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BIRTH ORDER AND BIRTH RATE BIAS: FINDINGS IN A REPRESENTATIVE SAMPLE OF THE ADULT POPULATION OF GREAT BRITAIN

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Summary. Birth order and family size have been studied in a representative sample (10,000) of the adult population of Great Britain. This was done to test theoretical predictions about the ways in which the birth-order distribution in a population sample will be biased by secular changes in family size. The principal predictions were that, in a sample born during a period when family size was decreasing, the distribution of birth ranks in the larger families would be biased towards an over-representation of later born subjects (i.e. those lower in birth order), while in smaller families there would be an under-representation of later born. In a sample born during a period when family size was increasing, the reverse effects would occur. It was also predicted that among subjects from large families there would be an excess of females; and that the extent of the bias due to decrease in family size would be greatest in the unskilled and least in the highly skilled social classes.

The findings confirmed these predictions. The sample also showed an unpredicted excess of subjects in the middle ranks of families. It is suggested that the hypothesis of birth rate bias may be used for predicting the type of birth-order distribution to be expected in a sample of any population.

Introduction

The study of birth order and family size, as factors in disease, has proved to be full of technical traps. Bytheway (1974) has recently discussed an old trap concerning family size; we now draw attention to a new one concerning birth order.

It was implicitly assumed by Greenwood & Yule (1914)—and the assumption has not been seriously questioned until lately—that, in a representative sample of the general population free from the bias of 'incomplete families' there would be a random distribution among birth ranks for each family size, i.e. that for each family size there would be equal numbers in each birth rank. But Price & Hare (1969) put forward reasons for supposing that secular changes in family size and in the number of new families being started would bias the birth-order distribution in any represen-

tative sample of an adult population, and that the major effects of this bias could be predicted from the nature of the secular changes. In their study of birth order and family size among 21,000 adult psychiatric patients (Hare & Price, 1969), they found a non-random distribution of birth order which closely followed their theoretical predictions. They argued that psychiatric patients could in this respect be taken as representative of the general population and they later brought forward evidence to suggest that the hypothesis of birth rate bias could neatly explain the apparently conflicting results of studies made in different countries on birth rank in schizophrenia (Hare & Price, 1970).

However, the view that psychiatric patients could in this respect be taken as representative of the general population was challenged by Barry & Barry (1971). Therefore, for a definitive test of the hypothesis, it was necessary to study a sample of the general population. Birtchnell (1972) reported such a study and this generally confirmed the hypothesis. But his sample was drawn from the North-East of Scotland, it was on the small side (3160 persons aged 20 and over), its representativeness might be open to some doubt (the information was derived from a postal questionary sent to 4000 persons selected from the lists of seven general practices), and his definition of sibling led to the inclusion of step-sibs, adopted sibs and an unstated proportion of twins, and to the exclusion of sibs who had lived 'only a short time'. We have studied a representative sample (10,000) of the adult population of Great Britain and report our findings here.

Method

The information was collected by a commercial survey firm as part of a routine survey made during the 6 months April–September 1972. The interviews were generally carried out in the home, using structured questionaries with prompt lists and re-call aids where appropriate (see Appendix A for details of the questionary). Family size was defined as the number of children born alive to a respondent's mother. Interviews were conducted with a quota sample of individuals aged 15 and over; the quota controls were applied to age, social class, sex and household status. For the purposes of the present study, the results were restricted to adults aged 21 and over. This restriction led to some imbalance in the sample's representativeness and the imbalance has been corrected by part-weighting. From Table 1 it may be seen that, for the sample as a whole, the extent of this weighting is small and can reasonably be neglected. Among 10,725 subjects approached for interview, the number of non-respondents was 389 or rather under 4%; a further 283 who were twins (2·7% of those answering) were excluded from the present study. This left 10,053 respondents, corrected by weighting to 10,050; a break-down was made by sex, by five age-groups, and by four social classes, and weighting factors were applied to each of these subgroups. (The full tables are available to interested readers. See also Hare (1974) for the subgroup weightings.)

