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Birth Order and Schizophrenia*

By K. L. GRANVILLE-GROSSMAN

Characteristics which are wholly genetically determined are distributed at random among all the members of a sibship. Dependence of the distribution on birth rank (i.e. maternal parity at the birth of the subjects) or on position within the sibship provides presumptive evidence of non-genetic causes and may give some indication of their nature (McKeown and Record, 1956). Investigations on the birth order of schizophrenics (Tables VI and VII) have to date given no clear and consistent results, and further study appears to be indicated.

Material

The probands comprised a one-in-two representative sample of all in-patients over the age of 16 years who were discharged from Maudsley and Bethlem Royal Hospitals during the years 1949–1962, diagnosed as schizophrenic (International Classification of Diseases Code Number 300). The representative sample was obtained by selecting those patients who had been given an odd registration number at the time of admission. The sample comprised 1,252 patients, but the records of 8 were not available, and the study restricted to the remaining 1,244 subjects (562 males and 682 females).

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Methods and Results

From the in-patient records of the subjects, the sex, birth rank and size of sibship (i.e. total number of live children born to the mother) were noted. The distributions are set out in Tables I and II. Only those subjects (22 male and 30 female) whose birth orders are not known have been excluded. Twins are entered in the tables as one half to each of the possible birth ranks into which they may have been born.

The data are analysed by the Greenwood-Yule method (Greenwood and Yule, 1914; Gregory, 1958), which compares the observed

TABLE I

Distribution of Male Probands by Birth Rank and Size of Sibship

Size of sibship	Birth rank														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
1	59														59
2	57·5	64·5													122
3	21	35	39												95
4	14·5	19	26	13·5											73
5	4	9·5	14	8·5	14										50
6	8·5	2·5	6	5·5	10	9·5									42
7	2	4	5	3	7	5·5	5·5								32
8	2	4	2	4	1	0	4	4							21
9	1	0	2	1	0	3	3·5	5·5	4						20
10	0	1	1	1	0	0	0	3	0	1					7
11	0	1	0	0	0	1	0	2	0	0	0				4
12	0	0	0	0	1	0	1	1	2	2	0	1			8
13	0	1	1	0	0	0	0	0	0	1	0	1	1		5
14	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
21	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Total	169·5	141·5	96	36·5	33	19	15	16·5	6	4	0	2	1	0	540

Birth order not known 22

TABLE II

Distribution of Female Probands by Birth Rank and Size of Sibship

Size of sibship	Birth rank																Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
1	72																72
2	62	72															134
3	48·5	50·5	33														132
4	26	20·5	24·5	19													90
5	12	13	10·5	17	16·5												69
6	7	6	6	6	10	5											40
7	4	3	5	4	3	12·5	3·5										35
8	3	1	0	4	5	4·5	5·5	0									23
9	1	1	3	3	1	1	4	0	1								15
10	0	2	1	2	4	3	1	4	4	2							23
11	3	0	0	0	0	1	0	2	1	0	1						8
12	1	0	0	0	0	2	1	1	0	0	1	0					6
13	0	0	0	0	0	1	0	0	0	0	0	1	1				3
14	0	0	0	0	0	0	0	0	0	0	0	0	1	0			1
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Total	239·5	169	83	55	39·5	30	15	7	6	2	2	1	2	0	0	1	652

Birth order not known 30

distribution of birth ranks with that to be expected if all birth ranks within a given size of sibship are equally represented. Symbolically this expectation is that the number of subjects (Fx) from sibships with x members will be distributed evenly among the possible birth ranks (i.e. Fx/x to each).

The expected number of subjects in each birth rank is calculated separately for each size of sibship. Summing the individual expectations of a given birth rank gives the total expected number in that birth rank. The distributions of observed and expected numbers are then compared, using the χ^2 test.

Birth Rank

The observed and expected distributions of birth rank are set out in Table III.

(i) The observed distribution of birth ranks of male schizophrenics significantly differs from that expected ($\chi^2 = 25{\cdot}24$; 8 d.f.; $0{\cdot}01 > p > 0{\cdot}001$; Table IIIa). There are fewer first born than expected, and the later birth ranks are over-represented.

(ii) The distribution of the observed birth ranks of female schizophrenics (Table IIIb) does not differ significantly from that expected ($\chi^2 = 9{\cdot}48$; 9 d.f.; $p > 0{\cdot}1$).

(iii) When the data of Tables IIIa and IIIb are combined, the effect of birth rank, irrespective of sex, may be tested. Table IIIc shows that the differences between observed and expected distributions do not reach statistical significance ($\chi^2 = 13{\cdot}42$; 9 d.f.; $p > 0{\cdot}1$).

