# CHAPTER 10: WHAT IS THE ADVANTAGE OF LEFT-HANDEDNESS?

"His left hand is under my head, and his
right hand doth embrace me"

*Song of Solomon*, ii, 6.

"Birth, and copulation, and death
That's all the facts when you come to brass
tacks"

T.S. Eliot, *Sweeney Agonistes*

## 10:1 Introduction

In previous chapters I have argued that handedness is determined by a simple genetic system with two alleles at a single locus. There are, I hypothesise, just two phenotypes, right and left-handedness. Given the supposed frequencies of the two phenotypes (about 9.5% and 90.5%), and of the underlying alleles (D = 0.81; C = 0.19) then by necessity we are dealing with a genetically controlled [redacted]

that these handedness proportions may well have been [redacted] temporale of modern brains.

Taken together the above evidence suggests that there

[illegible]

more millenia.

Genetic theorists (see e.g. Cavalli-Sforza and Bodmer, 1971) have carefully examined the necessary

[illegible]

forces need bear no obvious relation to the main phenotypes. Thus it has been suggested that schizophrenia is maintained by an increased fecundity of the grand-parents; and phenylketonuria by an increased IQ of the heterozygote (the homozygote of course having a very low IQ). In at least [redacted]

disadvantage due to sperm immotility, an anomaly which seems to bear little obvious relation to the side of the heart. It is thus quite possible that the relative advantages of the two forms of handedness may bear no relation at all to brain function.

In trying to explain the balanced polymorphism of handedness we must therefore seek at least two selective forces which together maintain the D and C alleles. This ultimately affect reproductive capacity: that is, the persons concerned must eventually contribute a greater proportion of their genes to the gene-pool than the prior probabilities would suggest. (For a more detailed

discussion of quite what is meant by fitness see the Appendix to this chapter).

The literature on handedness is replete with suggestions that right handers are of greater IQ than will be DC rather than CC (see Chapter 7), then there must be an advantage of left-handers over right for some characteristics. These fitnesses need only be very small; Cavalli-Sforza and Bodmer point out that fitnesses of the order of $10^{-5}$ (i.e. the heterozygote is only 0.001% better at reproducing than the homozygote) will result in balanced polymorphisms after several thousand generations.

[redacted]

1978; Mayo et al. 1978) have

[redacted]

small fitness differentials, of actually demonstrating

[redacted]

a large number of their students, dividing the students (mean age 20.18 years) into those who had two biological parents, those with only one biological parent (due to [redacted]

Handedness correlated better with biological parents [redacted]

a. the ANOVA used was invalidated by the gross bimodality of the Oldfield handedness questionnaire (see Figure 2.3).

b. the students had, on average, lived with their [redacted]

[redacted]

| | Right | Left | N | % Left | Right | Left | N | % Left |
|---|---|---|---|---|---|---|---|---|
| [redacted] | | | | | | | | |
| parent:- | | | | | | | | |
| a. Biological parent | 16 | 11 | 27 | 40.74% | 56 | 25 | 81 | 30.80% |
| b. Step-parent | 15 | 12 | 27 | 44.44% | 60 | 21 | 81 | 25.92% |

There is an increased incidence of sinistrality in both mothers and fathers who do not come from a family with two biological parents (Mothers, $X^2 = 62.21$, 1 df, $p < 0.001$; Fathers, $X^2 = 45.11$, $p < 0.001$).

[redacted]

illegitimate rather more often than might be expected (Pringle 1961).

The little that is known about hand usage in sexual behaviour (Oldfield, 1970) seems to further our knowledge little beyond that of the Song of Songs.

## 10:2 The number of children in left-handed families

If there is a reproductive advantage in being left-handed then we might well expect to find that left-handers come from larger families than do right-handers; alter- [illegible]

parents are left-handed) might have more children than non-left-handed matings. Data to test both of these hypotheses can be obtained from Surveys I and II, and the study, sex of propositus is included as a further inde-pendent variable. Table 10.2 shows the results of this fourway analysis of variance.

Table 10.3 shows a summary of the relevant analyses of Tables 10.1 and 10.2; the significance levels of the main effects, and the size and variation of the fitted constants for the analysis of variance equation (Multiple Classification Analysis - see Nie et al, 1975). From this [illegible]

latter table it is clear that in Surveys I and II there is no significant tendency for left-handers to come from [illegible]

larger families. The NCDS data does not show a significant effect; however if a one-tailed test is used (since the [illegible]

direction of the effect was specified in advance) then left-handed propositi have a tendency (p = 0.078) to come from larger families (an average of 0.05 children greater). Whether this latter effect is truly significant is a moot point. Figure 10.1 shows the NCDS data plotted as a children more in left-handed matings, the combined one-tailed probability being 0.0016.

