Birth Order, Family Size, and Decline of SAT Scores

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ABSTRACT: *Scholastic Aptitude Test (SAT) scores of three cohorts were examined together with data on family configuration, collected in an attempt to calculate the contribution made to the score decline by family factors. The analysis shows that only a negligible fraction of the decline in SAT scores can be explained by changes in family configuration. In general, SAT scores showed little variation with birth order and family size—much less than found in other data sets. The results are discussed in the light of surveys of younger populations, for which test scores parallel birth trends remarkably well.*

According to a recent count (Wharton, 1977), 79 hypotheses have been advanced to explain the alarming decline in Scholastic Aptitude Test (SAT) scores during the last decade. Some hypotheses lay the blame on parental neglect, others on the spread of drugs, growing anti-intellectualism, waning support for schools, inadequate teacher training, addiction to TV, and even food additives. Most of these conjectures, however, are nonfalsifiable. Among those that are testable is the hypothesis that at least some portion of the decline in SAT scores can be attributed to the changing family configuration (Zajonc, 1976).

This hypothesis is derived from the confluence model (Zajonc & Markus, 1975), which describes the influences of family factors on intellectual development. In particular, the model predicts a systematic decline of intellectual performance in relation to birth order. Because the average order of birth in the United States has been declining in parallel with the decline in SAT scores, a causal connection was suspected. This hypothesis of a causal connection between the changing SAT scores and birth order patterns was further reinforced by data on younger populations from Iowa and New York. Both states have programs of extensive testing of the elementary school population. The results of these Iowa and New York programs are of particular interest because their recent surveys cover the local minimum in birth trends. Inasmuch as the U.S. birthrate increased steadily from the war years until the early sixties, the average order of birth of these cohorts must have undergone a corresponding decline. That is, from the late forties on, children born in the postwar era came from increasingly larger families and were correspondingly lower in order of birth on the average. A dramatic reversal of this trend occurred in 1962, and since that time there has been a steady increase in the average order of birth.

Although the SAT scores of individuals born in 1962 and thereafter will not be known until 1980, their scores in elementary school are already available, at least in New York and Iowa. If intellectual performance scores are indeed associated with birth order, we would expect a reversal in the trend of these scores for children born after 1962. It was precisely this finding among the New York and Iowa children that strengthened the supposition about the relation between SAT scores and birth order (Zajonc, 1976, pp. 233–234).

How much of the drop in the SAT scores could be attributed to the changing family patterns? A simple calculation can provide some hints. We first need some indication of how much of a difference in intellectual performance is associated with differences in birth order. Breland's (1974) research provides the best source for this purpose because his population is most similar to that taking SAT tests. Breland examined a large sample of high school students (nearly 800,000) who took the National Merit Scholarship Qualification

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Test (NMSQT), relating their scores to family factors. We have recalculated his data to establish the relation between birth order (averaged over all family sizes) and NMSQT scores. According to this calculation, the NMSQT scores for the first five birth orders are 105.46, 102.79, 101.86, 99.38, and 96.89. By a linear fit ($r^2 = .99$), these average scores represent a decline of 2.16 points for each birth rank. For purposes of evaluating SAT scores (which have a mean of 500 and a standard deviation of 100), we can convert these scores and Breland's figures (which have a mean of 102.5 and a standard deviation of 21.249) into standard scores, $(M - \bar{M})/SD$. When Breland's data are converted into standard units and the linear relation between these units and birth order is calculated, NMSQT scores decline by .10205 standard units per birth rank.

For purposes of illustration we have selected the period of 1965 to 1977, because during that period both SAT scores and the average order of birth in the United States showed steady monotonic trends. Between 1965 and 1977, there was a drop of 34.5 points in the average overall SAT score (averaged over the verbal and quantitative portions). This decline from an average of 483.5 to 449.0 represents .345 standard units. According to the U.S. census, during the same period there was a change in the average order of birth of about one half of a birth rank (from an average order of 2.3973 to 2.9448). Since each birth rank changes a standard intellectual score by .10205 units, we should expect a change of .10205 (2.9448 − 2.3973) = .055872 standard units in the average SAT score associated with changes in the average order of birth. This change amounts to no more than 5.6 SAT points. Therefore, if changes in birth order *alone* were responsible for the SAT decline, the national average today should be around 478 rather than 450. Clearly, then, only a fraction (16%) of the massive decline in SAT scores can be attributed to the changing family patterns. Beaton, Hilton, and Schrader (1977) compared the reading scores of high school seniors tested in 1960 and the scores of those tested in 1972 and found that a decline in these scores calculated on the basis of changes in birth order was only "about one-fourth as large as the observed" decrease. In comparing the SAT scores of college entrants in this manner, Beaton et al. found that the magnitude of the contribution of birth order effects was smaller yet; proportionately less of the drop in SAT scores could be attributed to birth order effects, which is in agreement with the above projection of 5.6 points out of a total decline of 34.5.

