correlation between sexes yielded a very high value of .96, and a high correlation was shown to persist within family size.

BIRTH ORDER, FAMILY CONFIGURATION AND VERBAL ACHIEVEMENT[1]

Hunter M. Breland

Educational Testing Service

Beyond being merely an intriguing concept, the use of birth order as a research variable stems from its value as a useful indicator of early life experience. The only child, for example, faces a much different familial environment than does the last child of a large family. Nichols (1968) has described birth order as a "particularly felicitous variable" because valid information about it can be obtained at almost any age and because it reveals a great deal about early family life. Kammeyer (1967) has referred to it as an "extremely accessible datum." As reported information, such as that obtained through questionnaires in survey research, birth order has the special advantage that it is usually reported accurately. These features of birth order, as well as similar demographic variables of family structure, perhaps explain their popularity as research variables.

The long history of research on relationships between birth position and achievement variables is well documented by numerous reviews (e.g., Altus, 1966; Bayer & Folger, 1967; Bradley, 1968; Hsiao, 1931; Jones, 1933, 1954; Murphy, Murphy, & Newcomb, 1937; Sampson, 1965; Schachter, 1963; Schooler, 1972; Sutton-Smith & Rosenberg, 1970). Only those reviews by Altus and by Schachter argued strongly for the existence of a relationship (that early-born, and especially firstborn, have higher achievement). Altus (1965) suggested that the observed relationship was due to a verbal factor. Most of the other reviewers indicate that little evidence exists for a relationship between birth order and intelligence or other achievement indicators.

A recent study of a very large sample by Record, McKeown, and Edwards (1969), however, shows clearly that highly significant and consistent relationships do exist (firstborn and early-born scored higher on verbal reasoning test). Eysenck and Cookson (1969) obtained a similar pattern of results for 4,000 11-year-olds with respect to English examination scores. The Record investigation, of over 50,000 subjects, was conducted by matching medical data collected at birth with Eleven-plus examination scores for children of the city of Birmingham, England. The authors suggested that the differences observed were primarily due to between-family differences in terms of social class and mother's age at birth. Such a suggestion arose out of observations that relationships similar to those among birth order, family size, and verbal reasoning scores existed as well among social class, mother's age, and verbal reasoning scores.

The analyses of the present study represent an attempt at verification of the Record and the Eysenck observations, but with suspected confounding factors controlled. A second objective was to explore the possibility that any observed relationship is due to a verbal factor, as Altus had indicated. Finally, the question of the effects of specific family configurations formed by sibling spacing and sex differences (as well as birth order and family size) was investigated. It was hypothesized that closely-spaced siblings experience environmental influences similar to those of twins. A number of previous investigations have indicated that sex of sibling is important as well but with no consistent direction in findings (e.g., Chittenden, Foan, Zweil, & Smith, 1968; Cicirelli, 1967; Koch, 1954, 1956; Rosenberg & Sutton-Smith, 1964).

Methods

Samples

Two samples of National Merit Scholarship participants tested in 1962 and almost the entire population of participants tested in 1961 were examined.[2] The first sample consisted of a random selection of the 1962 participants and was termed the Normative Sample. The original sampling of almost 1,400 was reduced to 884 subjects by a 64% return of questionnaires. This group was reduced further to 793 subjects by the exclusion of twins and participants of family sizes greater than five. And since missing data on any one of the several measures used caused additional cases to be excluded, the resulting sample size was reduced, finally, to 670. The distribution of the final 670 cases, by birth order and family size is presented in Table 1.

Insert Table 1 about here

The second sample consisted of a random selection of high-scoring 1962 participants; this sample was called the Commended Group. An 84% response rate to questionnaires, and the exclusion of twins and participants from family sizes greater than five children, resulted in a total of 1,147 subjects for the 1962 Commended Group. The distribution of these cases is shown in Table 2.

Insert Table 2 about here

The third sample, essentially all participants tested in 1965, was termed simply the 1965 Sample. In the spring of 1965, the NMSQT was administered to 794,589 eleventh-grade students from a total of 17,608 different high schools. Exclusive of twins and family sizes greater than five, as well as a small number of cases for whom information was not complete, the distribution of cases by birth order, family size, and sex is given in Table 3.

Insert Table 3 about here

Data

All subjects involved were administered the National Merit Scholarship Qualification Test (NMSQT) in the spring of their junior year of high school. In addition, selected subjects tested in 1962 were requested to complete a Student Questionnaire. Questionnaires were also requested from parents and teachers of these selected participants. From the questionnaire information a very large number of variables were available for examination. In the present study, particular attention was directed to mother's education, father's education, family income, and mother's age.

The second major source of information involved in the present study consisted of NMSQT scores for 1965 participants. For the 1965 administration, all subjects were requested to complete an information grid immediately prior to taking the test. This information grid included an item concerning the position of the subject in his family, whether he or she was a twin, and the sexes and spacing of siblings.

Instruments

The NMSQT consists of five tests: English Usage, Mathematics Usage, Social Studies Reading, Natural Science Reading, and Word Usage. Although these test titles describe the test materials well for the most part, the English Usage test is primarily a test of grammatical knowledge and the Word Usage test is a vocabulary test. These tests are described in detail in the National Merit Interpretive Manual (1965). Characteristics of these tests, including numbers of items, means, standard deviations, and reliabilities are shown in Table 4. The sum of the five NMSQT tests, the Selection

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Insert Table 4 about here

Score, serves as an index of a student's overall educational development.

For the 1962 participants (Normative Sample and Commended Group), four additional measures of father's education, mother's education, family income, and mother's age at birth were used. These measures are described in Appendix I. The first three of these additional measures served as controls for socioeconomic status and the fourth as a control for possible physiological effects as implied by Record et al. (1969).

For the 1965 Sample, information on socioeconomic status and mother's age was not available. On the other hand, very detailed information was available concerning the subjects' family structures.

Analyses

The data for the two 1962 samples were analyzed by means of an exact least-squares multivariate analysis of variance and covariance as described by Bock (1963). Computations were performed using the Multivariance program

of Finn (1972).

These techniques were applied, first, to a basic design as depicted below:

Family Size	1	2	3	4	5
1	0	x	x	x	x
2	0	0	x	x	x
3	0	0	0	x	x
4	0	0	0	0	x
5	0	0	0	0	0

Birth Order

This design involves two factors, family size and birth order, each having five levels of observation. Certain cells in such a design, of course, are nonexistent, and these are indicated by "x" above. The "0" indicates that observations are available for those cells. The design was completed by the inclusion of the covariates--mother's education, father's education, family income, and mother's age.

The primary objective in the various analyses of variance and covariance which were performed was to reduce the statistical model to its most parsimonious level. The tests of significance were used to determine which of the terms in the model contributed beyond random variation. Once the most parsimonious model was arrived at, point estimates of means for each of the family size and birth-order combinations were made. For example, a model of the form,

$$y_{\cdot jk} = u + a_j + b_k + (ab)_{jk} + e. \quad ,$$

may be reduced if the interaction term, $(ab)_{jk}$, can be demonstrated to consist

of only random variation. The reduced model for estimation would be of the form,

$$\hat{y}_{.jk} = \hat{u} + \hat{a}_j + \hat{b}_k ,$$

which provides point estimates of the means for each cell in an analysis of variance model.

For the very large 1965 sample, practicalities of data reduction dictated a different approach. Mean scores were computed for each of the 82 sibship configurations and these were then combined to test birth-order effects, spacing effects, and sibling sex effects by means of t-tests.

Results

1962 Normative Sample Results

The relationships among the covariates and the independent variables, birth order and family size, were first examined. These are shown in Figures 1, 2, 3, and 4 in the form of both observed and estimated (ignoring interactions) means for each of the family size/birth-order combinations. The most pronounced of the relationships are those for father's education and mother's age (Figures 2 and 4). One notes that the socioeconomic variables appear to be highly correlated. That such is the case is demonstrated by the pooled within-group correlation matrix of Table 5. The correlation

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Insert Figures 1-4 and Table 5 about here

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between father's education and mother's education is .54 and that between father's education and family income is .52. The correlation between mother's education and family income, however, is somewhat less (.35), as might be expected.

These relationships among the socioeconomic variables are not surprising. Nor is a relationship between family size and socioeconomic status surprising, since this is commonly reported in the literature. But relationships between birth order and socioeconomic variables are puzzling and may relate to a unique characteristic of this population of post-World War II birth groups. Some other possible reasons for these puzzling relationships have been pointed out by Schooler (1972).

Whether these relationships contribute to the explanation of effects of birth order on NMSQT scores, however, depends as well on the degree to which the covariates predict NMSQT scores. This degree of prediction was examined through a consideration of correlations. The correlations between the socioeconomic variables and Selection Score were all positive and in the range from .13 to .18, with father's education being the best predictor. Accordingly, any one of the three socioeconomic variables would explain less than 4 per cent of the variance in Selection Score. The multiple regression of the three taken simultaneously (R = .19) explains only slightly more of the variance in Selection Score.

Figure 5 shows the results of the analyses of covariance. The plotted curves demonstrate the nature of the relationships and the p-values indicate the degree of relationship. Note that statistically insignificant interactions are ignored when either plotting relationships or interpreting p-values for main effects. With such a low multiple R for the covariates as predictors of NMSQT Selection Score, the comparison of the analysis of variance with the analyses of covariance yields about what would be expected--very little

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Insert Figure 5 about here

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difference in the adjusted means. Although the birth-order effect was reduced to some degree (from $p < .0045$ to $p < .0610$), the adjusted means look very much the same as the unadjusted means. And for family-size effects, the reduction in significance level was only from $p < .0036$ to $p < .0042$. Thus the control of socioeconomic status appears to have had more influence on birth-order effects than it did on family-size effects. Such a result leads one to suspect that family-size effects may not be merely an artifact of socioeconomic status after all.

When mother's age was added to the multiple regression, the value of R increased to .23. The effect of this additional covariate, however, was to reverse the direction of the adjustment, since mother's age was positively related to NMSQT score. The result was to adjust the birth-order effect back to about what it was before the socioeconomic variables were removed ($p < .0007$). The addition of mother's age made practically no difference with respect to family-size effects ($p < .0045$).

A similar analytical procedure was performed with the five NMSQT tests considered as a multivariate set (random dependent variables). That is, rather than using Selection Score (the linear combination of the five NMSQT tests) as a single univariate dependent variable, the five tests were analyzed as a single set of random variables. The three-step process of covariate adjustments yielded a pattern of p-values similar to that obtained from the Selection Score analysis. This multivariate analysis is given in Table 6.

Insert Table 6 about here

In both the univariate and multivariate analyses, therefore, the influence of the socioeconomic variables was to reduce the birth-order effect.

And in both analyses, the influence of mother's age was to increase the birth-order effect. Neither of these influences, however, was appreciable and, one notes, they tend to cancel each other. Both socioeconomic status and mother's age operated in the same direction with respect to family-size effects, but, again, neither influence was appreciable.