In summary, the NCDS provides limited support for the possibility of left-handed propositi coming from larger families. The data from surveys I and II provides good support for the possibility that left handed parents [illegible]

have slightly larger families than do non-right handed [illegible]

parents. Regrettably this latter hypothesis cannot be further tested on the large NCDS data.

10:3 <u>Parental age and handedness</u>

direction, and thus the one-tailed probability = 0.058. Figure 10.2 shows a graph of the NCDS data as a function of class, parity and sex.

II, the mother's age at the birth of the first four children being analysed separately (note that in this analysis, each mother may re-appear in each of the four tables, whereas in the NCDS analysis each mother can only appear once, at a single parity).

Table 10.4 summarises the data of Tables 10.5 and 10.6. It is clear that there is probably no effect of parental type, although the data is only from survey II (r = 0.873 in the NCDS data) is is not surprising that in a simple four-way analysis of variance there is a similar effect as to maternal age. The more interesting question [illegible]

is whether when the relative contribution of the maternal-paternal correlation is partialled out, there is still a paternal age effect. Table 10.7 shows an analysis of variance with maternal age as a co-variate. Now there is not a hint of a paternal age effect; and indeed the class effect is much-reduced and appears to be quadratic in [illegible]

[redacted]

interpreted partly as a maternal cohort effect, and partly as an interaction with social class. There is however

[redacted]

not a hint of a main effect due to parity, and the

[redacted]

in which the dependent variable is the number of abortions, miscarriages or ectopics suffered by the mother (a square-root transformation has been used to stabilise variance)

[illegible]

and the independent variables are social class, propositus handedness, parity and sex. The parity effect is highly significant (as would be expected). There are no class

[illegible]

or sex effects. Handedness shows no significant main effect. The highly significant four-way interaction is almost certainly an artefact of non-normality and may be ignored.

In survey II the mothers were asked to report how many miscarriages they had had. Mothers of right handed propositi

[illegible]

In summary there is no evidence for a difference in history of miscarriages as a function of handedness.

[redacted]

A reproductive advantage could also manifest itself as an earlier onset of puberty, and hence an increased (or

[redacted]

cases it is necessary to analyse by social class, parity (or strictly maternal cohort in some cases) and propositus

[redacted]

Table 10.12 shows the stage of development of the boys' genitalia. There is a highly significant effect

[redacted]

of handedness, although it is in the opposite direction to that predicted. I suspect that this result is spurious.

[redacted]

although there may be a significant trend in the class

[redacted]

no effects of handedness of girl's sexual development.

[redacted]

## 10:7 Summary

There is evidence that left-handers have relatively younger mothers, and that left-handed matings produce more progeny. There is also some evidence that left-

[redacted]

APPENDIX 10:1 FITNESS AND HANDEDNESS

Lest it is not quite clear what advantages are being proposed, let us consider a formal model, using the notation of Cavalli-Sforza and Bodmer (1971: p.125 et [illegible]

Let the fitnesses of the three genotypes, DD, DC and CC be 1-s, 1 and 1-t respectively. For a balanced polymorphism s and t must both be greater than zero. If [illegible]

other allele; if s and t are > 1, then an unstable equilibrium will eventually result in either one or other [illegible]

$$\text{Fitness}_{\text{Right-handers}} = F_r = 1. - 0.7249s - 0.0199t$$

[redacted]

Relative fitness of right-handers with respect to left-handers

$$= RF = \frac{F_r}{F_l} = \frac{1. - 0.7249s - 0.0199t}{1 - 0.19t}$$

It may readily be shown (Cavalli-Sforza and Bodmer, 1971, Eq'n 4.5) that in a stable polymorphism at equilibrium:-

$$\frac{t}{s} = \frac{p(D)}{p(C)}$$

[redacted]

If we consider the situation when s = 0, i.e. there is a disadvantage to being CC, then it becomes clear that:-

$$\frac{F_r}{\;} = \frac{1. - 0.0199t}{\;} > 1$$

[redacted]

conversely for t = 0, i.e. a disadvantage to being DD, then:

$$\frac{F_r}{F_1} = 1.\ 0.7249s > 1$$

[redacted]