Relative Position within the Sibship

As Gregory (1958) has pointed out, the Greenwood-Yule reconstruction enables the expected number of subjects in any given position within the sibship to be calculated. The expected number of eldest is found by reference to Table III; it is equal to the expected number of first-born, but since only children are both eldest and youngest, they are best excluded and their number subtracted. The expected number of youngest is equal to the expected number of eldest; all remaining are in the intermediate position. The observed numbers of probands who are eldest, youngest, and of intermediate position are determined directly from Tables I and II; here, too, only children are excluded.

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TABLE III

Observed and Expected Distributions of Birth Ranks: (a) for male probands; (b) for female probands, and (c) for probands of both sexes

	Male Schizophrenics		Female Schizophrenics		Male and Female Schizophrenics	
Birth rank	Observed	Expected	Observed	Expected	Observed	Expected
1	169·5	199·57	239·5	239·40	409	437·97
2	141·5	139·57	169	167·40	310·5	306·97
3	96	78·57	83	100·40	179	178·97
4	36·5	46·90	55	56·40	91·5	103·30
5	33	28·65	39·5	33·90	72·5	62·55
6	19	18·65	30	20·10	49	38·75
7	15	11·65	15	13·43	30	25·08
8	16·5	7·08	7	8·43	23·5	15·51
9	} 13	} 10·35	6	5·56	12	10·00
10 or greater			8	6·97	15	12·87
Total	540	540	652	652	1,192	1,192
	$\chi^2 = 25·4$; 8 d.f. $0·01 > p > 0·001$		$\chi^2 = 9·48$; 9 d.f. $p > 0·1$		$\chi^2 = 13·42$; 9 d.f. $p > 0·1$	
	(*a*)		(*b*)		(*c*)	

(i) Table IVa shows that male schizophrenics are less often first-born and more often last-born than expected; this is highly significant statistically ($\chi^2 = 8·91$; 2 d.f.; $0·025 > p > 0·01$).

(ii) The distribution of female schizophrenics among the various positions does not depart from expectation ($\chi^2 = 1·54$; 2 d.f.; $p > 0·1$; Table IVb).

(iii) Combining the data of Tables IVa and IVb shows that when sex is not considered as a separate variable, schizophrenia is not associated with any particular position in the sibship (Table IVc; $\chi^2 = 4·11$; 2 d.f.; $p > 0·1$).

DISCUSSION

The investigation has shown that male, but not female, schizophrenics tend to be born late in their sibships. Before drawing any conclusion concerning the relationship between this finding and the aetiology of schizophrenia, the possibility of artefact should be excluded as far as possible. Since the expected distributions of birth ranks and of positions in the sibship are calculated from a knowledge of the distribution of size of sibship, circumstances which affect the latter may distort the expected distributions and may lead to an apparent effect of birth order when perhaps none really exists.

Two circumstances in particular may lead to an apparent preponderance of later born subjects (McKeown and Record, 1956). The first is when the population studied includes subjects from incomplete sibships, i.e. those into which further members are born after the time of the investigation. The size of these sibships will be under-estimated, and this will lead to an apparent preponderance of individuals born into the later birth ranks. One can only be certain that a sibship is complete if at the time of the study the subject's mother has passed her reproductive period, but the age of the subject at the time of the study gives some indication, since the older he is, the more likely is his sibship to be complete.

The second source of artefact is introduced when there is a reduction in the fertility of the mothers after the birth of their affected offspring. It is known that parents may restrict the number of further pregnancies after the birth of a deformed child. To a less obvious degree, it may be that similar restrictions occur when the young child exhibits a persistent disturbance of behaviour, the first sign of later

TABLE IV

Observed and Expected Distributions of Positions in Sibship for: (a) male probands; (b) female probands, and (c) probands of both sexes

	Male Schizophrenics		Female Schizophrenics		Male and Female Schizophrenics	
	Observed	Expected	Observed	Expected	Observed	Expected
Eldest	110·5	139·6	167·5	167·4	278	307·0
Youngest	157	139·6	155	167·4	312	307·0
Intermediate ..	213·5	201·8	257·5	245·2	471	447·0
Total	481	481	580	580	1,061	1,061
	$\chi^2 = 8{\cdot}91$; 2 d.f. $0{\cdot}025 > p > 0{\cdot}01$		$\chi^2 = 1{\cdot}54$; 2 d.f. $p > 0{\cdot}1$		$\chi^2 = 4{\cdot}11$; 2 d.f. $p > 0{\cdot}1$	
	(*a*)		(*b*)		(*c*)	

psychiatric illness. This reduction in fertility will distort the distribution of size of sibships, creating an apparent preponderance of affected individuals born later in their families.