The validity of the preceding analyses is, of course, dependent upon the degree to which the assumptions of analysis of variance and analysis of covariance have been met. As a check on the assumption of linearity of regressions, scatterplots were examined and revealed no obvious departures from linearity. Because of the striking relationship between father's education and birth order, a special polynomial regression analysis was performed of the regression of Selection Score on father's education. Neither quadratic nor cubic relationships resulted in significantly greater fit of the data points than the simple linear relationship. The scatterplots also failed to reveal any obvious departures from the assumption of normality. Bartlett's test for homogeneity of variances was satisfied with the exception of the four-child family. Since the effects cited persisted in the other family sizes, however, this departure would not appear to have caused spurious findings with respect to birth-order effects. But it would suggest, in combination with the higher means for the four-child family (Figure 5), that these estimates may have been amplified, perhaps, by poor sampling of the four-child family. Tests for homogeneity of regression were performed using procedures of the Multivariance Version V program (Finn, 1972). No nonparallel regressions were detected for any of the within-group regressions employed in the analyses of covariance.

In an investigation of natural phenomena, however, it is not possible to satisfy completely all assumptions of analysis of variance nor, especially,

of analysis of covariance. Common violations of assumptions in these techniques have been pointed out by a number of writers (e.g., Cochran, 1957; Elashoff, 1969; Evans & Anastasio, 1968; Harris, Bisbee, & Evans, 1971; Lord, 1960; Smith, 1957; Werts & Linn, 1971). Assumptions of random assignment to treatment groups can only be satisfied by an experimental approach, as is the case for statistical independence of covariates and treatments. But it is unlikely that birth order, for example, caused the differences observed in socioeconomic status. The possibility of errors of measurement in the covariates, which could have attenuated the covariance adjustments, would likewise not seem to have caused difficulty. The close similarity in the observed and estimated means for the covariates suggests very little measurement error.

As a check on such a possibility, however, as well as a check to determine if for any reason the covariance procedure was not effective (that is, confounding variables were not, in fact, controlled), a two-way analysis of variance of father's education and birth order was conducted. Father's education was used because it was the most pronounced of the socioeconomic relationships. And family size was ignored because it is only a traditional variable in birth-order studies because of suspected relationships between it and SES. Actually, as can be seen from the previous analyses of this study, family size is a very poor control for SES.

This two-way analysis of variance, in which socioeconomic status was actually controlled, produced results precisely in agreement with the analyses of covariance. Both birth-order and father's education effects were significant beyond the .0001 level. Although this analysis of the 1962 Normative Sample would appear to be convincing enough, it was decided to conduct an additional analysis of a similar nature on an entirely different group of subjects, the 1962 Commended Group.

1962 Commended Group Results

The examination of the covariate relationships for this sample revealed considerable differences from that of the Normative sample. As indicated in Figure 6, none of the socioeconomic variables were significantly related to

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Insert Figure 6 about here

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birth order. But both father's education and family size, however, were significantly related to family size. This was in marked contrast to the comparable relationships in the Normative sample, where there was no significant family-size effect with respect to either father's education, mother's education, or family income. The mother's age relationship, given in Figure 7, is strikingly

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Insert Figure 7 about here

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similar to that for the Normative sample (Figure 4) indicating high accuracy for the reported mother's age.

The correlation matrix for the 1962 Commended Group is presented in Table 7. All correlations with NMSQT scores are, of course, very low due to the extremely narrow range of scores for this select group (approximately two standard deviations above the mean). The remaining correlations, however,

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Insert Table 7 about here

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show a pattern very similar to that of the Normative sample (Table 5). The correlation of father's education and mother's education was almost the same for both samples (.50 vs .54), as was that for mother's education and family

income (.33 vs .35). And while the correlation of father's education was high for both samples, it was slightly higher for the Normative sample (.42 vs .52), as might be expected.

The estimated Selection Score means for the Commended Group before and after the covariance adjustments are given in Figure 8. What is of special

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Insert Figure 8 about here

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interest in Figure 8, however, is not the effect of the covariance adjustments (since there was little to adjust for), but that a significant birth-order relationship exists for the Commended Group despite the limited range of scores. It is a rare variable that shows significant effects in such a limited range.

The influence of adding mother's age to the analysis of covariance was minimal, as would be expected, and yet the direction of influence was the same as for the Normative sample, indicating consistency for this influence.

The Commended Group observations were also analyzed by taking the five NMSQT scores as a multivariate set. The results obtained in this way were similar to those obtained when the five tests were summed to arrive at the Selection Score as criterion. These results were also similar to those obtained from the multivariate analysis of the Normative sample. The birth-order effect was still statistically significant ($p < .0477$), while the family-size effect was not ($p < .5654$). As in the Normative sample, when mother's age was added to the covariate set, the birth-order effect was accentuated ($p < .0135$).

Normative Sample Step-Down Analysis

Since both of the previous analyses indicated that real effects on NMSQT scores exist, the next question of interest related to the sources of these effects. An investigation of sources was conducted using the individual NMSQT test scores. These tests were considered in several different orders and the Roy-Bargmann step-down F statistic computed for each variable in each order. By ordering the NMSQT test of most interest last in the step-down progression, it was possible to determine if this variable made a unique contribution to the effect of interest.

With Word Usage ordered last, the results for the Normative sample are shown in Table 8. The important contrast to note is that between the Math Usage

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Insert Table 8 about here

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test and the Word Usage test, since these represent the extremes in terms of verbal components. The univariate p-values, with no covariates removed, indicated that the birth-order effect on Math Usage score was not significant ($p < .9670$). By contrast, the effect of birth order on Word Usage score was profound ($p < .0001$). The step-down p-values showed that, even after the influences of all other tests were removed, the Word Usage contribution was still significant ($p < .0134$).

Also in Table 8, the covariates are seen to have little influence on the Word Usage score but considerable influence on birth-order differences with respect to English Usage and Natural Science Reading. As in the previous analyses, the socioeconomic variables tend to reduce the birth-order effects and mother's age tends to increase them. It is of special interest to note that, when all covariates have been removed and when Word Usage is ordered last, the birth-order effect is still highly significant ($p < .0051$).

Considering the final p-values for both English Usage and Social Studies Reading along with Word Usage, it is suggested by Table 8 that those scores with the greatest verbal components are related to birth order while those with the least verbal components (Math Usage and Natural Science Reading) are not.

The family-size effects, noted previously, are especially interesting when viewed from the perspective of the step-down analysis. As shown in Table 9, these effects appear to be different in nature from those associated

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Insert Table 9 about here

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with birth order, even though both influences are related to higher scores for early-born (and smaller families). For family-size differences in abilities, the Word Usage score is not the greatest influence. In fact, when all covariates and all other test variances are removed, the effect of family size on Word Usage is reduced beyond any likelihood of being significant ($p < .5437$). Only the Social Studies Reading score retains a p-value less than .05 ($p < .0431$) at the final step.

Since the birth-order effects appear to be verbal, it is of interest to examine this family-size relationship to Social Studies Reading to determine if it too may be due to a verbal factor. To test such a possibility, Social Studies Reading score was ordered last in the step-down analysis. The resulting p-values at the final covariance state (both socioeconomic variables and mother's age removed) are shown in Table 10. Although these figures do

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Insert Table 10 about here

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not demonstrate conclusively that the family-size effect on social studies was a verbal factor, this is the implication. When Word Usage is placed in a prior order, the Social Studies differences with respect to family size disappear. In any event, whatever difference occurs is not unique to Social Studies Reading ability.

Commended Group Step-Down Analysis

The results of the step-down analysis on the NMSQT tests for the Commended Group were quite similar to those for the Normative sample, although these two sets of subjects were entirely different. Birth-order effects remained after all covariates and all influences of other tests were removed ($p < .0040$), as shown in Table 11. And as was the case for the Normative sample, the Natural

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Insert Table 11 about here

Science Reading scores were most influenced by the various eliminations. Although the birth-order effect on Natural Science Reading would appear to be quite significant from an observation of the univariate p with no covariates removed ($p < .0172$), it becomes almost nonexistent after all covariates and other test effects are eliminated ($p < .3819$). This was precisely the pattern that was observed in the Normative sample. The only pattern that was not repeated was that for the English Usage score, which was substantially affected by the covariates in the Normative sample. For the Commended Group, however, the existence of birth-order effects on either English Usage or Math Usage appear to be much less probable than in the Normative sample.

The family-size effects for the Commended Group were not considered in a step-down analysis since no effects occurred either for the combined tests or for the individual tests.

As for the Normative sample, Word Usage was reordered to examine the apparent effect of birth order on Social Studies Reading score ($p < .0122$). The consequences of this reordering are indicated in terms of changed p-values as shown in Table 12. One notes the same pattern of p-values obtained for this

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Insert Table 12 about here

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same order with the Normative sample. That is, the Social Studies Reading differences become insignificant when ordered last. And, again, the implication is that what differences did occur with respect to Social Studies Reading score were a result of verbal factors which were eliminated by placing Word Usage in a prior order.

1965 Sample Results

As previously described, the large 1965 Sample was analyzed by computing mean Selection Scores for each of the 82 sibship configurations. This analysis was performed for males and females separately. These mean Selection Scores were then used to rank order the 82 configurations (based on various birth orders, spacings, and sexes), and the ranks for males and females were compared. Next, the rank ordering was performed within families of a constant size. Finally, combinations of sibship configurations were formed for the investigation of birth order, sibling spacing, and sex of sibling effects.

These rank orderings for the total set of 82 configurations are included in Appendix II. The rank-order correlation between sexes obtained was .96, suggesting a very high consistency in ranks for both males and females. The sibling

configurations occupying ranks 1, 6, 10, 14, 20, 62, 64, and 68 were identical for both males and females. Twins occupied rank 72 for males and rank 70 for females, which indicates agreement with most twin research (that twin averages are low on achievement tests, especially those with large verbal components). That such a high correlation was not merely an artifact of increasing family size was demonstrated by a similar rank-order correlation within the 36 configurations of the three-child family where a value of rho = .95 was obtained.

When those configurations representing constant birth order and constant family size were combined, the relationships depicted in Figure 9 resulted. One observes from Figure 9 that the pattern of Selection Score means is much

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Insert Figure 9 about here

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like that found for the 1962 Normative sample (Figure 5), where the means were estimated using the least squares techniques. One notable difference between Figures 9 and 5 occurs for the case of the four-child family. The high values of mean Selection Scores estimated for four-child families in Figure 5 are most probably due to sampling difficulties. And the rise in mean scores from birth order four to birth order five is most certainly a result of the small numbers of observations in these cells.

Whereas the results of the 1962 Normative sample were statistically significant primarily in terms of main effects, however, almost all of the differences in Figure 9 are significant beyond the .01 level. This is, of course, because of the much larger number of cases represented in Figure 9.

Combinations of sibling configurations were also combined to obtain comparisons among different categories with respect to the number of siblings

of a given sex. While some very small differences were noted, almost none of these attained statistical significance (despite the large number of cases), and there was little consistency with regard to direction of effects. It was concluded, therefore, that effects of sex of sibling were not of great importance. Others have found sex of sibling to be significantly related to achievement variables (e.g., Koch, 1954).

Sibling spacing effects were examined by a similar grouping of sibship configurations. An analysis of spacing effects was possible only for two-child and three-child families, since spacing information was ignored for the larger family sizes. The results of the spacing analyses are shown in Figures 10 and 11. These two figures indicate that a consistent spacing

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Insert Figures 10 and 11 about here

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effect operates with respect to laterborn. Where the interval spacing of siblings is far (3 years or more), the mean scores for secondborn or thirdborn are above the average for such configurations. However, where the secondborn or thirdborn follows his preceding sibling closely in age (by 1 or 2 years), the mean scores are somewhat depressed.