2944

Table 10.2 Analysis of variance of total chil[illegible]

of father's social class (C), and propositus parity (P),

sex (S) and handedness (H).

| | df | F | P |
|---|---|---|---|
| Main Effects | | | |
| H | 1 | 2.004 | 0.157 |
| C | 4 | 43.518 | ≪ 0.001 |
| P | 3 | 1158.427 | ≪ 0.001 |
| S | 1 | 0.042 | 0.837 |

lysis of family
x L, L x R
OVA tables are
tus handedness,
al handedness
). All MCA

| $P_{two}$ |
|---|
| 0.658 |
| 0.148 |
| 0.014 |
| 0.050 |
| 0.295 |
| 0.210 |

results of an analysis of variance of maternal age at
a multiple classification analysis, and for surveys II
d family type (RxR vs RxL, LxR, LxL) whilst for the
dedness is given; the full analysis of variance is
.6 for survey II. All MCA results are adjusted for

| | | Parental handedness | | | | |
|---|---|---|---|---|---|---|
| wo | $p_{one}$ | R x R | RxL, LxR, LxL | Direction | $p_{two}$ | $p_{one}$ |
| 404 | 0.202 | 0.11 | -0.46 | + | 0.364 | 0.182 |
| 353 | 0.573 | 0.07 | -0.29 | + | 0.626 | 0.313 |
| 020 | 0.010 | -0.05 | 0.16 | - | 0.095 | 0 952 |
| 172 | 0.086 | -0.11 | 0.22 | - | 0.289 | 0.855 |
| 116 | 0.051 | | | | | |

$p = 0.0182$ $\quad$ $x^2 = 6.142$, 8 df, $\quad$ $p = 0.631$

$p = 0.00667$

...ities of survey ...y type.

| ...d 1 | | II: |
|---|---|---|
| | p | df |
| ...97 | 0.404 | 1 |
| ...24 | 0.364 | 1 |
| ...79 | 0.378 | 1 |
| | | 383 |
| | | 386 |

| ...d 1 | | |
|---|---|---|
| SD | N | Mean |
| ...53 | 299 | 31.07 |
| ...55 | 59 | 30.82 |
| ...96 | 42 | 31.41 |
| ...87 | 24 | 30.52 |

analysis of variance of maternal age upon

| 2 | II: Child 3 | | | II: Child 4 | | |
|---|---|---|---|---|---|---|
| p | df | F | p | df | F | p |
| 0.853 | 1 | 5.497 | 0.020 | 1 | 1.894 | 0.172 |
| 0.626 | 1 | 2.807 | 0.095 | 1 | 1.137 | 0.282 |
| 0.737 | 0 | - | - | 0 | - | - |
| | 228 | | | 84 | | |
| | 230 | | | 86 | | |

| 2 | Child 3 | | | Child 4 | | |
|---|---|---|---|---|---|---|
| N | Mean | SD | N | Mean | SD | N |
| 270 | 33.26 | 5.87 | 148 | 34.06 | 3.73 | 46 |
| 57 | 33.56 | 7.52 | 41 | 35.86 | 6.96 | 23 |
| 41 | 34.16 | 6.97 | 25 | 8.11 | 9.99 | 9 |
| 19 | 33.83 | 8.53 | 12 | 31.66 | 4.03 | 6 |

Table 10.5 Analysis of variance of mother's age at birth of child as a function of child's parity (P), handedness (H) and sex (S), and of husband's social class (C).

| | df | F | P |
|---|---|---|---|
| **Main Effects** | | | |
| H | 1 | 2.473 | 0.116 |
| C | 4 | 75.917 | ≪ 0.001 |
| P | 3 | 973.932 | ≪ 0.001 |
| S | 1 | 0.001 | 0.989 |
| **Interactions** | | | |
| H x C | 44 | 1.127 | 0.342 |
| H x P | 3 | 1.864 | 0.133 |
| [illegible] | [illegible] | [illegible] | [illegible] |
| H x C x P | 11 | 1.499 | 0.124 |
| H x C x S | 4 | 0.941 | 0.439 |
| H x P x S | 3 | 4.713 | 0.003 |
| C x P x S | 12 | 1.336 | 0.190 |
| [illegible] | [illegible] | [illegible] | [illegible] |