What is surprising about these data is that predictions for the elementary school populations are borne out so accurately, both in respect to the precise timing of the change in intellectual scores and in respect to the direction of the changes. The decline in SAT scores, too, is beginning to show the predicted leveling off. It appears quite likely that their trend will reverse, just as the trend of the elementary school scores has, because the children who were in elementary school in the early seventies are now begining to take their SATs.

The purpose of the present article is to examine in greater detail the role of family factors in the decline of SAT scores by sampling three cohorts of college entrance candidates.

Method

The research reported here was carried out in collaboration with the College Entrance Examination Board (CEEB) and the Educational Testing Service (ETS). We received permission from the CEEB to collect family-configuration data from each of three recent SAT cohorts. The confidential nature of this information was thoroughly protected by a specially designed procedure.

A random sample of 12,597 names from among the 1970–71, 1973–74, and 1976–77 SAT participants was selected by ETS research personnel.[1] The parents or guardians of each student received by mail a questionnaire requesting the birth date and sex of the candidate and the birth dates of the student's siblings. The mail questionnaires sent from ETS were returned to ETS, where the responses were merged with the corresponding SAT scores and with data from the Student Descriptive Questionnaire (SDQ). The SDQ contains a variety of information about students' academic performance, their career aspirations, participation in school and community activities, and so forth. As the responses from the mail questionnaire were merged with SAT scores and SDQ data at the ETS, the students' names were removed. ETS then delivered to us a file contain-

[1] The ETS part of the project was conducted by Rex Jackson and Sandy M. Campos, whose assistance is very much appreciated.

TABLE 1

SAT Scores and Birth Order of Cohorts in 1970–1971, 1973–1974, and 1976–1977

Item	1970–1971	1973–1974	1976–1977
N	1,897	1,309	3,956
SAT Verbal	473.9	460.8	441.2
SAT Quantitative	511.9	499.3	484.5
SAT combined	492.9	480.6	462.8
Mean order of birth (sample)	2.03	2.21	2.28
Mean order of birth (U.S. population)	2.678	2.805	2.903

Note. SAT = Scholastic Aptitude Test.

ing *only* SAT scores, SDQ data, and family-configuration information for each individual; the identity of the students thus remained unknown to us. In this way the privacy of all information analyzed was protected.

For the sample of 12,597 students, there were 7,692 returns, yielding a 61% response rate, which is common for this type of mail questionnaire. Of the 7,692 returns, 530 could not be used because they contained incomplete or contradictory information. Thus, the final sample size was 7,192. Since the SDQ was not instituted until the 1971–72 testing year, SDQ data were obtained only for the 1973–74 and 1976–77 cohorts.

Results

AGGREGATE OVERALL TRENDS

The mean SAT scores and average orders of birth for the three cohorts are presented in Table 1. As is apparent from the table, the average score dropped considerably over the 6 years. In 1970–71 the average combined SAT score was 492.9, whereas in 1976–77 it was only 462.8, a drop of 30.1 points or .301 standard units. The average order of birth for the 1970–71 sample was 2.03; the national figure was 2.68. For the 1976–77 sample, the comparable figures were 2.28 and 2.90. If we take the sample figures, we find that there was a decline in the order of birth of .25, or one quarter of a birth rank. Since by previous estimates we expect a decline of .10205 standard SAT units with each birth rank, there should have been a decline only one twelfth as large as actually occurred, that is, $.25 \times .10205 = .026$ rather than .301 standard units. In other words, if nothing but birth order had contributed to the trend, we should have observed a decline of 2.6 points, instead of the actual drop of 30.1 points.

EXTRAPOLATION ANALYSIS

More accurate estimates of the contribution of family factors to the SAT trends can be made by extrapolating SAT scores for the later cohorts on the basis of the earlier ones, with the assumption that no changes other than a change in birth order occurred. Table 2 presents the number and percentage of students of each cohort in each family position together with their respective average SAT scores. Because of small numbers of students in some family positions, students from families of more than five children were combined in order to obtain more stable SAT averages. If, as we suspect, the percentage of college entrants who were from small families and had high birth orders decreased while the percentage of those from large families and with later birth orders increased, this changing family pattern should be reflected in the lowering of the overall SAT averages. This extrapolation can be performed simply by assuming that within each family position no change in SAT scores occurred over the 6 years subsequent to 1970–71. What did change is the *proportion* of individuals within each position. Thus, if family factors were solely responsible for the decline in SAT scores, then a vector product of the 1970–71 SAT score columns and the percent-of-cohort columns in years 1973–74 and 1976–77 should be approximately equal to the obtained SAT averages.