Discussion

The analyses of variance and covariance for the 1962 samples confirm the relationship between birth order and achievement, often noted in the literature. These analyses suggested, also, that the observed relationship was not attributable to family differences of father's education, mother's education, and family income, or to family differences of mother's age, or to combinations of these factors. Moreover, the relationship between family size and

achievement appeared to be related to some characteristic of family size itself rather than to socioeconomic status alone. Such a result is in close agreement with the contention advanced by Nisbet (1953).

That the primary source of the score differences is verbal in nature was indicated by the step-down analyses on the individual NMSQT tests. After all other sources of variation were removed, the birth-order differences for the most purely verbal of the NMSQT test (Word Usage) remained. Furthermore, when Word Usage was removed first, all other differences became insignificant. The step-down analyses for the family-size effects revealed slightly different, but similar, verbal differences.

The detailed breakdowns of family configurations available for the 1965 Sample was useful for substantiating the results of the two smaller 1962 samples, as well as for investigation of more subtle effects of sibling spacing and sibling sexes. One unusual finding occurred with regard to the influence of sibling sexes. Several investigations had reported significant differences in birth-order effects where the number of like-sexed siblings was varied. These studies had failed, however, in demonstrating any consistent direction for such effects. The present study indicated no appreciable differences at all when the number of like-sexed siblings was varied.

Conversely, the 1965 Sample suggested some striking effects associated with age spacing of siblings. Where a sibling followed closely in age, the scores were depressed. This observation was made whether the family size was two-child or three-child. Where the age spacing interval was far, however, the same differential did not occur.

Because the birth-order effects on total scores appear to be attributable to a specific ability of a verbal nature, and because of the apparent

importance of spacing effects, one is led to believe that these differences are due to environmental causes. Neither physiological theories nor economic theories would explain differences in verbal achievement, but not in nonverbal achievement. And although closeness of siblings might be related to socioeconomic status (poor parents have closer children), the fact that scores are depressed only for closely following siblings tends to preclude such a possibility.

Therefore, of the three traditional explanations for birth-order effects (physiological, economic, and social-psychological), the last would seem to offer the most promise. Much speculation has been made of the possibility that parents have greater expectations for their firstborn, and that such expectations drive the firstborn to greater achievements. Even though such an explanation is social-psychological the results of the present study would not entirely support such a theory. Nor would an expectancy theory appear to explain the significantly lower achievement for closely following siblings, but not for nonclosely following siblings.

An entirely different social-psychological theory, however, would seem to explain not only the results reported herein but the results of studies of twins and of family-size effects as well. A common denominator tying together low achievement for twins, those of larger families, later birth orders, and closely following siblings is the lack of isolation from other siblings during early developmental stages. And this common factor relates specifically to verbal development. Only firstborn nontwins, and laterborn who follow at some distance, have the opportunity for close one-to-one interactions with parents (and at the higher verbal level of parent/child interaction). McGurk and Lewis (1972) describe these parent/child interaction differences among different sibling configurations in more detail.

The twin study of Record, McKeown, and Edwards (1970) serves as an excellent demonstration of the effect of isolation from other siblings. Even though normal twins who grew up to the time of testing (age 11) together had decidedly depressed verbal reasoning scores, surviving twins whose co-twin died at birth or shortly thereafter had scores about the same as nontwins. Nisbet's (1953) study indicated that family-size effects were not entirely due to socioeconomic factors. And the present study appears to support Nisbet's contention. For families of no more than five children, as studied here, there is no indication of appreciable family-size effects due to socioeconomic causes. Past studies which have shown that the family-size effect relates to lower socioeconomic status for large families no doubt included very large family sizes. In such cases of very large families, the socioeconomic factor probably is of considerable importance. Finally, spacing effects similar to those reported here are detectable in previous studies by Koch (1954, 1956) and by Rosenberg and Sutton-Smith (1964), although these studies, involving relatively small numbers of cases, were not in all aspects internally consistent.

Conclusions

Analyses of three new sets of data indicated consistent birth-order effects, suggesting higher academic achievement for earlyborn. Additionally, the often observed relationship between family size and achievement was corroborated. But the contention that the larger family sizes have lower achievement because they have lower socioeconomic status was not supported. It was concluded that the family-size effect was most probably due to the same causes, in part, as advanced for the birth-order effects, viz.,

differential parent/child interaction during early developmental stages.

Such a social-psychological hypothesis was supported as well by analyses indicating that both the birth-order and family-size effects on achievement scores were due primarily to a verbal factor. Neither physiological theories nor economic theories would account for these specific ability differences. Moreover, only a social-psychological theory would appear to explain different achievements for different sibling spacings.

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Footnotes

[1]This paper is a condensed version of a dissertation (Breland, 1972) completed at the State University of New York at Buffalo.

[2]The author is indebted to Robert C. Nichols, State University of New York at Buffalo, for the unusual data sets involved in this study.

Table 1

Distribution of 1962 Normative Sample Participants

by Family Size and Birth Order

Family Size[a]	Birth Order					
	1	2	3	4	5	Totals
1	79					79
2	119	90				209
3	61	76	45			182
4	56	37	21	23		137
5	12	13	12	10	16	63
						670

[a]Number of children in family.

Table 2

Distribution of 1962 Commended Participants

by Family Size and Birth Order

Family Size[a]	Birth Order					Totals
	1	2	3	4	5	
1	175					175
2	282	137				419
3	172	96	49			317
4	108	33	20	14		175
5	32	13	6	6	4	61
						1,147

[a]Number of children in family.

Table 3

1965 Participants by Sex, Family Size, and Birth Order

Family Size	Birth Order					
	1	2	3	4	5	
			Males			
1	38,650					
2	61,867	45,481				
3	45,657	31,149	22,208			
4	25,815	17,497	11,119	8,227		
5	12,632	8,391	5,776	3,763	4,193	
			Females			
1	39,403					
2	59,634	46,416				
3	44,168	31,704	22,878			
4	26,167	18,393	11,769	8,513		
5	12,739	9,193	5,854	4,059	3,734	
			Total			
1	78,053					
2	121,501	91,897				
3	89,825	62,853	45,086			
4	51,982	35,890	22,888	16,740		
5	25,371	17,584	11,630	7,822	7,927	
Totals	366,732	208,224	79,604	24,562	7,927	687,049

Table 4

Characteristics of the NMSQT Summarized from Samples Representative of National Merit Program Participants

Measure	Number of Items	Mean	S.D.	Reliabilities KR-20	Reliabilities Odd/Even
English Usage	76	19.5	4.5	.89	.90
Math Usage	40	20.5	6.0	.85	.87
Soc. Sci. Read.	51	21.0	5.0	.87	.88
Nat. Sci. Read.	51	21.0	5.5	.84	.86
Word Usage	88	21.0	5.0	.94	.94
Selection Score	306	103.5	22.5	.97	.97

Note.--From National Merit Interpretive Manual (SRA, 1965). (Based on data from test administrations during the years 1960-64.)

Table 5

1962 Normative Sample Correlation Matrix

Variable Number and Description	Variable Number									
	1	2	3	4	5	6	7	8	9	10
1. Mother Age	1.00									
2. Mother Education	.16	1.00								
3. Father Education	.11	.54	1.00							
4. Family Income	.04	.35	.52	1.00						
5. English Usage	.16	.12	.16	.07	1.00					
6. Math Usage	.09	.13	.13	.11	.29	1.00				
7. Social Studies	.11	.10	.13	.09	.45	.40	1.00			
8. Natural Science	.10	.08	.11	.11	.46	.46	.65	1.00		
9. Word Usage	.17	.14	.18	.10	.54	.40	.64	.58	1.00	
10. Selection Score	.16	.15	.18	.13	.69	.69	.82	.83	.81	1.00

Table 6

Multivariate Analysis of Covariance

Step	Operation	Birth Order	Family Size	Interaction
			$p <$	
1.	ANOVA	.0078	.0247	.0693
2.	SES removed	.0413	.0257	.0903
3.	SES + Mother's Age removed	.0015	.0406	.1153

Table 7

1962 Commended Group Correlation Matrix

Variable Number and Description	Variable Number									
	1	2	3	4	5	6	7	8	9	10
1. Mother Age	1.00									
2. Mother Education	.08	1.00								
3. Father Education	.00	.50	1.00							
4. Family Income	-.03	.33	.42	1.00						
5. English Usage	-.02	.05	.02	.00	1.00					
6. Math Usage	-.02	.01	.08	.08	-.11	1.00				
7. Social Studies	.06	.04	-.01	.07	-.05	.01	1.00			
8. Natural Science	-.05	.02	-.02	-.02	-.17	.11	.21	1.00		
9. Word Usage	.09	.07	.04	.02	.15	-.16	.23	.06	1.00	
10. Selection Score	.02	.07	.06	.07	.36	.50	.55	.46	.46	1.00

Table 8

1962 Normative Sample

Step-Down Analysis for Birth Order Effects

Variable	Univariate p	Step-Down p
No Covariates Removed		
English Usage	.0476	.0476
Math Usage	.9670	.9460
Social Studies	.0025	.0187
Natural Science	.0223	.4528
Word Usage	.0001	.0134
SES Covariates Removed		
English Usage	.2130	.2130
Math Usage	.9484	.8270
Social Studies	.0178	.0324
Natural Science	.1042	.4278
Word Usage	.0025	.0331
SES and Mother Age Covariates Removed		
English Usage	.0049	.0049
Math Usage	.8910	.9332
Social Studies	.0016	.0406
Natural Science	.0137	.4832
Word Usage	.0001	.0051

Table 9

1962 Normative Sample

Step-Down Analysis for Family Size Effect

Variable	Univariate p	Step-Down p
	No Covariates Removed	
English Usage	.0391	.0391
Math Usage	.0097	.0766
Social Studies	.0058	.0487
Natural Science	.0570	.3658
Word Usage	.0856	.7620
	SES Covariates Removed	
English Usage	.0442	.0442
Math Usage	.0085	.0645
Social Studies	.0070	.0486
Natural Science	.0639	.3508
Word Usage	.1236	.8345
	SES and Mother Age Covariates Removed	
English Usage	.1071	.1071
Math Usage	.0341	.1188
Social Studies	.0083	.0431
Natural Science	.0586	.3624
Word Usage	.0782	.5347

Table 10

Normative Sample Step-Down Analysis

After Re-Ordering of Variables

	Birth Order	Family Size
	$p <$	
Math Usage	.8910	.0341
Word Usage	.0001	.1015
English	.5279	.5243
Natural Science	.6848	.2107
Social Studies	.2295	.2798

Table 11

1962 Commended Group

Step-Down Analysis for Birth Order Effects

Variable	Univariate p	Step-Down p
	No Covariates Removed	
English Usage	.8093	.8093
Math Usage	.6236	.6866
Social Studies	.0748	.0797
Natural Science	.0172	.0561
Word Usage	.0091	.0378
	SES Covariates Removed	
English Usage	.8079	.8079
Math Usage	.6521	.7153
Social Studies	.0681	.0727
Natural Science	.0130	.0437
Word Usage	.0114	.0498
	SES and Mother Age Covariates Removed	
English Usage	.7396	.7396
Math Usage	.6675	.7239
Social Studies	.0107	.0122
Natural Science	.1929	.3819
Word Usage	.0005	.0040

Table 12

Commended Group Step-Down Analysis

After Re-Ordering of Variables

	Birth-Order Effect
	$p <$
Math Usage	.6675
Word Usage	.0004
English	.5712
Natural Science	.3487
Social Studies	.2204

Figure Captions

Fig. 1. Mother education, 1962 normative sample, observed and estimated means by birth order and family size.