TABLE 10.7 Analysis of variance of father's age at birth of child as a function of his own social class (C), and of propositus handedness (H), sex (S) and parity (p). Analysis of covariance is also given, taking maternal age into account.

| | Without co-variate | | | With co-variate | | |
|---|---|---|---|---|---|---|
| **Main Effects** | df | F | p | df | F | p |
| H | 1 | 0.401 | 0.526 | 1 | 0.328 | 0.567 |
| C | 4 | 48.298 | 0.001 | 4 | 4.995 | 0.001 |
| P | 3 | 724.232 | 0.001 | 3 | 45.927 | 0.001 |
| S | 1 | 1.557 | 0.212 | 1 | 1.503 | 0.220 |
| Co-Variate | - | - | - | 1 | $1.59 \times 10^5$ | 0.001 |
| **Interactions** | | | | | | |
| H x C | 4 | 2.260 | 0.060 | 4 | 2.237 | 0.063 |
| H x P | 3 | 2.893 | 0.034 | 3 | 1.460 | 0.223 |
| H x S | 1 | 4.734 | 0.030 | 1 | 1.949 | 0.163 |
| C x P | 12 | 1.255 | 0.238 | 12 | 1.679 | 0.065 |
| C x S | 4 | 1.629 | 0.164 | 4 | 0.560 | 0.692 |
| P x S | 3 | 0.602 | 0.614 | 3 | 0.621 | 0.602 |
| H x C x P | 11 | 1.535 | 0.112 | 11 | 1.762 | 0.055 |
| H x C x S | 4 | 0.934 | 0.443 | 4 | 0.890 | 0.469 |
| H x P x C | 3 | 4.014 | 0.007 | 3 | 1.286 | 0.277 |
| C x P x S | 12 | 1.837 | 0.037 | 12 | 1.594 | 0.086 |
| [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| Residual | 10855 | | | 10853 | | |
| Total | 10932 | | | 10931 | | |

Multiple Classification Analyses (adjusted for independents and for co-variate) Grand Mean = 29.94

| H | C | P | S |
|---|---|---|---|
| Right - 0.01 | I 0.19 | 0 -0.48 | Male -0.04 |
| [illegible] | [illegible] | [illegible] | [illegible] |

Table 10.8 Analysis of variance of interval between marriage and the birth of the mother's first child, as a function of parity of present child (P), social class (C), the sex of the child (S), and the writing hand of the child (H).

| | df | F | P |
|---|---|---|---|
| **Main Effects** | | | |
| H | 1 | 0.235 | 0.628 |
| C | 4 | 27.350 | ≪ 0.001 |
| P | 3 | 126.247 | ≪ 0.001 |
| S | 1 | 1.474 | 0.225 |
| **Interactions** | | | |
| H x C | 4 | 0.419 | 0.795 |
| H x P | 3 | 1.364 | 0.252 |
| H x S | 1 | 0.037 | 0.848 |
| C x P | 12 | 0.856 | 0.583 |
| C x S | 4 | 1.207 | 0.306 |
| P x S | 3 | 2.027 | 0.108 |
| H x C x P | 12 | 7.535 | < 0.0001 |
| H x C x S | 4 | 1.417 | 0.228 |
| H x P x S | 3 | 0.118 | 0.949 |
| C x P x S | 12 | 0.887 | 0.560 |
| H x C x P x S | 11 | 0.641 | 0.795 |

Table 10.9 Analysis of variance of interval between birth of pre[vious] child and present child, as a function of husband's social class (C), and propositus parity (P) and sex (S) and handedness (H).

| | df | F | p |
|---|---|---|---|
| **Main Effects** | | | |
| H | 1 | 0.187 | 0.665 |
| C | 4 | 8.306 | <0.001 |
| P | 3 | 13.871 | ≪0.001 |
| S | 1 | 0.554 | 0.457 |
| **Interactions** | | | |
| H x C | 4 | 0.806 | 0.521 |
| H x P | 3 | 0.801 | 0.493 |
| H x S | 1 | 0.514 | 0.474 |
| C x P | 12 | 0.598 | 0.846 |
| C x S | 4 | 0.656 | 0.622 |
| P x S | 3 | 0.707 | 0.548 |
| H x C x P | 11 | 1.056 | 0.398 |
| H x C x S | 4 | 2.077 | 0.081 |
| H x P x S | 3 | 1.026 | 0.380 |
| C x P x S | 12 | 1.047 | 0.402 |
| H x C x P x S | 10 | 0.874 | 0.557 |
| Residual | 7123 | | |
| Total | 7199 | | |