These sources of artefact may be tested for. To test the effect of incomplete sibships, the subjects are grouped by sex and age at admission. For each group, Slater's index of birth order is calculated (Slater, 1962). (In each group, the mean value of $\frac{m-1}{n-1}$ is computed, where m = the birth rank and n = size of sibship. A mean value greater than 0·5 indicates a preponderance of later born subjects; one of less than 0·5 a preponderance of earlier born subjects.)

Table V presents the values computed for the different groups. While young males do give higher values than older males, the tendency is for all males, irrespective of their age at admission, to come from late in their families. In particular, those after the age of 35 years who almost certainly all come from complete sibships, show high values, so that the inclusion of incomplete fraternities cannot wholly account for the findings. Furthermore, young females who might also be expected to come from incomplete fraternities do not give high values of Slater's index. This suggests that the effect of incomplete sibships can be discounted here.

The second possible source of bias, namely reduced fertility of the mothers after the birth of male schizophrenics, may also be tested for. If male (but not female) schizophrenics-to-be tended to show behavioural disturbances in early childhood, leading their parents to restrict the number of further pregnancies, a birth order effect similar to that found might be apparent. The data in Table V might then indicate that it is principally those males who become schizophrenic early in life who also show early behavioural disturbances, and consequently also an effect on the subsequent reproduction of the parents.

If this bias is in fact operating, it would be expected that male schizophrenics would tend to come from small families. From Tables I and II it can be calculated that mothers of male schizophrenics have, on average, slightly more children than do mothers of female schizophrenics (4·19 and 4·14 respectively). This difference is opposite to that which would be expected were there reduced fertility after the birth of the male probands.

Before postulating a causal relationship for the association between late birth rank and schizophrenia in males, one other possibility should be considered, namely that male schizophrenics are admitted more readily when they are born late in their sibships. This sort of bias cannot be excluded with certainty, but it is difficult to suggest an explanation involving one sex and not the other. If the possibility of bias in selection is set aside on the ground that there is no supporting evidence, the association

TABLE V
Slater's Index of Birth Order according to Age of Probands at Admission

Age at Admission	Male Schizophrenics		Female Schizophrenics	
	No.*	Slater's Index	No.*	Slater's Index
16–19	39	0·63	48	0·46
20–24	95	0·57	80	0·50
25–29	120	0·57	98	0·52
30–34	84	0·50	82	0·59
35–39	64	0·59	83	0·53
40–44	79	0·54	65	0·46
45–49			39	0·53
50–59			49	0·47
60 and over			36	0·46
All	481	0·561	580	0·510

* These numbers do not include only children.

between birth order in males and schizophrenia must be accepted as indicating an aetiological relationship.

Previous investigators have, in general, found no association between incidence of schizophrenia and birth rank (Table VI). Their methods compare the observed distribution of birth ranks with that expected on a null hypothesis and are, therefore, similar to that used in the present investigation. Discrepancies between the results presented here and those already published cannot, therefore, be attributed to differences in method.

Previously, only Rao (1964) has shown a relationship between incidence of schizophrenia and birth rank. Her finding of higher than expected numbers in the earlier birth ranks may be criticized on the ground that she may have been dealing with a biased sample. That there were three times as many males as females among her subjects suggests the existence of factors influencing admission to hospital, and her findings may be an effect of this bias in selection.

Other published work on birth rank (Table VI) has shown no association, and therefore seems to be at variance with the present findings. Examination of Table VI shows that all except two of the previous studies have not considered the sexes separately. The two exceptions (Goodman, 1957; Johanson, 1958) present data on relatively few males (98 and 91 respectively).

TABLE VI
Schizophrenia and Birth Rank

Authors	Place of Study	Number and Sex	Association found between Schizophrenia and Birth Rank
Pollock *et al.* (1939)	U.S.A.	175 M. and F.	Nil
Malzberg (1940)	U.S.A.	549 M. and F.	Nil
Böök (1953)	Sweden	120 M. and F.	Nil
Goodman (1957)	U.K.	211 M. and F.	Nil
Johanson (1958)	Sweden	91 M.	Nil
Grosz and Miller (1958) ..	U.S.A.	156 M. and F.	Nil
Gregory (1959)	Canada	437 M. and F.	Nil
Hallgren and Sjogren (1959) ..	Sweden	214 M. and F.	Nil
Smith and McIntyre (1963) ..	Canada	283 M. and F.	Nil
Rao (1964)	India	2,227 M. and F.	1st and 2nd born

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The present study shows a birth order effect in males only and an effect without statistical significance when the sexes are combined, and may, therefore, not be incompatible with past ones.