Fig. 2. Father education, 1962 normative sample, observed and estimated means by birth order and family size.

Fig. 3. Family income, 1962 normative sample, observed and estimated means by birth order and family size.

Fig. 4. Mother age, 1962 normative sample, observed and estimated means by birth order and family size.

Fig. 5. Selection score, 1962 normative sample, estimated means with and without covariate adjustments by birth order and family size.

Fig. 6. Socioeconomic variables, 1962 commended group, estimated means by birth order and family size.

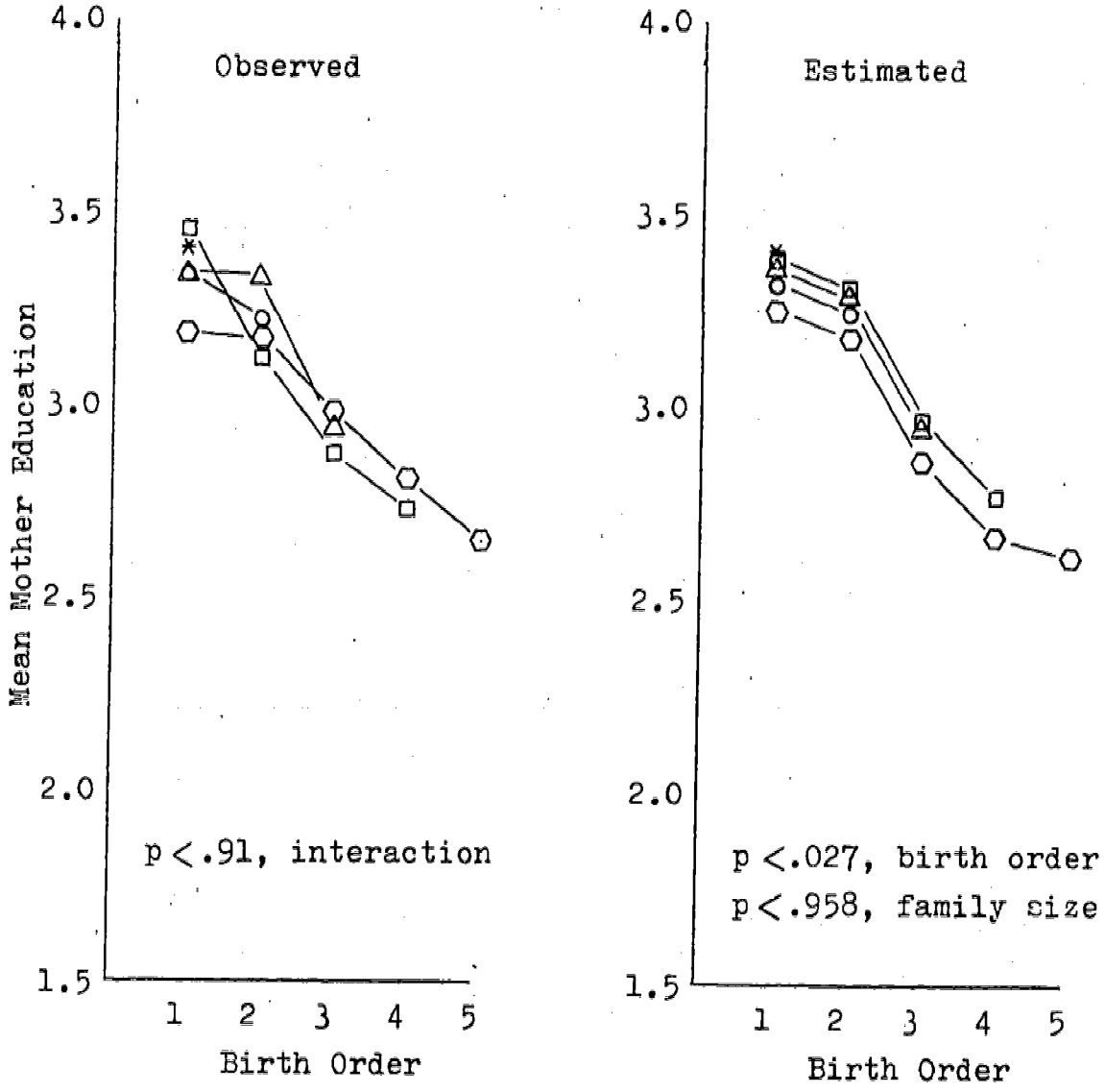
Fig. 7. Mother age, 1962 commended group, observed and estimated means by birth order and family size.

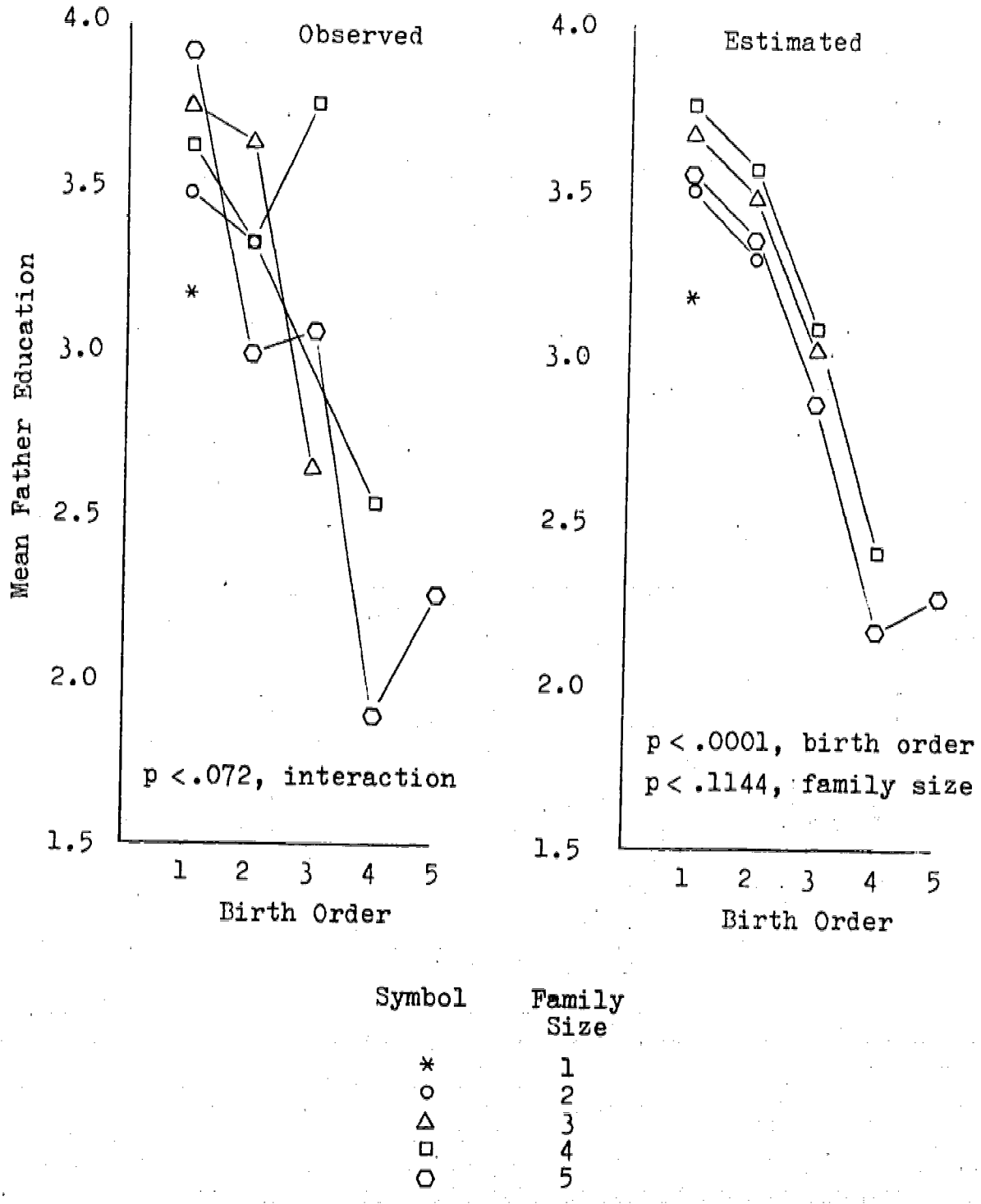
Fig. 8. Selection score, 1962 commended group, estimated means with and without covariate adjustments.

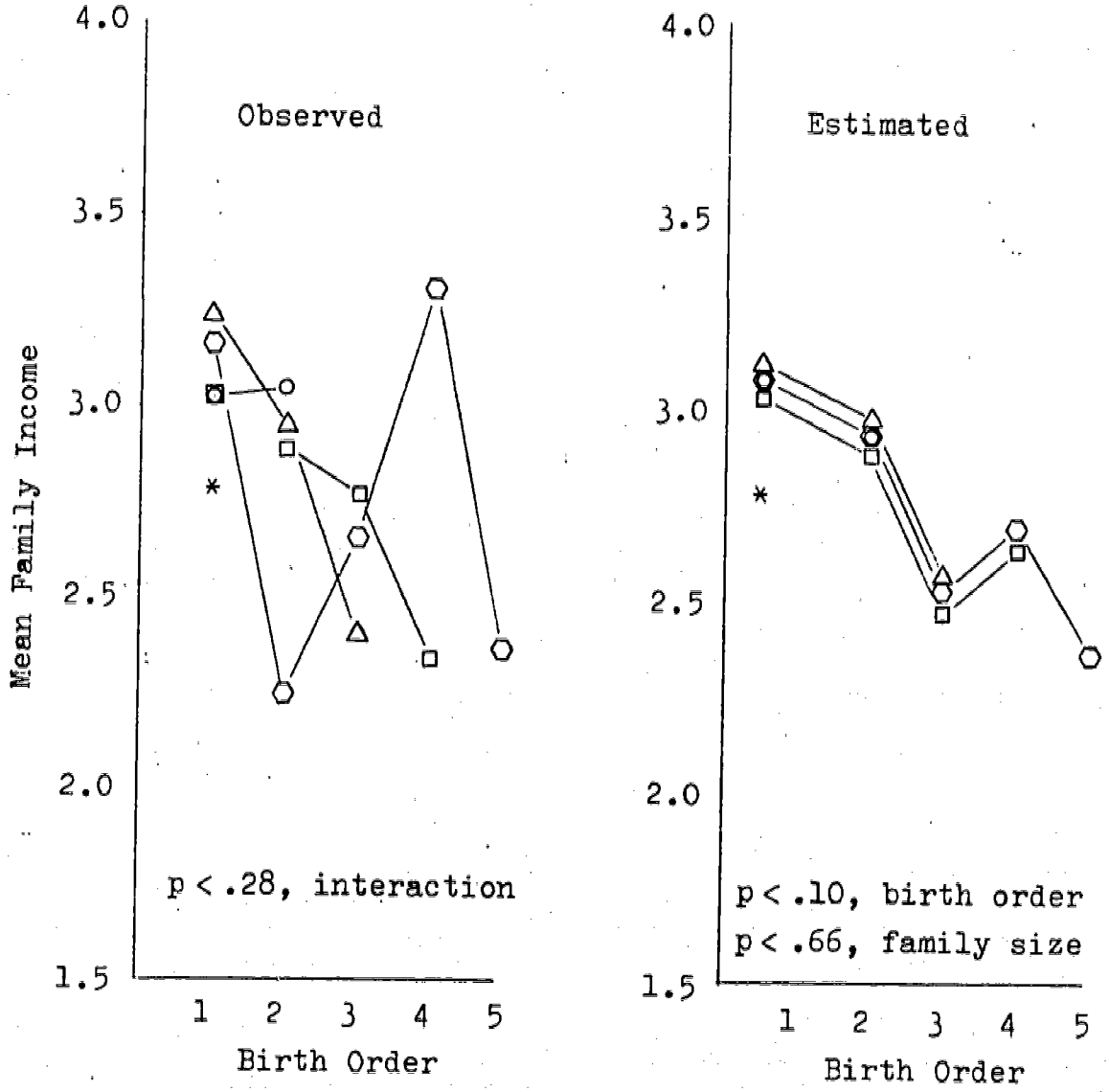
Fig. 9. Selection score, 1965 sample, means by sex, birth order, and family size.

