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Handedness of Parents and Sex of Progeny: Failure to Replicate the Results of James (1986)

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James (1986*b*) reported that males are significantly more common in the offspring of right-handed than of left-handed people. In this study we report data from an additional 38 562 offspring from 11 separate generations in six different studies. No significant relationship was found between parental handedness and sex of offspring.

Introduction

James (1986*b*) analysed data from eight published studies of left- and right-handedness in families and found the surprising result that the offspring of left-handers were more likely to be female than were the offspring of right-handers; more specifically, taking a weighted average across the eight studies, two right-handed parents had a mean of 8·1% more male offspring than did parental combinations in which one or both were left-handed. The difference was statistically significant from chance expectations with $p < 0{\cdot}005$. The result is important for the study of handedness since the sex ratio is a "hard" biological variable, and any association with handedness, which is essentially a psychological preference, must reflect some biological underpinning for the psychological preference.

The study of James (1986*b*) was motivated by two theoretical considerations. First, he was interested in the prediction resulting from the extensive and complex theory of Geschwind (see Geschwind & Galaburda, 1985*a*, *b*, *c*), a synoptic and critical overview of which has been given by McManus & Bryden (1991). The central feature of the theory is that lateralization of the brain, and hence left-handedness, is the result of raised intrauterine testosterone levels. In a second theoretical approach, and as part of an extensive series of well-documented studies of the sex ratio at birth (James 1987*a*, *b*), James (1986*a*) has suggested that in humans, the sex ratio is determined by parental gonadotrophin, androgen and oestrogen levels, high androgen levels in particular being associated with the subsequent birth of boys. As James (1986*b*) then put it, "One might suppose that if both hypotheses were correct then left-handed parents should produce an excess of boys. The point seemed worth testing" (p. 243). Confusingly however these data of James found a significant effect, but in the opposite direction to that predicted. This is of interest both for studies of the sex ratio and for studies of handedness although it is not obviously explained in terms of the Geschwind theory unless, as James speculates, high foetal testosterone

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levels are associated with *low* adult testosterone levels. Despite the *ad hoc* nature of that speculation, there is little doubt, given the widespread interest in the Geschwind hypothesis within neuropsychology, that James's finding could be used as evidence in favour of the Geschwind theory, and invoked as support for Geschwind's explanation of the supposed relationship between left-handedness and a wide range of conditions, such as dyslexia, autism, stuttering and many auto-immune conditions. Taken overall then it is clear that such a counter-intuitive result as James's required replication. The point seemed worth testing.

Material and Method

As part of a review of the genetics of handedness (McManus & Bryden, 1992) we assembled all the published and unpublished data which we could find on the incidence of handedness in families. We excluded the eight studies which James had used in his study, and we necessarily excluded all studies which did not give sufficient data about the sex of offspring within family types (specifically the studies of Ramaley, 1913; Ferronato *et al.*, 1974; Mascie-Taylor, unpublished data; Chaurasia & Goswami, unpublished data; Leiber & Axelrod, 1981 and Carter-Saltzmann, 1991). In the remaining data sets (Bryden, 1979; Porac & Coren, 1981; Spiegler & Yeni-Komshian, 1983; McManus, 1985; McManus *et al.*, unpublished data) the sex ratio in the children of two right-handers ($RH \times RH$) was compared with the sex ratio in all other parental combinations ($RH \times LH$, $LH \times RH$ and $LH \times LH$). In studies in which data were collected from several generations the results of each generation were analysed separately and then summary statistics combined. Data from each study were analysed using the method of James (1986*b*), calculating a chi-squared statistic for each 2×2 table, and then calculating the square root of chi-square (chi), and assigning a sign to the value of chi according to whether the effect was in the predicted direction (+) or in the opposite direction (−). Individual values of chi were then summed to give a value of sigma chi, which can be treated as a normal deviate with standard deviation equal to the square root of the number of tables that have been combined. The value of the normal deviate can then be compared with the zero value expected under the null hypothesis.

Results

A total of 11 separate sets of parent offspring data were obtained, containing a total of 38 562 offspring. The data of all but three [NCES propositi, maternal and paternal families (McManus *et al.*, unpublished data)] have been previously published, at least in part, but in the case of the data of McManus (1985), the details of the sex ratios are previously unpublished.

Table 1 summarizes the results for each study. Combining across studies, in 33 271 children of $RH \times RH$ matings, there was a sex ratio of 107·9 males for every 100 females, whereas in 5291 offspring of matings containing a left-hander, there were 109·5 males for every 100 female offspring. In interpreting these results it must be remembered that they do not correspond to total populations, and hence to unbiased

TABLE 1

The sex ratio of offspring in relation to the handedness of their parents, expressed as the number of males for every 100 females

Source	*RH* × *RH*			All others			Chi-squared	Signed chi
	Male	Female	Sex ratio	Male	Female	Sex ratio		
Bryden (1979)	6770	5883	115·1	953	854	111·6	0·37	0·61
Porac & Coren (1980)	188	196	95·9	34	41	82·9	0·33	0·57
Spiegler & Yeni-Komshian (1983)	2629	2871	91·6	567	542	104·6	4·09	−2·02
ICM1 (McManus, 1985), parents	181	195	92·8	26	33	78·8	0·34	0·58
ICM1 (McManus, 1985), propositi	1148	737	155·8	253	169	149·7	0·13	0·36
ICM2 (McManus, 1985), maternal family	301	726	41·5	36	81	44·4	0·11	−0·33
ICM2 (McManus, 1985), paternal family	732	270	271·1	58	24	241·7	0·21	0·45
ICM2 (McManus, 1985), propositi	496	356	139·3	142	90	157·8	0·67	−0·82
NCES (McManus *et al.*, unpublished data), maternal family	1429	2534	56·4	185	317	58·4	0·12	−0·35
NCES (McManus *et al.*, unpublished data), paternal family	2332	1189	196·1	263	131	200·8	0·04	−0·21
NCES (McManus *et al.*, unpublished data), propositi	1063	1045	101·7	249	243	102·5	0·01	−0·07
Total	17269	16002	107·9	2766	2525	109·5		−1·22

populations. Nevertheless, using the same statistical method as James (1986*b*), analysis shows that the difference is not significantly different from that expected under the null hypothesis ($z = -0{\cdot}037$, N.S.); it is also in the opposite direction to that reported by James.

Discussion

The paper of James (1986*b*) had made an interesting and striking finding, originally based on a prediction from the Geschwind theory; although the empirical data assembled by James had found a significant result which was in the opposite direction to the prediction, the effect was still surprising and important for understanding both the sex ratio and handedness. However the acid test of any statistical significance

test of a discrepancy from a null hypothesis is that the findings replicate in an independent sample of data. In the present study we have analysed 38 562 offspring in comparison with the 27 420 offspring studied by James; it is therefore likely that our study had sufficient power to find an effect if it had been present. We must therefore conclude that there is no reliable relationship between the handedness of parents and the sex of their offspring, and that not only can the effect not be used as support for a modified verson of the Geschwind theory of lateralization, but that there is no need to invoke other explanations. The lack of any association which is compatible with the Geschwind theory is consonant with other studies that have failed to replicate other predictions of the theory (e.g. McManus *et al.*, 1990; Bryden *et al.*, 1991; Marchant-Haycox *et al.*, 1991), as also is a meta-analysis of other associations predicted by the theory (Bryden & McManus, 1992).

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