Relative position within the sibship, in the present study, varies significantly with schizophrenia in males, but not in females, nor when the sexes are considered together. In many of the previous investigations (Table VII) the data have not been analysed by sex, and their negative results may be attributed to this. In those where sex has been considered, a higher than expected incidence among last-born males has been found, especially in the larger investigations (Schooler, 1961; Wahl, 1956; Goodman, 1957). The findings on relative position within the sibship presented here are, therefore, not incompatible with those of previous workers.

The demonstrated birth order effect is almost certainly the expression of some causal agent more closely related to schizophrenia. Advanced parental age can be excluded as the factor on which the effect is based, since a previous study on the same subjects has shown no significant association of schizophrenia with parental age (Granville-Grossman, 1966a). If parental loss with subsequent economic deprivation in childhood were important, the effect might be secondary, since after the death of the parent no further children would be born into the sibship. This, too, has been tested in another study and no evidence for it found (Granville-Grossman, 1966b).

The causes of schizophrenia detected by the birth order effect appear to be related to those aspects of the environment which vary with sex as well as with the different positions in the sibship. The environments of the two sexes tend to differ throughout life. Those features which depend on birth rank, however, probably show less variation as time goes by, suggesting that the aetiological factors responsible for the findings are likely to be found in the childhood of the subjects.

The environment of boys certainly differs from that of girls (Sears *et al.*, 1957). That these differences may be important in psychological development has been demonstrated by Hampson (1963), who showed that the gender role and orientation of hermaphroditic adults is much more closely related to the sex assigned during childhood than to physical sexual variables such as chromosomal or gonadal sex. The environment appears to vary with the position in sibship also. Sears *et al.* (1957) have shown, for

TABLE VII
Schizophrenia and Relative Position within the Sibship

Author	Place of Study	Number and Sex	Association found between Schizophrenia and Position in Sibship
Malzberg (1940) (analysed by Gregory, 1958)	U.S.A.	549 M. and F.	Last born (in families with 4 or more sibs)
Patterson and Zeigler (1941)	U.S.A.	442 M. and F.	Nil
Böök (1953)	Sweden	120 M. and F.	Nil
Plank (1953)	U.S.A.	75 M.	Nil
Wahl (1954)	U.S.A.	231 M.	Nil
Wahl (1956)	U.S.A.	568 M.	Last born
Goodman (1957)	U.K.	142 M.	Nil
		164 F.	Nil
Johanson (1958)	Sweden	91 M.	Nil
Gregory (1959)	Canada	437 M. and F.	Nil
Kay and Roth (1961)	U.K. and Sweden	76 M. and F.	Nil
Schooler (1961)	U.S.A.	M.	Last born (in families with 4 or more sibs)
		F.	Nil
Farina *et al.* (1963)	U.S.A.	167 M. and F.	Nil
Burton and Bird (1963)	U.S.A.	241 M. and F.	Nil
Smith and McIntyre (1963)	Canada	283 M. and F.	Nil

example, that first children are more often breast-fed than last-born, and that discipline differs with birth rank. The most obvious variation, however, is perhaps the amount of attention which the child receives from his siblings; the first-born is likely to have fewer playmates in early childhood than those born later. That the relationship between the sibs may be important is suggested by Tienari's finding that among male monozygotic twins discordant for schizophrenia, the schizophrenic tends to have been the more submissive of the pair from an early age (Tienari, 1963).

The importance of the factor is possibly not great, since the differences found between the expected and observed distributions of birth orders, although highly significant statistically, are not numerically large. The differences found are consistent with a multifactorial aetiology. Subjects whose total genetic constitution makes it very likely that they will develop schizophrenia are possibly not influenced by their childhood environment, but in other cases the presence or absence of the postulated factor may determine, to a greater or lesser extent, whether or not the illness is manifest. The differences demonstrated between males and females suggest that the aetiology of schizophrenia may be somewhat different for the two sexes. The later age of females at diagnosis (Kraepelin, 1919), the higher concordance for schizophrenia between female members of a family than between males (Rosenthal, 1962), and the modifiability by the environment of the course of the illness among males (Brown, 1959; Brown *et al.*, 1962) all lend some support to this view.

Summary

Using the Greenwood-Yule method to investigate birth order, the later birth ranks and last-born position were found to be over-represented among a group of 562 male schizophrenics. No association between birth order and schizophrenia was found in a group of 682 females.

It is concluded that there is a causal relationship between birth order and schizophrenia in males.

2B

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K. L. Granville-Grossman, M.D., M.R.C.P., D.P.M., *Consultant Psychiatrist, Queen Elizabeth II Hospital, Welwyn Garden City, Herts.*

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