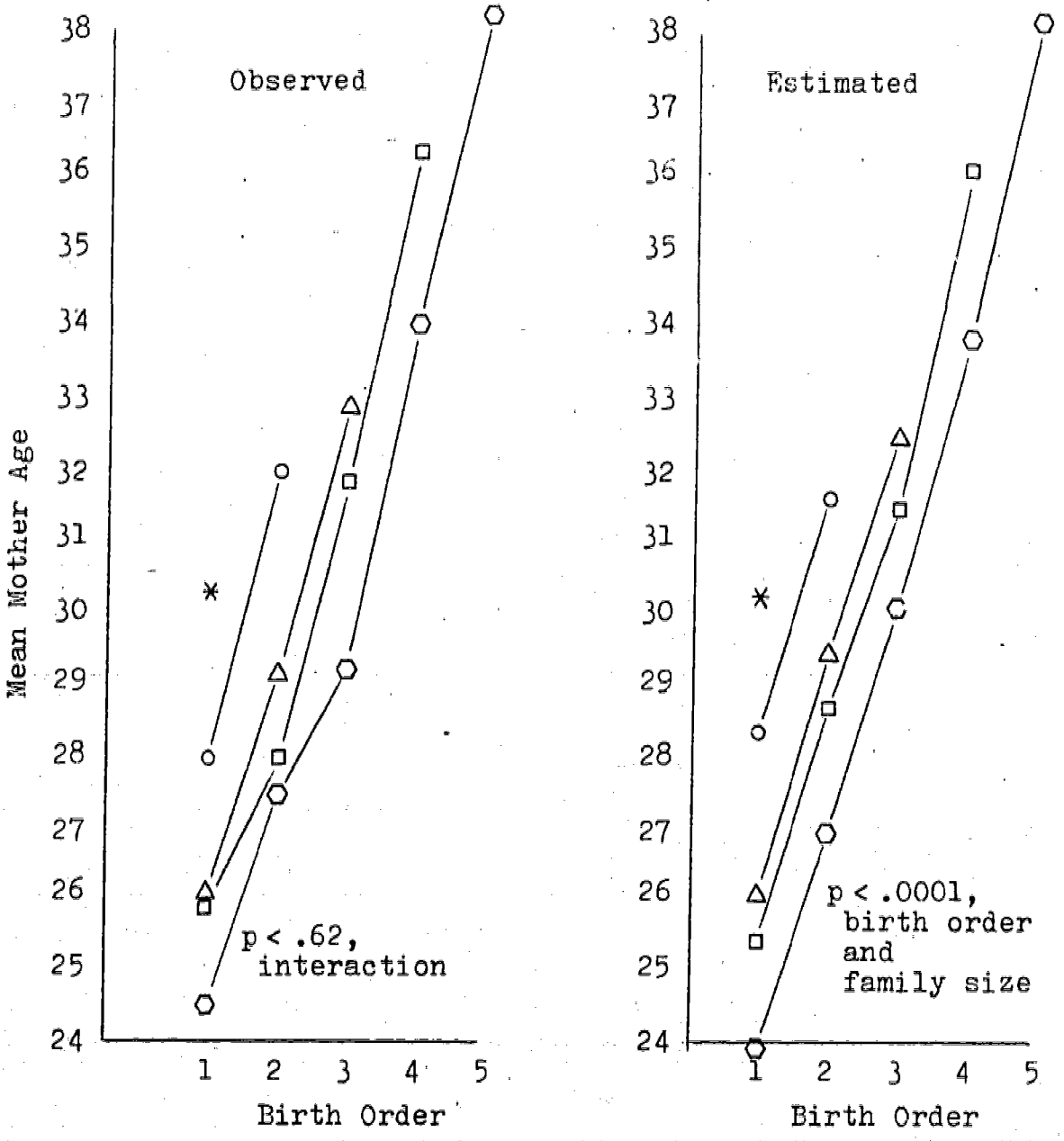
Fig. 10. Spacing effects on selection score, two-child families, 1965 sample.

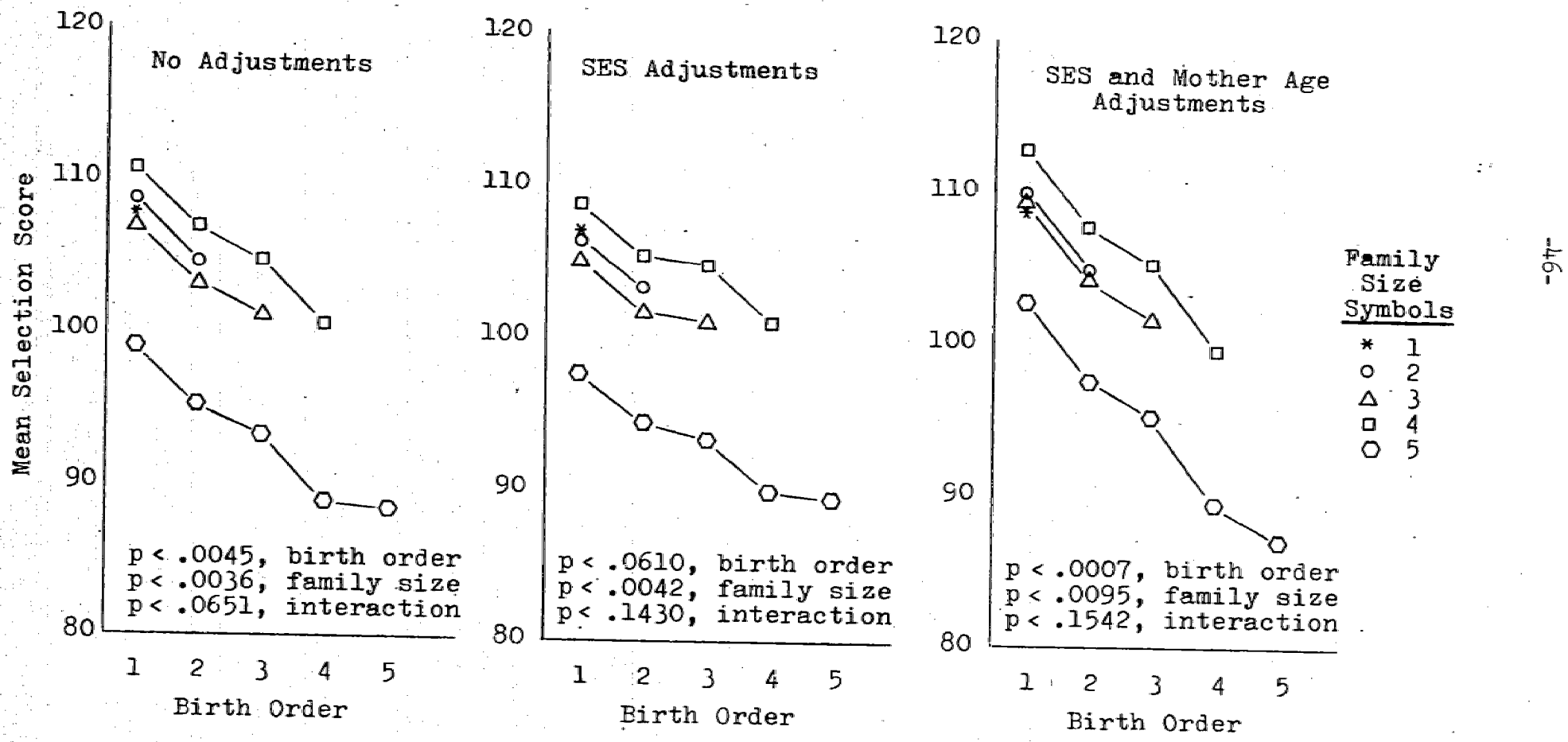
Fig. 11. Spacing effects on selection score, three-child families, 1965 sample.