Table 1. Birth order and family size in a random sample of adult respondents from the general population of Great Britain

	Family size									
	1	2	3	4	5	6	7	8	9	10+
Total no. interviewed:	1289	2069	1897	1463	1095	774	518	386	287	275
Correctly post-weighted:	1281	2051	1888	1463	1096	781	526	393	290	279
Birth order										
1st/only	1281	1026	625	353	206	125	71	42	27	46
2nd	0	1025	714	381	192	99	74	41	21	18
3rd	0	0	549	404	256	154	64	34	25	15
4th	0	0	0	325	218	135	89	45	36	9
5th	0	0	0	0	224	127	75	67	45	14
6th	0	0	0	0	0	142	61	49	36	19
7th	0	0	0	0	0	0	91	46	26	13
8th	0	0	0	0	0	0	0	68	30	25
9th	0	0	0	0	0	0	0	0	44	29
10th/more	0	0	0	0	0	0	0	0	0	90
Totals*	1281	2051	1888	1463	1096	782	525	392	290	278

* These totals are the sum of the birth ranks for each family size; they differ to an unimportant extent from the weighted totals of line 2.

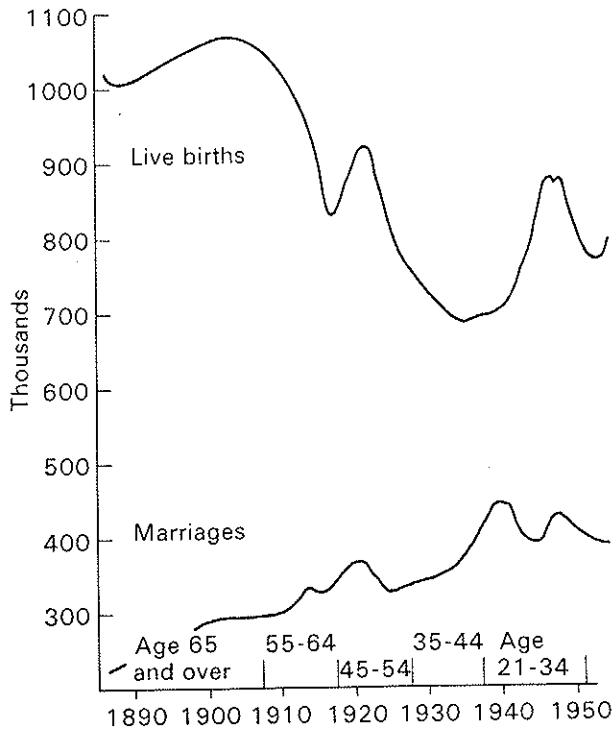
The hypothesis and its expectations

Any factor which is associated with birth order and which causes the movement of persons into or out of a section of the population will influence the birth-order distribution in that section. There are of course many such factors, of which death in childhood and emigration are perhaps the most obvious. Yet it is our view that, in most actual populations, by far the most important factor will be that due to secular changes in family size. The next most important factor is likely to be changes in the number of new families being started, though for Great Britain during the present century this effect is likely to be comparatively small.

Like any other factor, changes in family size affect the distribution of birth order in a particular age-group by affecting: (1) the chance that elder sibs will have died or moved into a higher age-group; (2) the chance that younger sibs will have died or not yet attained the requisite age. In as far as these chances operate, then the first will cause elder sibs to be removed from the group and thus leave an over-representation of younger sibs, while the second will cause a deficiency of younger sibs and so leave an over-representation of elder sibs. If the age-group under consideration is that of all adults, then the chance of elder sibs having died will increase with the age of a

person in the sample, while the chance of younger sibs not yet having reached adulthood will be greatest for the youngest adults in the sample.

In Great Britain, family size decreased fairly steadily between about 1900 and 1937. (See Text-fig. 1 which shows secular changes in live birth rate. Live birth rate is, of course, closely related to family size. The correlation coefficient between live



Text-fig. 1. Numbers of live-births and marriages in Great Britain (i.e. England and Wales plus Scotland); 5-year running average. The base-line indicates the years of birth for the age-groups of the present population sample. Data from Registrar General (1966) and Registrar General for Scotland (1963).

births and the mean ultimate family size of marriage cohorts for the years 1920–44 in England and Wales (Registrar General, 1966) is 0·975.) Let us consider those members of the population who were alive in 1972 and had been born between 1900 and 1937 (i.e. aged between about 35 and 70). The older members of this sample will have been born at a time when large families were relatively common; therefore persons in the sample who are from large families would tend to be relatively old. But because, in adult life, death rate increases with age, older members of large families would be more likely than younger members to have died by 1972. Therefore, persons from large families who were still alive in 1972 will tend to be the

younger members of those families. Hence, in the 1972 sample as a whole, there will tend to be an over-representation of the younger members of large families.