Table 3 summarizes the results of the extrapolation. The figures represent the observed and extrapolated amounts of change separately for the verbal and quantitative parts of the SAT. It is eminently clear from Table 3 that the extrapolated estimates are minimal and that changes in the distribution of birth positions could have contributed very little to the decline. The largest extrapolated change is that for the verbal SAT between the 1970–71 and the 1976–77 cohorts. This extrapolated change amounts to only 1.6 SAT points. Note that there was an actual change of 32.8 points. Thus, the largest absolute extrapolated change accounts for only one twentieth of the decline. This, of course, is even less than the 2.6 points that would be expected from our preliminary calculation based on the gross average shifts in the birth order of the cohorts (see above). The prediction of the 1971-to-1974 decline for verbal scores is relatively better (1.33 points out

TABLE 2

Verbal and Quantitative SAT Scores and Family Patterns in Three Cohorts

BO–FS	1970–1971 % of cohort	n	SAT-V	SD	SAT-M	SD	1973–1974 % of cohort	n	SAT-V	SD	SAT-M	SD	1976–1977 % of cohort	n	SAT-V	SD	SAT-M	SD
1–1	6.48	123	478.93	112.83	511.35	123.33	5.19	68	448.97	116.21	471.47	104.87	4.32	171	453.63	124.06	470.53	128.71
1–2	12.92	245	478.75	107.21	505.85	110.74	11.69	153	483.01	105.67	507.65	123.01	11.60	459	459.17	112.34	492.20	120.87
2–2	12.92	245	467.88	107.37	511.60	112.84	10.77	141	467.30	110.11	505.60	121.05	10.77	426	444.32	107.95	483.55	121.64
1–3	10.65	202	493.05	109.05	520.03	115.79	9.17	120	473.17	107.67	509.58	123.00	11.12	440	464.05	113.93	501.77	124.27
2–3	10.44	198	485.40	94.99	530.03	107.81	9.85	129	462.09	105.30	516.98	118.56	9.13	361	441.63	103.63	495.08	120.05
3–3	7.12	135	462.84	102.80	513.54	115.03	9.93	130	460.31	107.57	501.92	111.84	9.91	392	438.75	104.29	480.69	113.13
1–4	5.48	104	483.26	117.49	526.14	105.54	4.81	63	496.67	111.18	527.30	113.69	5.79	229	455.94	120.77	495.94	133.59
2–4	5.85	111	465.67	100.43	504.23	106.06	6.49	85	463.53	100.28	509.65	118.58	5.38	213	435.12	100.58	485.63	116.43
3–4	4.06	77	460.58	95.75	497.43	122.70	5.27	69	434.78	101.93	472.90	108.70	4.80	190	425.00	95.58	477.74	116.36
4–4	3.48	66	468.26	103.60	518.52	118.27	4.20	55	469.45	114.33	518.18	131.40	4.78	189	452.65	103.04	498.15	117.27
1–5	2.64	50	496.52	117.26	517.48	121.13	2.75	36	439.17	111.52	501.39	115.98	1.72	68	424.71	112.75	468.97	121.51
2–5	2.74	52	494.50	109.00	519.23	112.81	2.60	34	462.35	123.71	484.12	120.33	1.92	76	407.63	108.00	460.92	117.53
3–5	2.21	42	465.07	108.50	516.93	129.61	2.29	30	441.00	110.37	471.33	131.56	2.40	95	412.74	107.31	460.11	119.35
4–5	1.27	24	445.83	104.17	497.92	100.61	2.06	27	428.89	112.40	470.37	126.05	2.68	106	435.85	107.20	483.96	112.13
5–5	1.00	19	471.63	115.01	505.00	81.28	1.60	21	435.71	101.17	486.19	105.09	1.67	66	450.15	109.73	478.18	120.05
6+	10.75	204	451.06	109.65	491.01	111.53	11.31	148	436.96	119.84	474.26	112.59	12.01	475	407.96	118.34	464.91	125.99
Total	100.00	1,897	473.95	107.02	511.86	113.25	100.00	1,309	460.83	110.42	499.26	119.61	100.00	3,956	441.20	111.37	484.46	121.74

Note. BO = birth order; FS = family size; SAT-V = Verbal subscale of the Scholastic Aptitude Test; SAT-M = Quantitative subscale.