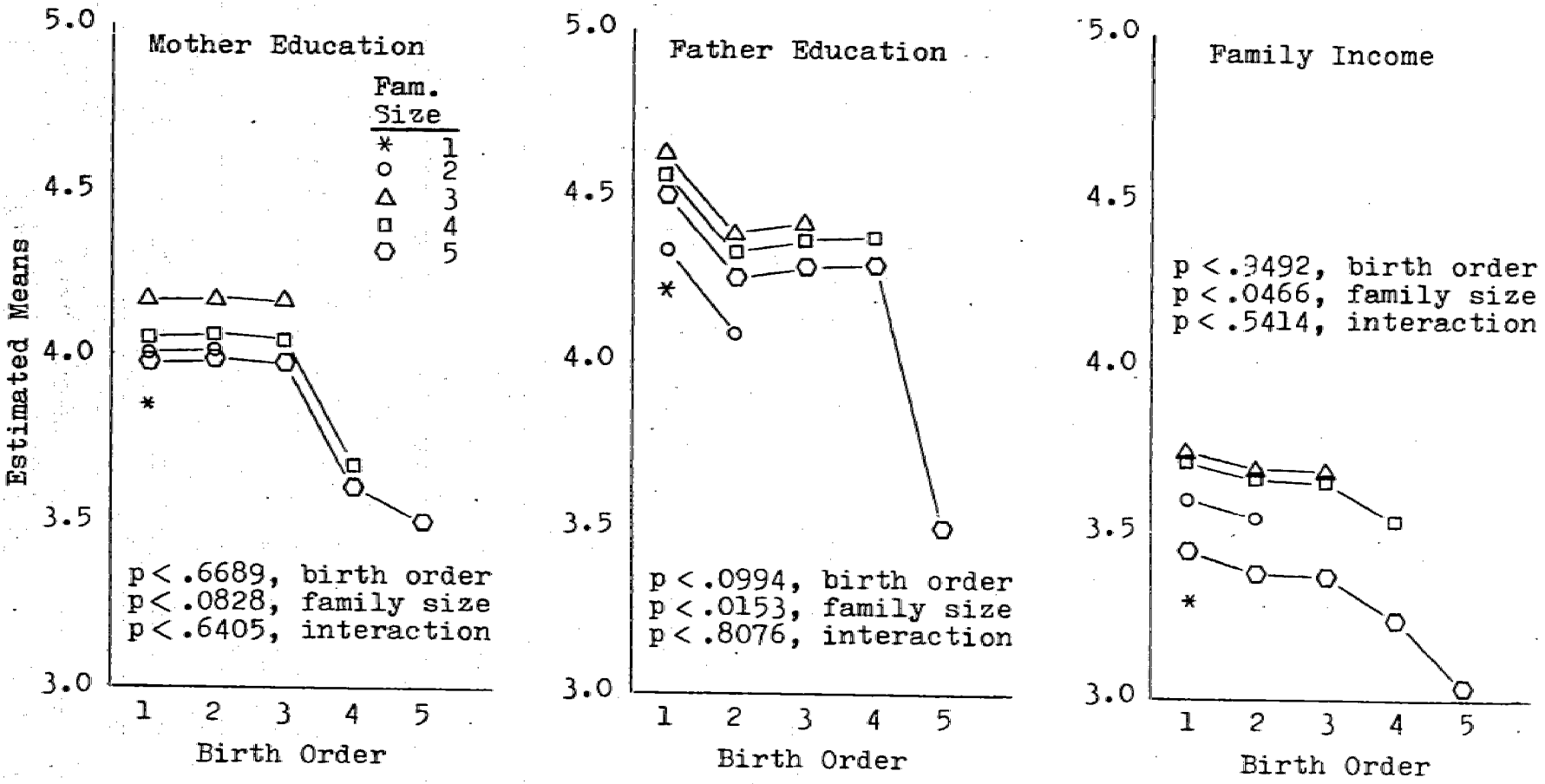

Observed
Estimated
Mean Mother Education
4.0
3.5
3.0
2.5
2.0
1.5
1 2 3 4 5
Birth Order
p < .91, interaction
p < .027, birth order
p < .958, family size
Symbol
Family Size
* 1
o 2
△ 3
□ 4
⬡ 5

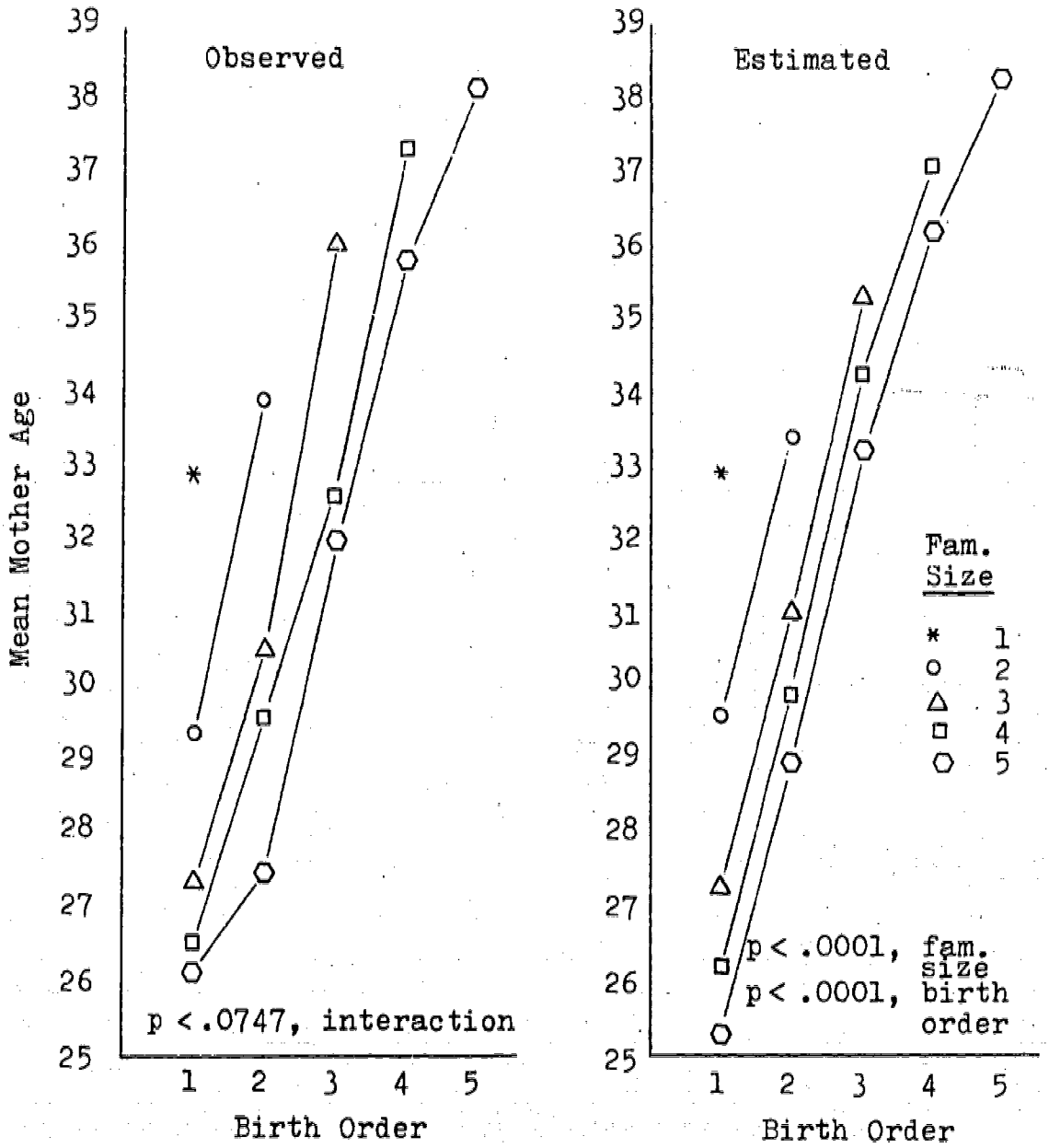

Observed
Estimated
Mean Father Education
4.0
3.5
3.0
2.5
2.0
1.5
1 2 3 4 5
Birth Order
p <.072, interaction
p < .0001, birth order
p < .1144, family size
Symbol
Family Size
* 1
o 2
△ 3
□ 4
⬡ 5

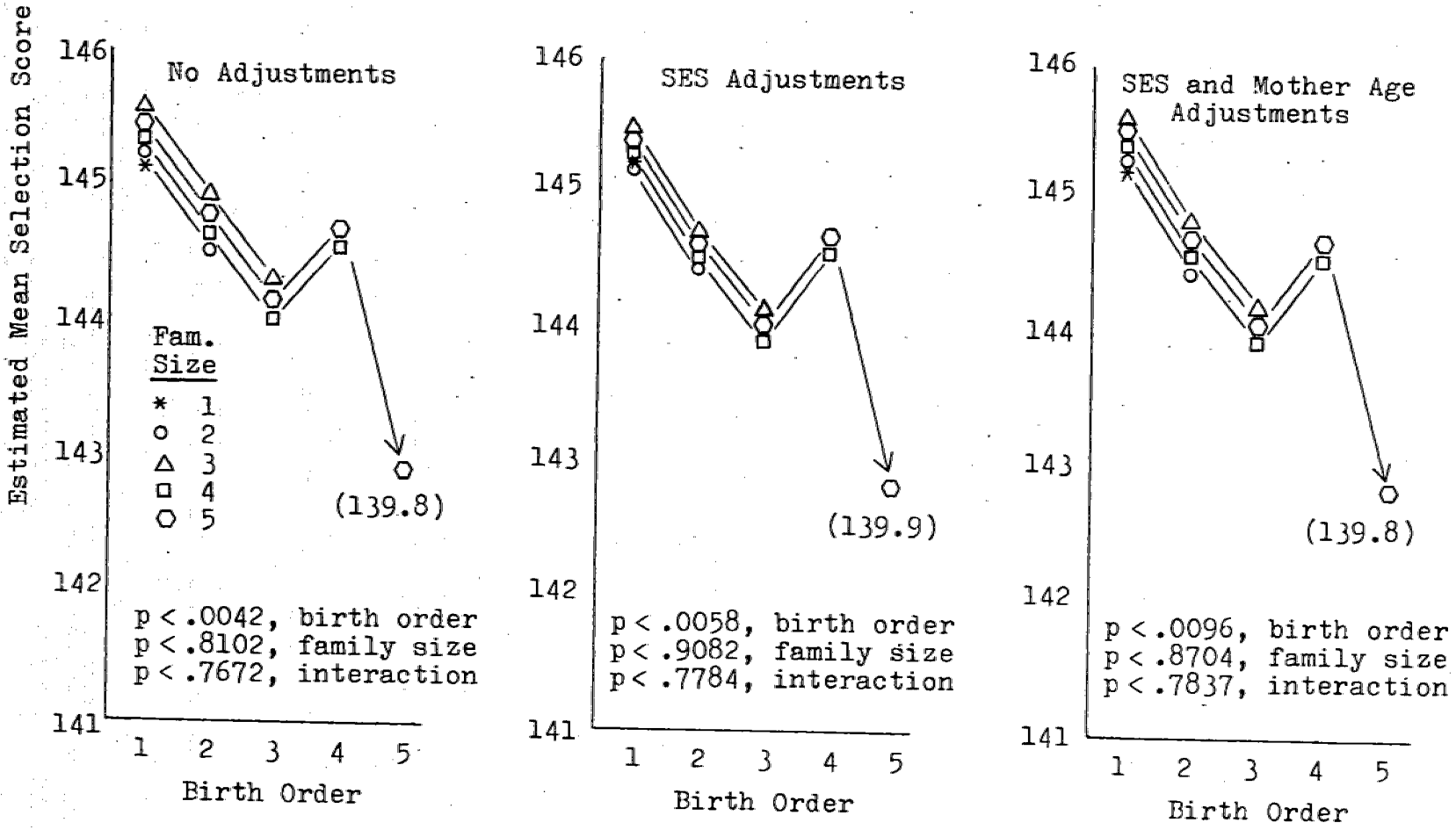

Observed
Estimated
Mean Family Income
4.0
3.5
3.0
2.5
2.0
1.5
1 2 3 4 5
Birth Order
p < .28, interaction
p < .10, birth order
p < .66, family size
Symbol
Family Size
* 1
o 2
△ 3
□ 4
⬡ 5