Multiple Classification Analysis Grand Mean = 3.53 years

| H | | C | | P | | S | |
|---|---|---|---|---|---|---|---|
| Right | 0.001 | I | -0.30 | 1 | 0.11 | Male | -0.01 |
| Left | -0.03 | II | 0.01 | 2 | 0.15 | Female | 0.01 |
| | | III | 0.07 | 3 | 0.15 | | |
| | | IV | -0.04 | 4 | -0.04 | | |
| | | V | -0.26 | | | | |

Multiple R = 0.103

Table 10.10 Analysis of variance of number of abortions /miscarriages/ectopics (after square-root transformation to stabilise variance) as a function of husband's social class (C), parity (P), and propositus handedness (H).

| | df | F | p |
|---|---|---|---|
| **Main Effects** | | | |
| H | 1 | 0.001 | 0.981 |
| C | 4 | 1.847 | 0.100 |
| P | 3 | 33.571 | ≪0.0001 |
| S | 1 | 0.001 | 0.978 |
| **Interactions** | | | |
| H x C | 4 | 1.652 | 0.158 |
| H x P | 3 | 0.365 | 0.778 |
| H x S | 1 | 1.749 | 0.186 |
| C x P | 12 | 0.748 | 0.705 |
| C x S | 4 | 0.087 | 0.987 |
| P x S | 3 | 0.164 | 0.921 |
| H x C x P | 11 | 1.520 | 0.117 |
| H x C x S | 4 | 1.009 | 0.401 |
| H x P x S | 3 | 3.032 | 0.028 |
| C x P x S | 12 | 0.901 | 0.545 |
| H x C x P x S | 12 | 2.808 | 0.001 |
| Residuals | 11195 | | |
| Total | 11273 | | |

Multiple Classification Analysis

Grand Mean = 1.05
(NB. All variables are expressed as square-roots)

| H | C | P | S |
|---|---|---|---|
| [illegible] | [illegible] | [illegible] | [illegible] |

Table 10.12 Analysis of variance of developmental stage of boys' genitalia by social class of father (C), parity (P) and own-handedness (H)

| | [illegible] | [illegible] | [illegible] |
|---|---|---|---|
| Main Effects | | | |
| H | 1 | 8.702 | 0.003 |
| C | 4 | 0.236 | 0.918 |
| P | [illegible] | [illegible] | [illegible] |
| H x C | 4 | 1.191 | 0.313 |
| H x P | 3 | 0.467 | 0.705 |
| C x P | 12 | 1.309 | 0.205 |
| H x C x P | 12 | 0.810 | 0.641 |
| Residual | 5311 | | |
| Total | 5350 | | |

Multiple Classification Analysis    Grand Mean = 1.80

| H | | C | | P | |
|---|---|---|---|---|---|
| Right | 0.01 | I | 0.01 | 0 | 0.01 |
| Left | -0.08 | II | 0.02 | 1 | -0.001 |
| | | III | -0.01 | 2 | -0.04 |
| | | IV | -0.01 | 3 | 0.02 |
| | | V | -0.00 | | |

Multiple R = 0.050

Table 10.13 Analysis of variance of stage of development of boys' pubic hair, as a function of father's social

[redacted]

| | df | F | p |
|---|---|---|---|
| Main Effect | | | |
| H | 1 | 0.369 | 0.543 |
| C | 4 | 1.659 | 0.157 |
| P | 3 | 1.097 | 0.349 |
| Interactions | | | |
| H x C | 4 | 0.539 | 0.707 |
| H x P | 3 | 1.921 | 0.124 |
| C x P | 12 | 0.406 | 0.962 |
| [redacted] | | | |
| Residual | 5279 | | |
| Total | 5318 | | |

Multiple Classification Analysis    Grand Mean = 1.41

| H | |
|---|---|
| Right | 0.001 |
| Left | -0.01 |

| C | |
|---|---|
| I | 0.00 |
| II | 0.01 |
| III | 0.00 |
| IV | -0.001 |
| V | -0.09 |

| p | |
|---|---|
| 0 | 0.01 |
| 1 | 0.00 |
| 2 | -0.03 |
| 3 | -0.00 |

Table 10.14 Analysis of Variance of developmental stage of girls' breasts as a function of father's social class (C), own parity (p) and own handedness (H).