TABLE 3

Observed and Extrapolated Amount of Change in SAT Scores

Change	1970–1971 to 1973–1974		1973–1974 to 1976–1977		1970–1971 to 1976–1977	
	SAT-V	SAT-M	SAT-V	SAT-M	SAT-V	SAT-M
Observed	−13.12	−12.60	−19.63	−14.80	−32.75	−27.40
Extrapolated[a]	−1.33	−.61	+.79	+.40	−1.56	−.61
Percentage accounted for	10.1	4.9	4.0[c]	2.7[c]	4.8	2.2
Extrapolated[b]	−1.18	−2.46	−.55	−1.95	−1.42	−2.56
Percentage accounted for	9.0	19.5	2.8	13.2	4.3	9.4

Note. SAT-V = Verbal subscale of the Scholastic Aptitude Test; SAT-M = Quantitative subscale.
[a] Uncorrected for sex ratio.
[b] Corrected for sex ratio.
[c] For this figure, an increase in scores rather than a decline was predicted.

of 13.12), with changes in birth order accounting for about 10% of the drop in the scores. In general, the extrapolations are weaker for the quantitative scores than for the verbal scores. The extrapolation for the 1974-to-1977 changes is altogether in the wrong direction.

The SAT population may have changed in other ways besides family configuration, of course, and in ways that may have cancelled, obscured, or interacted with such family factors. Among the 79 hypotheses offered to explain the drop, it has been suggested that the increasing proportion of women and low-income students, who tend to score low on all or some portions of the SAT, may be responsible for the decline in scores. For example, women's scores on the quantitative parts of the SAT are generally lower.

To determine how much of the decline in scores could be traced to the increasing proportion of women candidates, separate extrapolations were made for the years 1973–74 and 1976–77 in the same way as previously, except that the changing sex ratio was also taken into account. The proportion of subjects within each family-configuration category was broken down by sex, and the projected extrapolation scores for these subcategories were obtained by reference to the corresponding 1970–71 SAT scores for males and females. As can be seen from Table 3, the prediction is improved, especially for the quantitative part of the SAT. Also, the extrapolated 1974-to-1977 changes are now in the right direction. Finally, when the extrapolation is corrected for the changing sex ratio, the predictions for the quantitative part of the SAT are now better than those for the verbal part, because of the greater difference in scores between men and women on that portion of the test.

Because of a variety of economic factors, especially inflation, the parental income of the cohorts rose over the period of the study. Since an extrapolation that corrects for income would require some form of arbitrary categorization as well as assumptions about inflation, we investigated the contribution of this variable to the decline by means of multiple regression procedures. Because the SDQ information was available only for the last two cohorts, only these cohorts are in-

TABLE 4

Summary of Multiple Regression Analyses for Verbal and Quantitative SAT Scores

Independent variable	Partial correlation with SAT scores		Regression coefficient		*SE*		*t*	
	SAT-V	SAT-M	SAT-V	SAT-M	SAT-V	SAT-M	SAT-V	SAT-M
Birth Order (BO) × Family Size (FS)	−.067	−.040	−1.225	−.802	.296	.327	4.14**	2.45*
Cohort	−.070	−.057	−13.218	−11.968	3.080	3.401	4.29**	3.52**
Income	.007	.002	.929	.345	2.135	2.357	.43	.15
BO × FS × Income	.012	.012	.080	.086	.107	.118	.75	.74
Cohort × Income	.033	.035	.667	.771	.325	.359	2.05*	2.15*
BO × FS × Cohort × Income	−.002	−.004	−.002	−.005	.015	.017	.13	.28

Note. SAT-V = Verbal subscale of the Scholastic Aptitude Test; SAT-M = Quantitative subscale.
* $p < .05$. ** $p < .001$.

cluded in this analysis. The results of the regression analysis, however, do not demonstrate any improvement in prediction (see Table 4). The variables that were entered into the regression equation were cohort (scored as 4 and 7 for 1974 and 1977, respectively), income (scored according to SDQ categories), the joint multiplicative effects of birth order and family size (Birth Order × Family Size), the interaction between these family factors and income (Birth Order × Family Size × Income), the interaction of cohort by income (Cohort × Income), and the four-way interaction of birth order, family size, cohort, and income (Birth Order × Family Size × Cohort × Income). Later birth orders and larger family sizes (more than five children) were *not* collapsed into one category, as they were in the extrapolation analysis, but retained their true values. These variables accounted for only about 8% of the variance in the verbal SAT scores and about 6% in the quantitative SAT scores. It is clear from Table 4, however, that income could not have played a significant role in the inaccuracy of the extrapolated figures, because for both scores the four-way interaction shows coefficients close to zero and equally low partial correlations.