Again, the younger members of this sample will have been born at a time when small families were relatively common; and therefore persons in the sample who are from small families will tend to be relatively young. As such families would have been started only comparatively recently, many of the younger sibs would not have been born by 1937 and therefore could not be included in the sample. Thus among these small families the sample population would contain an over-representation of the elder-born. This argument applies to any sub-sample defined in terms of an age-range.

From about 1938, however, family size has on the whole been increasing (see Text-fig. 1). Where family size is increasing in a population, the above effects on birth-order distribution will be reversed and we should expect to find, in the age-range 21–35, an under-representation of younger sibs in large families and their over-representation in small families. The latter effect will, to an uncertain extent, be offset by the consideration that younger sibs may not yet have reached adult age. We should also note that the change in family size since 1938 has fluctuated and the overall increase has been smaller than the decrease in the earlier decades.

The same line of reasoning may be applied to the factors of sex and social class. As females tend to live longer than males, we should expect a present-day representative sample of the population to show an excess of females among those family sizes which are at present commoner in older age-groups, i.e. among larger families. Again, family size and changes in family size have varied with social class. We should therefore expect our sample to show social class differences in the distribution of birth order; and as family size was largest and decreased most steeply among the unskilled class, we should expect this class to show the effects of decreasing family size to a larger extent than the more skilled classes.

It is of course possible to deduce further expectations for smaller sub-divisions of our sample population but we did not think the sample sufficiently large for such expectations to be satisfactorily examined.

To sum up, the hypothesis of birth rate bias leads to the following expectations in our 1972 sample of the adult population of Great Britain:

1. As regards the sample as a whole: the birth order of respondents will not be randomly distributed; and since the respondents aged 35 and over form nearly three-quarters of the sample, the general effect will be that of respondents over 35.
2. As regards age: for respondents over 35, there will be an excess of later born among large families and a deficiency of later born among small families; for respondents aged under 35 the reverse may be found.
3. As regards sex: large families will show an excess of females.
4. As regards social class: the less skilled classes will show the consequences of decreasing family size to a greater extent than the more skilled.

Results

We may now examine the findings in the light of the above expectations.

1. From Table 1 it is apparent that there is considerable heterogeneity for birth rank among all family sizes greater than 2. For family sizes 3–9, the degree of heterogeneity is significant below the 5% level for each size except size 6 (where $P = 0{\cdot}10$). It is also apparent that there is an excess of later born among large families (5–9) and a deficiency of later born among small families (2–4). For the large families, the number in the lower half of the sibships (a middle rank being divided between the halves) is 1634 compared with the expected number of 1542·5 if the distribution were random ($\chi^2 = 5{\cdot}43$, $P < 0{\cdot}02$).

2. Table 2 shows for the five age-groups the observed and expected numbers in the lower half of sibships for small and for large families. In each of the four older age-groups, later born sibs are over-represented in the large families; and for the

Table 2. Observed (O) and expected (E) numbers of respondents in the lower half of sibships†

Group	Small families (size 2–4)			Large families (size 5–9)		
	O	E	(O – E) as % of E	O	E	(O – E) as % of E
Whole sample	2660	2701	−1·5	1634	1542·5	+ 5·9*
Sex						
Male	1307	1335	−2·1	739·5	694	+ 6·6
Female	1352	1365·5	−1·0	898	851	+ 5·5
Age						
21–34	878·5	871	+0·9	286	286·5	0
35–44	511	498·5	+2·5	263	240	+ 9·6
45–54	493	495	−0·4	330·5	302	+ 9·4
55–64	385·5	415	−7·1	376	342	+ 9·9
65 and over	388·5	419	−7·3	383	371·5	+ 3·1
Social class						
I and II	393	383·5	+2·5	108·5	110·5	− 1·8
III clerical	696	701·5	−0·8	303	290	+ 4·5
III manual	823	829	−0·7	520·5	466	+11·7
IV and V	748·5	787·5	−5·0	711	674·5	+ 5·1

† The expected numbers are calculated on the assumption of an equal distribution of sib ranks in each family size. The lower half of a sibship includes half the numbers in a mid-rank. The column (O – E) shows the degree of over- or under-representation of respondents in the lower half of the families. The totals in rows and columns do not balance precisely: this is because different weighting factors were applied to each sub-group.