| | df | F | p |
|---|---|---|---|
| **Main Effects** | | | |
| H | 1 | 0.085 | 0.770 |
| C | 4 | 0.351 | 0.844 |
| P | 3 | 4.043 | 0.007 |
| **Interactions** | | | |
| H x C | 4 | 0.918 | 0.452 |
| H x P | 3 | 1.531 | 0.204 |
| C x P | 12 | 1.363 | 0.176 |
| H x C x P | 12 | 0.643 | 0.806 |
| Residual | 5041 | | |
| Total | 5080 | | |

Multiple Classification Analysis    Grand Mean = 2.01

| H | | C | | p | |
|---|---|---|---|---|---|
| Right | 0.001 | I | -0.02 | 0 | 0.03 |
| Left | -0.01 | II | 0.03 | 1 | 0.02 |
| | | III | -0.01 | 2 | -0.06 |
| | | IV | -0.01 | 3 | -0.11 |
| | | V | 0.02 | | |

Multiple R = 0.052

[redacted]

of girls' pubic hair as a function of father's social class (C), own parity (p) and own handedness (H).

| | df | F | p |
|---|---|---|---|
| Main Effects | | | |
| H | 1 | 0.734 | 0.392 |
| C | 4 | 0.223 | 0.926 |
| P | 3 | 4.000 | 0.007 |
| Interactions | | | |
| [redacted] | | | |
| H x P | 3 | 3.346 | 0.018 |
| C x P | 12 | 0.618 | 0.829 |
| H x C x P | 12 | 0.951 | 0.494 |
| Residual | 5006 | | |
| Total | 5045 | | |

Figure 10.1 Shows the family size (at propositus age 7, i.e. NCDS I) as a function of social class, sex of propositus and parity of propositus.

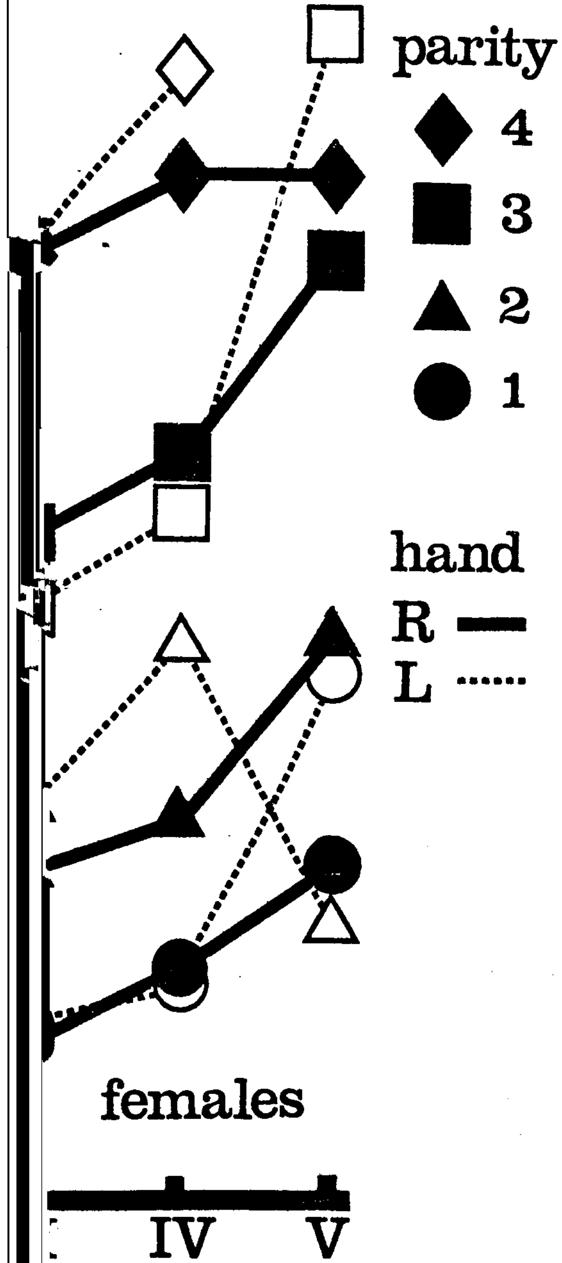
parity
4
3
2
1
hand
R
L
females
IV
V

Figure 10.2 Shows the mother's age at birth of the propositus as a function of social class, parity

and sex of propositus.