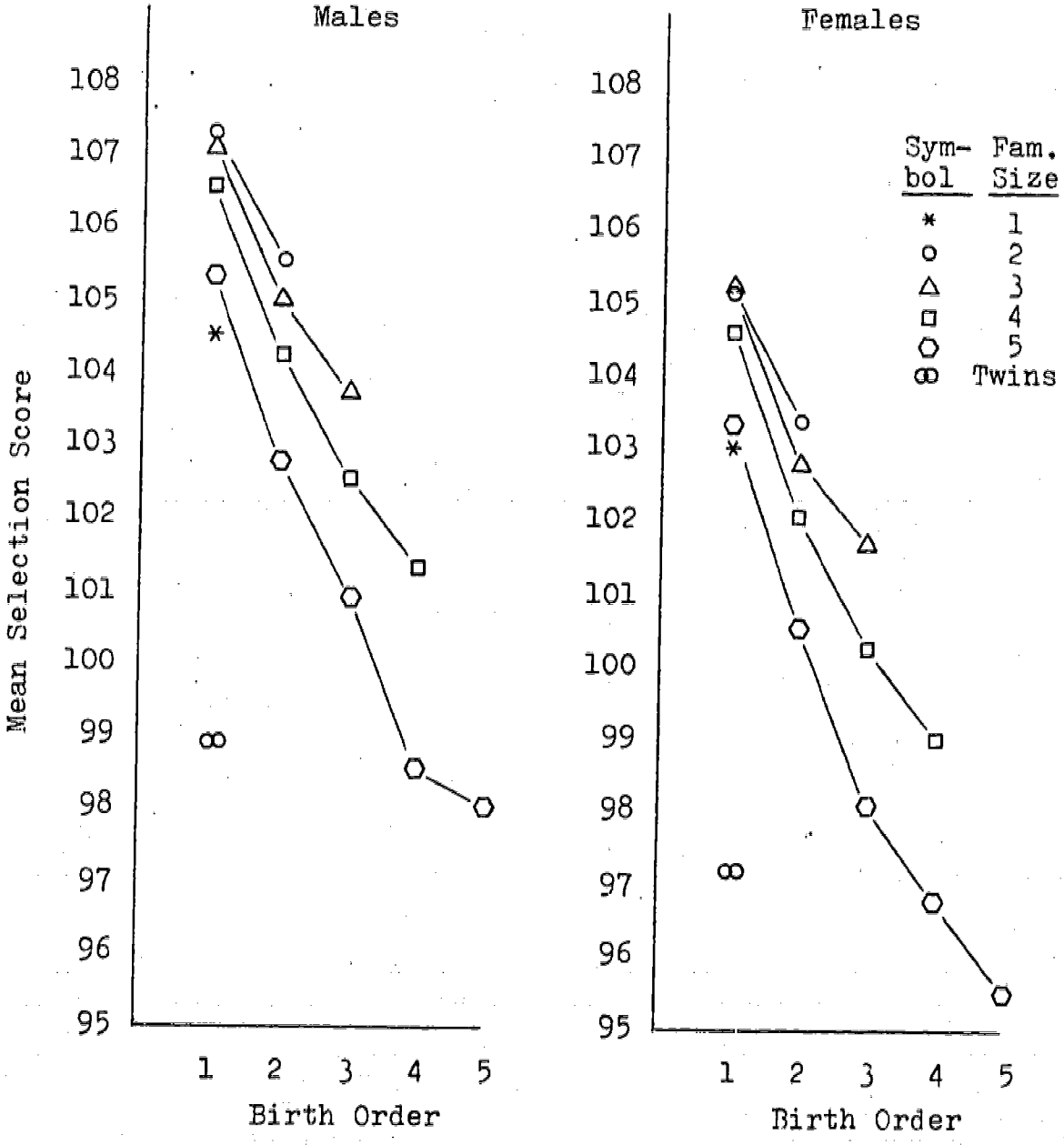

Observed
Estimated
Mean Mother Age
38
37
36
35
34
33
32
31
30
29
28
27
26
25
24
1
2
3
4
5
Birth Order
p < .62, interaction
p < .0001, birth order and family size
Symbol
Family Size
*
1
○
2
△
3
□
4
⬡
5

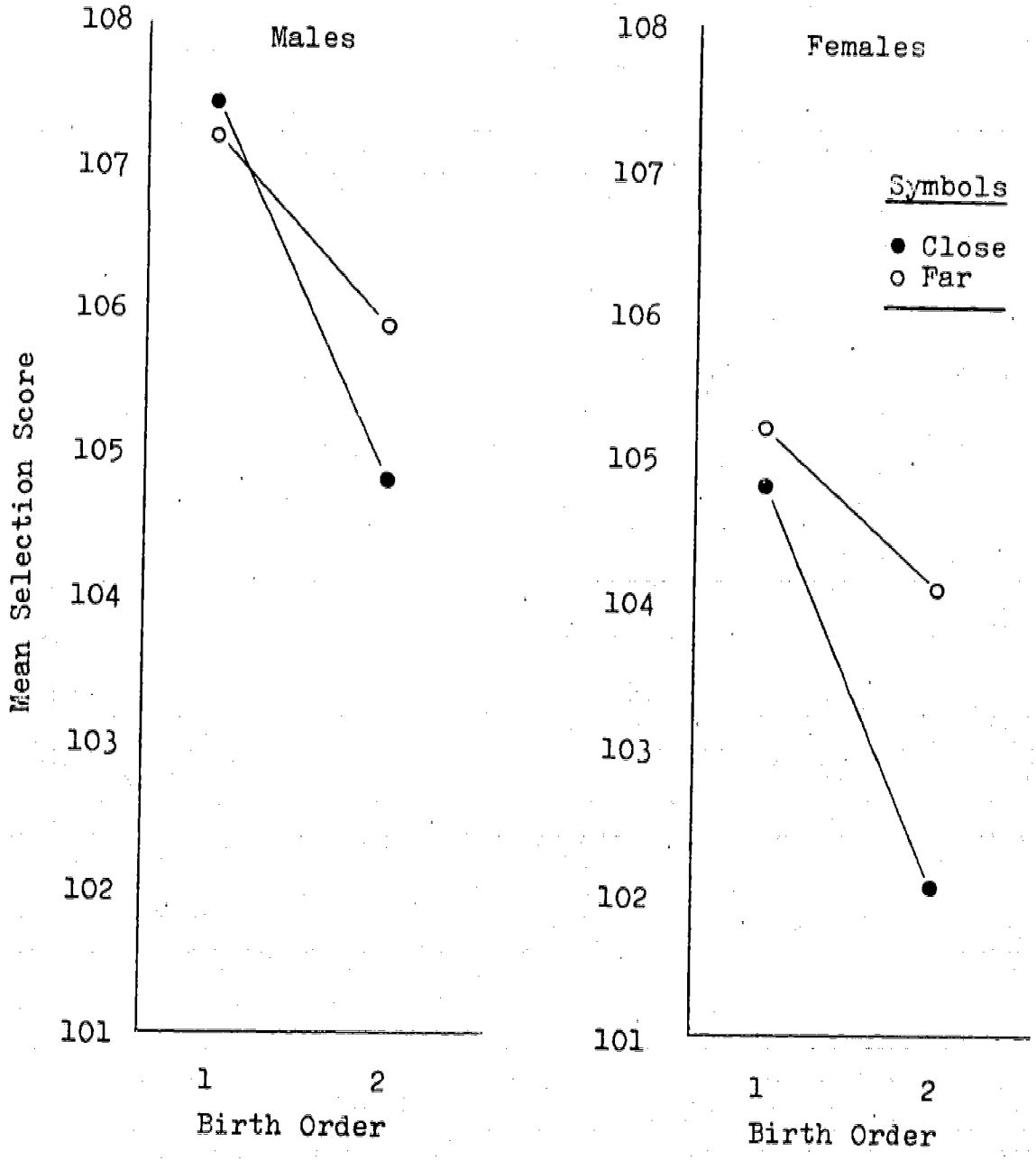

No Adjustments
SES Adjustments
SES and Mother Age Adjustments
Mean Selection Score
120
110
100
90
80
1 2 3 4 5
Birth Order
p < .0045, birth order
p < .0036, family size
p < .0651, interaction
p < .0610, birth order
p < .0042, family size
p < .1430, interaction
p < .0007, birth order
p < .0095, family size
p < .1542, interaction
Family Size Symbols
* 1
o 2
Δ 3
□ 4
⬡ 5

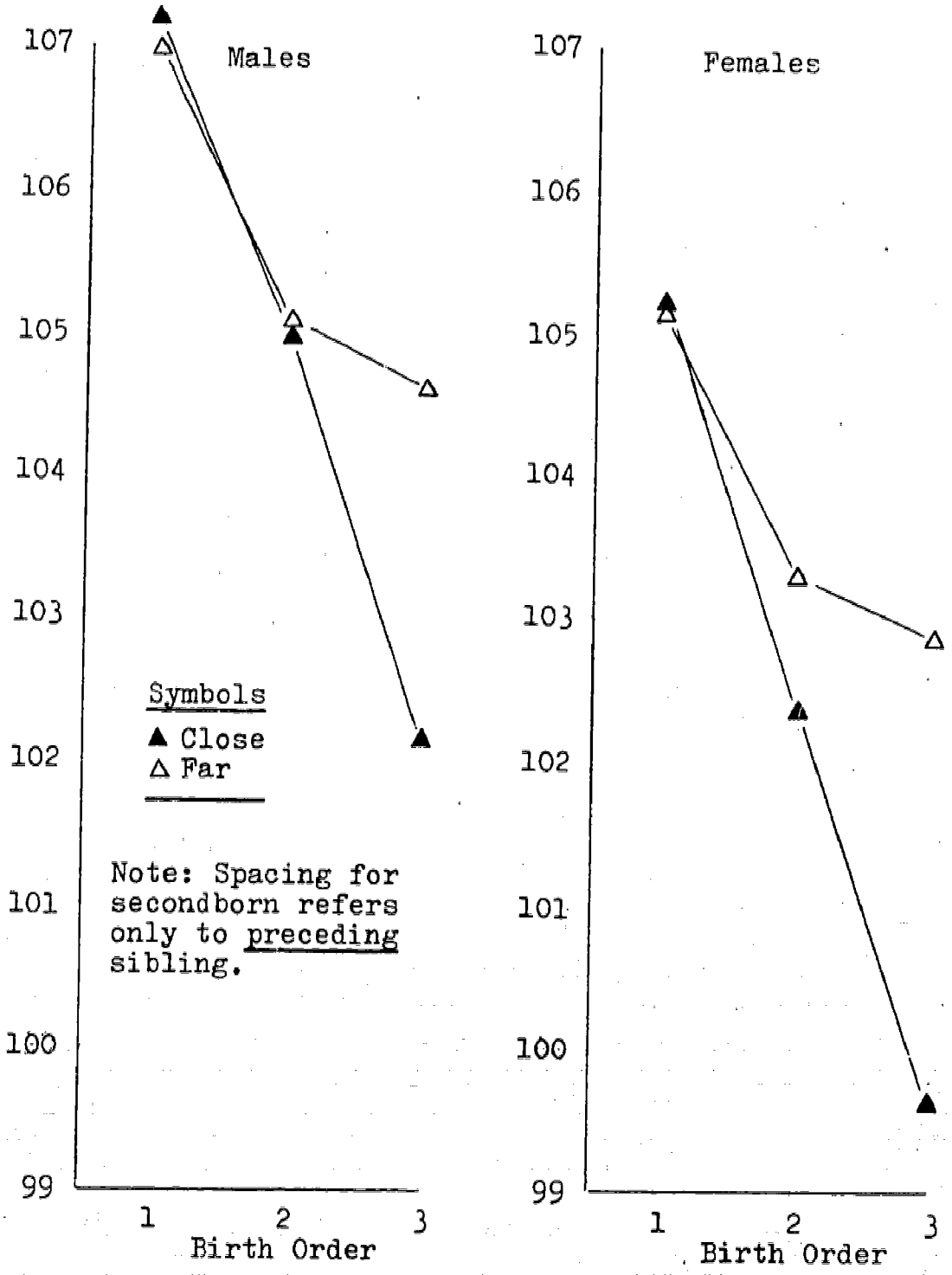

Mother Education
Fam. Size
* 1
o 2
Δ 3
□ 4
⬡ 5
p < .6689, birth order
p < .0828, family size
p < .6405, interaction
Father Education
p < .0994, birth order
p < .0153, family size
p < .8076, interaction
Family Income
p < .3492, birth order
p < .0466, family size
p < .5414, interaction
Estimated Means
5.0
4.5
4.0
3.5
3.0
1 2 3 4 5
Birth Order