* $P < 0{\cdot}02$.

three oldest age-groups there is under-representation of later born sibs in small families. Taking the four oldest groups together, the observed number of respondents in the lower half of large families is 1352·5, and the expected number 1255·5 ($\chi^2 = 7{\cdot}49$, $P < 0{\cdot}01$); for the two oldest age-groups the observed and expected numbers of sibs in the lower half of small families are 774 and 834 ($\chi^2 = 4{\cdot}32$, $P < 0{\cdot}05$). The youngest age-group, however, shows the opposite of these effects.

The same biases in the distribution in birth order are revealed more dramatically by the numbers of last born respondents. This is shown in Table 3. For ages 35 and over, the observed and expected numbers of last born among large families are 476 and 407·6 ($\chi^2 = 11{\cdot}5$, $P < 0{\cdot}001$), and the corresponding numbers for small families are 1217 and 1338·8 ($\chi^2 = 11{\cdot}1$, $P < 0{\cdot}001$).

Table 3. Observed (O) and expected (E) numbers of last born†

Group	Small families (2–4)			Large families (5–9)		
	O	E	(O − E) as % of E	O	E	(O − E) as % of E
Whole sample	1899	2021	− 6·0**	569	506	+12·5**
Sex						
Male	950	998	− 4·8	244	228	+ 6·9
Female	948	1022	− 7·3*	325	278	+16·9**
Age						
21–34	681	680	+ 0·1	94	98	− 4·4
35–44	370	379	− 2·3	105	79	+33·6**
45–54	340	365	− 6·8	107	100	+ 7·4
55–64	259	301	−13·9*	132	111	+19·5*
65 and over	248	295	−15·8**	132	119	+11·0**
Social class						
I and II	307	302	+ 1·8	51	37	+37·8*
III clerical	517	539	− 4·2	113	96	+17·6
III manual	584	616	− 5·1	197	155	+27·5**
IV and V	491	565	−13·0**	207	218	+ 4·9

† The expected numbers are given to the nearest whole number. See footnote to Table 2 about the totals.

* $P < 0{\cdot}05$; ** $P < 0{\cdot}01$.

3. The distribution of the whole sample by family size and sex is shown in Table 4. The proportion of females in larger families is 35 % compared with 32 % for males; this difference is highly significant ($\chi^2 = 13{\cdot}5$, $P < 0{\cdot}001$).

4. The observed and expected numbers in the lower half of sibships for four social groups are shown in Table 2. Taking classes III–V together, the observed and

Table 4. Family size, by sex

Sex of respondent	Family size	
	1–4	5+
Male	3274	1519
Female	3408	1848

$\chi^2 = 13{\cdot}5, P > 0{\cdot}001.$

expected numbers in the lower half of large families are 1534·5 and 1430·5 ($\chi^2 = 7{\cdot}6$, $P < 0{\cdot}01$). It is evident that social classes I plus II show quite a different distribution. Observed and expected numbers of last born are shown in Table 3. There is an unpredicted (and significant) excess of last born among large families in social classes I and II. This excess occurs in all but one of the family sizes 5–9; it could be accounted for if (as seems likely) there was a considerable over-representation of elderly females in this group.

Discussion

It is clear that the expectations of the hypothesis of birth rate bias are generally upheld in the present representative sample of the adult population of Great Britain. The practical value of this confirmation is that the hypothesis can be used to predict the bias to be expected in birth-order distribution of other population samples, given a knowledge of the changes that have occurred in the number of live-births and of marriages. But the predictions can only be made in a general way, for the population changes are subject to fluctuation from such events as war and there are many other factors which may affect the bias. What does seem evident, however, is that birth-rate bias will generally need to be taken into account in birth-order studies. In other words, it will generally need to be shown, before a meaningful association can be claimed between birth order and a particular factor, that the birth-order distribution of the subjects differs significantly from that to be expected in a sample of the general population having the same distribution of sex, age and social class.

The present sample population shows one remarkable feature which was not expected from our analysis of the effects of birth-rate bias. It can be seen from Table 1 that for every family size greater than 2 there is an over-representation of persons in the mid-rank (or in the mean of two mid-ranks). This over-representation is very marked and for family sizes 3–9 yields a χ^2 of 25·7 (1 d.f.). Moreover, it occurs in each sex, age group and social class. It does not seem at all likely to us that the explanation can lie in a tendency for respondents to think of their place in their family as 'about the middle'. A more plausible explanation is that the under-representation of the early ranks among some families and of the late ranks among

others—effects which occur whenever family size is changing—lead to a relative over-representation of the middle ranks in all families. This possibility is supported by the fact that the over-representation of the middle rank was greatest in those groups (social classes III–V and ages 45 and over) for whom family size had been changing most rapidly.