Discussion

The effects that family factors could have had on the SAT decline during the years 1970–77 must be considered quite minimal, according to the present analysis. In fact, their contribution is even smaller than that reported by Beaton et al. (1977), whose similar extrapolation from 1960 to 1972 showed birth order accounting for about 10% of the SAT decline. The most surprising finding, which accounts for the failure of our extrapolation to show any appreciable contribution of family factors, is that, contrary to the results of other comparable studies (e.g., Belmont & Marolla, 1973; Breland, 1974; Davis, Cahan, & Bashi, 1977; Flanagan & Jung, 1971; Claudy, Note 1), the 1970–71 SAT cohort shows very weak birth order and family size effects. A multiple regression analysis, in which verbal and quantitative SAT scores were regressed on birth order, family size, sex, and year, accounted for 3.1% and 6.1% of the variance in verbal and quantitative SAT scores, respectively, and showed birth order to have regression coefficients of −6.44 and −3.49. In standard units, these amount to .0644 and .0349, figures that are considerably smaller than the .10205

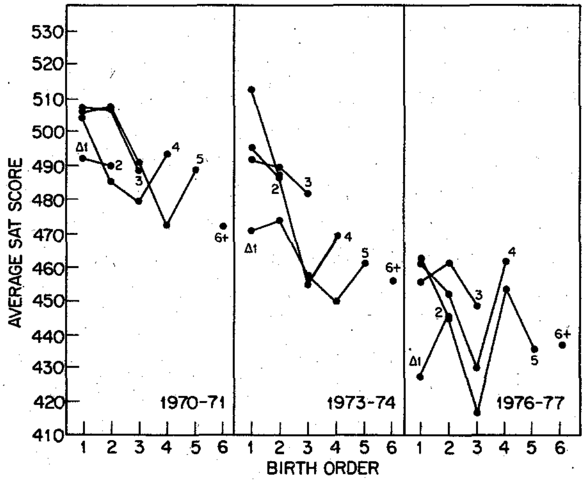

Figure 1. Combined verbal and quantitative SAT scores as a function of birth order and family size in three cohorts.

found for Breland's data. Similarly, family size produced decrements of .0347 and .0221 standard units per child in the verbal and quantitative scores, respectively. The partial correlations, too, were low: For the verbal and quantitative scores, respectively, they were −.04 and −.03. This latter finding is especially surprising in light of all the other research that shows consistent negative correlations between intellectual scores and family size, often with R^2 greater than .1 (Terhune, 1976). Figure 1 presents the combined SAT scores for the three cohorts, from which it is clear that birth order effects are minimal and that for the earliest cohort (1970–71) family effects are negligible.

We are confronted with a puzzling problem—a problem that may become even more puzzling if the predicted upswing in SAT scores materializes during the early eighties. That such an upswing may, in fact, take place is indicated by the leveling off of the scores in 1979. Because the decline and rise in SAT scores would then follow very closely parallel trends in the average U.S. order of birth, we would again be tempted to attribute the decline and then the rise to family-configuration factors. But the present study and that of Beaton et al. (1977) do not allow such a conclusion. Hence, other explanations must be sought.

Among the list of 79 hypotheses, it would be difficult to find one like the birth order hypothesis that explains both the decline and the anticipated rise in SAT scores. Of course, it is possible that one factor was responsible for the decline until 1980 and that another, after the first ceased to operate, may account for a subsequent rise. Again, it is not easy to select two such factors from the list of 79 hypotheses. The remote possibility remains that both Beaton et al. and we have samples that are not representative of the entire SAT population, and that in both studies students who scored low on the SAT but who came from small families and had high birth orders were somehow overrepresented and their converse numbers underrepresented.

What remains, therefore, is the hypothesis that the birth order prediction from the confluence model is correct after all, but that the effects are very weak and the samples used to test the prediction were too small to display the trends. If birth order effects are weak but birth order is *the only factor to have systematic effects* among all the multitude of factors that influence SAT scores, then the pattern of these effects may be revealed in large aggregate data sets but be locally concealed. Whether this is so will become evident by the mid-eighties.

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