Observed
Estimated
Mean Mother Age
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25
1 2 3 4 5
Birth Order
p < .0747, interaction
Fam. Size
* 1
o 2
△ 3
□ 4
⬡ 5
p < .0001, fam. size
p < .0001, birth order


Estimated Mean Selection Score
146
145
144
143
142
141
No Adjustments
Fam. Size
* 1
o 2
△ 3
□ 4
○ 5
(139.8)
p < .0042, birth order
p < .8102, family size
p < .7672, interaction
1 2 3 4 5
Birth Order
SES Adjustments
(139.9)
p < .0058, birth order
p < .9082, family size
p < .7784, interaction
Birth Order
SES and Mother Age Adjustments
(139.8)
p < .0096, birth order
p < .8704, family size
p < .7837, interaction
Birth Order


Males
Females
Mean Selection Score
108
107
106
105
104
103
102
101
100
99
98
97
96
95
1
2
3
4
5
Birth Order
Sym- bol
Fam. Size
*
1
o
2
△
3
□
4
⬡
5
∞
Twins


Males
Females
Mean Selection Score
108
107
106
105
104
103
102
101
1
2
Birth Order
Symbols
Close
Far


Males
Females
107
106
105
104
103
102
101
100
99
1
2
3
Birth Order
Symbols
▲ Close
△ Far
Note: Spacing for secondborn refers only to preceding sibling.

APPENDIX I

The three socioeconomic variables were obtained from questionnaire items including the following information:

Mother and Father Education:

8th grade or less	1
Part high school	2
High school graduate	3
Part college or junior college	4
College graduate	5
Degree beyond bachelor's	6

Family Income:

Less than $5,000 per year	1
$5,000 to $7,499	2
$7,500 to $9,999	3
$10,000 to $14,999	4
$15,000 to $19,999	5
$20,000 to $24,999	6
$25,000 and over	7

Mother's age at birth of subject was estimated by subtracting 16 years from the mother's age reported in the Parent Questionnaire.

Ranking of Mean NMSQT Scores for 82 Family Configurations

Rank		Birth	Fam.	Fam.	Sibship	Males			Females		
Male	Fem.	Order	Size	Code	Pattern[a]	Mean	S.D.	Cases	Mean	S.D.	Cases
1	1	1	3	41	XB - S	108.35	21.13	5,600	105.97	20.72	4,929
2	8	1	3	37	XB - B	108.22	21.13	5,235	105.14	20.66	5,050
3	2	1	3	39	XS - B	107.63	21.05	4,844	105.96	20.60	5,332
4	13	1	2	7	XB	107.54	21.39	9,657	104.72	21.02	10,591
5	11	1	2	9	XS	107.34	21.57	10,782	104.88	21.18	8,860
6	6	1	2	6	X - B	107.34	20.68	19,839	105.18	20.06	21,572
7	9	1	3	36	X - BB	107.17	20.50	6,085	104.96	19.66	5,597
8	5	1	2	8	X - S	107.10	20.79	21,589	105.30	20.11	18,611
9	4	1	3	43	X - SS	106.95	20.65	5,311	105.37	19.74	5,380
10	10	1	4	58	X,BBS	106.85	20.99	9,781	104.96	20.74	10,023
11	7	1	3	38	X - BS	106.77	20.64	11,932	105.17	20.17	11,377
12	3	1	3	44	XS - S	106.73	21.47	4,836	105.84	20.74	4,866
13	17	1	4	48	X,BBB	106.51	21.03	3,790	104.05	20.68	3,370
14	14	1	4	61	X,BSS	106.46	21.07	9,191	104.59	20.57	9,511
15	26	2	3	21	BX - B	106.12	21.03	2,664	103.10	20.37	2,887
16	22	2	3	23	BX - S	106.10	20.88	2,928	103.39	19.95	2,810
17	18	2	2	2	B - X	105.99	20.97	14,315	104.00	19.93	16,351
18	15	2	2	4	S - X	105.77	20.63	15,720	104.23	20.04	13,381
19	21	1	5	80	X,YYYY	105.67	21.25	10,569	103.56	21.12	10,919
20	20	2	3	16	B-X-S	105.59	20.77	3,004	103.62	19.94	2,753
21	12	1	4	49	X,SSS	105.54	21.30	3,053	104.79	20.93	3,263
22	16	2	3	17	B-XS	105.53	21.50	1,048	104.21	20.41	1,008
23	25	2	3	34	SX - S	105.35	20.60	2,359	103.13	20.48	2,636
24	41	2	2	3	BX	105.28	21.37	7,314	101.83	20.96	8,877
25	27	2	3	14	B-X-B	105.27	20.60	3,070	103.07	20.24	2,784
26	29	2	3	30	S - XS	105.22	21.10	900	103.05	20.50	922
27	19	2	3	27	S-X-B	105.12	20.88	2,836	103.66	20.01	3,051
28	33	2	3	32	SX - B	105.01	20.24	2,620	102.68	20.60	2,931
29	31	3	3	25	SS - X	104.94	20.63	3,798	102.86	20.01	3,617
30	42	2	4	59	B,X,SS	104.82	20.90	2,185	101.68	20.71	2,250

APPENDIX II (continued)

Rank		Birth	Fam.	Fam.	Sibship	Males			Females		
Male	Fem.	Order	Size	Code	Pattern[a]	Mean	S.D.	Cases	Mean	S.D.	Cases
31	23	2	3	29	S-X-S	104.74	20.42	2,812	103.30	19.94	2,688
32	30	3	3	10	BB - X	104.65	20.99	3,659	102.95	20.18	4,452
33	24	1	5	70	X,BBBB	104.61	21.41	1,191	103.30	21.19	934
34	43	2	4	56	B,X,BB	104.54	20.64	2,407	101.47	20.47	2,249
35	50	2	3	22	BXB	104.50	21.29	1,250	100.91	21.64	1,428
36	28	1	1	1	X	104.48	21.77	38,650	103.05	21.18	39,403
37	39	2	4	63	B,X,BS	104.41	21.38	4,499	102.06	20.54	4,443
38	35	2	2	5	SX	104.38	21.06	8,132	102.38	20.80	7,357
39	32	3	3	12	BS - X	104.38	21.22	6,689	102.77	20.06	6,945
40	36	2	3	28	S - XB	104.30	21.47	973	102.34	21.32	1,063
41	38	2	4	62	S,X,BS	104.10	21.23	4,210	102.14	20.55	4,703
42	40	2	4	57	S,X,BB	104.09	20.92	2,105	102.05	20.77	2,424
43	54	2	3	24	BXS	103.85	21.22	1,338	100.48	21.36	1,252
44	52	3	3	13	B - SX	103.80	21.80	1,386	100.57	20.77	1,512
45	37	2	3	15	B - XB	103.73	21.43	1,045	102.19	20.82	936
46	60	3	3	19	S - BX	103.63	21.34	1,494	99.94	20.72	1,491
47	49	2	3	33	SXB	103.31	20.75	1,162	100.95	21.70	1,304
48	34	2	4	60	S,X,SS	103.20	21.34	2,091	102.47	20.23	2,324
49	44	1	5	75	X,SSSS	103.08	21.48	872	101.41	21.82	886
50	61	3	4	64	BS,X,S	103.04	21.38	2,504	99.93	21.08	2,724
51	45	2	5	69	B,X,BBB	102.97	20.59	622	101.33	20.64	624
52	51	2	5	79	O,X,YYY	102.91	21.26	7,256	100.58	21.35	7,959
53	48	3	4	52	BB,X,S	102.72	21.30	1,593	100.99	21.14	1,680
54	56	2	5	74	S,X,SSS	102.54	22.56	513	100.27	20.58	610
55	58	3	4	65	BS,X,B	102.48	21.46	2,493	100.19	20.89	2,806
56	57	3	4	51	BB,X,B	102.38	22.11	1,567	100.26	21.38	1,542
57	55	3	4	54	SS,X,B	102.34	21.37	1,555	100.32	20.90	1,584
58	67	1	3	42	XBS	102.27	22.59	804	98.63	23.64	722
59	73	3	5	68	BB,X,BB	102.01	21.38	614	96.68	21.61	487
60	46	3	4	55	SS,X,S	101.96	21.03	1,407	101.13	20.84	1,433

Rank		Birth	Fam.	Fam.	Sibship	Males			Females		
Male	Fem.	Order	Size	Code	Pattern[a]	Mean	S.D.	Cases	Mean	S.D.	Cases
61	53	1	3	45	XSS	101.95	22.43	497	100.56	23.86	396
62	62	3	3	11	B - BX	101.93	20.97	2,385	99.57	20.45	2,402
63	59	3	3	26	S - SX	101.88	21.04	2,121	99.97	20.76	1,787
64	64	4	4	53	BSS,X	101.84	21.73	2,919	99.14	21.03	2,988
65	47	2	3	35	SXS	101.46	22.16	1,140	100.99	21.77	1,255
66	63	4	4	46	BBB,X	101.44	21.13	1,224	99.18	21.24	1,314
67	66	4	4	47	SSS,X	101.40	20.54	1,209	98.88	20.71	1,049
68	68	3	5	78	OO,X,YY	100.85	22.19	4,724	98.36	21.03	4,912
69	65	4	4	50	BBS,X	100.83	21.14	2,875	98.91	20.23	3,162
70	71	3	5	73	SS,X,SS	100.19	21.38	438	97.04	21.51	455
71	72	1	3	40	XBB	99.19	24.05	513	96.88	23.60	519
72	70	-	-	82	(Twin)	98.95	22.30	6,461	97.12	21.89	6,382
73	69	4	5	77	OOO,X,Y	98.79	21.56	3,132	97.14	21.32	3,451
74	79	5	5	76	OOOO,X	98.31	20.79	2,969	95.49	21.10	2,836
75	77	4	5	67	BBB,X,B	98.24	21.29	331	95.86	20.63	341
76	80	5	5	71	SSSS,X	97.75	20.73	506	95.48	20.31	356
77	81	-	-	81	(5+ Sibs)	97.75	22.65	45,725	95.10	22.79	48,363
78	82	4	5	72	SSS,X,S	97.67	21.41	300	93.56	21.11	267
79	78	3	3	20	BSX	97.56	21.79	296	95.49	20.32	269
80	74	3	3	18	BBX	97.34	22.13	193	96.48	22.79	215
81	75	3	3	31	SSX	97.32	19.26	190	96.33	22.06	188
82	76	5	5	66	BBBB,X	97.17	21.46	718	95.90	20.57	542

Note.--Rank order correlation between sexes, rho = .96.

[a]Sibship Patterns symbolized as follows: X(Sib position in birth order as measured from left to right), B(Brother), S(Sister), Y(Younger, where sex is unknown), O(Older, where sex is unknown). A dash, "-", indicates more than three years difference in age while adjacent letters indicate two years or less difference in age. A comma indicates "followed by."