Although the present study has demonstrated significant heterogeneity of birth order within particular family sizes, it should be noted that the overall distribution of birth order, when all family sizes are taken together, departs very little from that to be expected on a random distribution of birth ranks within each family size. (The fact was pointed out to us by Dr Eliot Slater; he computes the mean birth order of the total material (family sizes 1–9, Table 1) as $0{\cdot}5025 \pm 0{\cdot}0044$, the deviation from the expected value of 0·5 for a random distribution being negligible.) This is shown in Table 5. The effect is due, of course, to the deficit of later born sibs in the smaller

Table 5. Observed and expected† numbers of respondents, by birth order, for all families of size one to nine

	Birth order									
	1	2	3	4	5	6	7	8	9	Total
Observed	3756	2547	1486	848	538	288	163	98	44	9768
Expected	3807·4	2526·3	1500·8	871·5	505·8	286·6	156·2	81·2	32·2	9768·0*

† Expected on the assumption of an equal distribution of respondents in the birth ranks for each family size.

* $\chi^2 = 11{\cdot}64$, d.f. $= 8$, $P > 0{\cdot}1$.

families being balanced by the excess of later born in the large families; and it may be inferred that, in a population where family size had been increasing, the same balancing would also occur. Thus it may possibly be the case (though it would be unsafe to assume so without further study of samples from other countries) that in most actual samples of an adult population the overall distribution of birth ranks departs very little from expectation. This, of course, was the assumption originally made by the pioneers of birth order studies (e.g. Heron, 1907). Greenwood & Yule (1914) did not dispute this assumption but pointed out that, as family size varied with social class, it would be preferable in a population of patients to examine the distribution of birth order by individual family sizes. However, their method for comparing observed with expected birth order in a population sample depended on the further assumption of a random distribution of birth ranks within each family size. It is this latter assumption which the present study, and that of Birtchnell (1972), now show to be unjustified.

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Appendix A: The Questionary

Family size

Now I'd like you to think about family size, particularly your own brothers and sisters.

Q.1. Did your mother ever have any other live-born children besides yourself? I *don't* mean adopted children, nor step children belonging to your father, just your own mother's children.

IF NO, PROMPT: Any at all? Even any who may have died soon after birth?

GO TO Q.2 had brother/sister(s) v

GO TO NEXT SECTION: had none x; DK o; refused l

Q.2. Were you yourself a twin, a triplet or a quadruplet?

NEXT SECTION ← yes, a twin, etc. v

GO TO Q.3: no, not a twin x; DK o; refused l

Q.3. Still thinking only of your mother's children, how many *older* brothers or sisters did you have, with the same mother as yourself?

WRITE IN HOW MANY OLDER → .....

DK v
refused x
none o

N.B. IF RESPONDENT NOT SURE HOW MANY OLDER BROTHERS OR SISTERS, PROMPT: About how many? AND RECORD ESTIMATED NUMBER BELOW.

.....

Q.4. And how many *younger* brothers or sisters did you have, with the same mother as yourself?

WRITE IN HOW MANY YOUNGER → ....

DK v
refused x
none o

N.B. IF RESPONDENT NOT SURE HOW MANY YOUNGER BROTHERS OR SISTERS, PROMPT: About how many? AND RECORD ESTIMATED NUMBER BELOW.

.....

Appendix B

Diagrammatic representation of birth rate bias

The way in which a decreasing family size affects the birth-order distribution of a population sample can be simply illustrated by means of a diagram of the type proposed by Barker & Record (1967). In the diagram below, each row represents the siblings (in rank order) born to families begun at a particular period of time. Successive rows represent families born at later periods and are therefore progressively smaller in size. The space (S) between the vertical lines represents the age-range of a sample of the total population taken at a point in time. Persons under line (A) are not included in this sample because they were too old at the time or had died of causes associated with increasing age; persons under line (B) are not included because they were too young at the time. It can be seen that the sample contains an over-representation of the later born members of large families and an under-representation of the later born in small families.

A					S		B
1	2	3	4	5	6	7	
	1	2	3	4	5	6	
		1	2	3	4	5	
			1	2	3	4	5
				1	2	3	4
					1	2	3