Is the relationship between fertility of parents and children really weak?

Social Biology 46(1-2):122-145.

M Murphy

Population Studies,

Department of Social Policy,

London School of Economics,

Houghton St,

London WC2A 2AE, UK.

tele: 44-171-955-7661

fax: 44-171-955-6833

e-mail m.murphy@lse.ac.uk

Abstract

The relationship between fertility of parents and children has been designated as 'weak' by most investigators who have looked at this topic. This paper reviews the evidence over the past century and argues that, even allowing for problems with available data sources, the relationship was probably close to zero for pre-transitional populations, but that it has tended to become more substantial over time and it is now of a similar order of magnitude in developed countries as widely used explanatory variables such as female educational level. Possible mechanisms for the observed relationship are discussed, especially the role of socialisation and inherited factors. The ways in which the scientific agenda has been affected by prevailing orthodoxies is discussed. The types of data used are compared to the scientific questions posed and the limitations of the common comparison of married-mother/married-daughter pairs are considered. Finally some evidence from recent large-scale surveys in Britain and the US are presented to show changes over recent periods and the relative effects of sibship size of fathers and mothers.

Introduction

The association of fertility between parents and their children has been a subject of continuing scientific interest for a century. Pearson, Lee and Bramley-Moore (1899)[1] investigated the extent of fertility correlations among branches of the British upper classes, largely arising from Pearson's interest in its effect on population biology. Pearson (p. 260) pointed out that 'intellectual and emotional characters [that are] ... ultimately a result of physical conformation ... will be inherited according to the same law as that which holds for physically measurable organs'. He argued that fertility and fecundity come into the former group, although the possibility that preferences for a particular number of children in a given environment may be similarly transmitted is one that will form one of the interests of this review. Pearson and Lee considered the number of children of different dyads, including father-son, mother-daughter and paternal grandmother-granddaughter pairs, although they note that for the older generation the term 'parent' is equally suitable. As might be anticipated, Pearson product moment correlation coefficients are the most common form of summary measure used, and remain so.[2]

Pearson (p. 277) was careful to distinguish between intergenerational correlations that could arise because of transmission of fertility between parents and children and 'spurious' ones due to the mixing of heterogeneous populations. Subsequently, investigations have attempted to control for such heterogeneity, for example by breaking general populations into more homogenous units, or confining analysis to particular sub-populations. However, multivariate analysis is increasingly the method of choice for implementing such controls.

Studies of Pre-Twentieth Century Populations

Among the relationships and groups studied (Figure 1 - the standard errors are based on the assumption of independent random samples which will under-estimate values in some cases), Pearson and Lee found a maximum correlation coefficient of 0.2130 between the fertility of 1,000 mother-daughter pairs from the peerage and baronetage, both of whom had marriages that had lasted for at least 15 years. The lowest reported correlation coefficient between female pairs was 0.0418 for 4,418 pairs from a mixture of upper-class groups with the only restriction that the daughter should have been married for 15 years or her spouse had died before 15 years (these data were 'weighted' and the possibility of excluding some infant deaths was acknowledged). They attributed the low value in part to the particular characteristics of this population, because although heterogeneity would usually be expected to inflate correlations, Pearson and Lee argued that the female landed gentry were often 'heiresses', who in a system of largely impartible inheritance, were more likely to have come from smaller families.

{Insert Figure 1 about here}

Father/son analysis was based on 1,000 pairs. The male figure for the peerage corresponding to the female value of 0.2130 above was 0.0656 (but no restriction was placed on the length of the fathers' marriage), and the figure for landed gentry was higher at 0.1161, but included a restriction that the father's marriage should also have lasted for 15 years.

Essentially the same male data used by Pearson and Lee were reanalysed by Williams and Williams (1974) with almost identical numerical results, but with a very different

interpretation (see later). Pearson and Lee's results implicitly assume a population with no deliberate attempt at fertility limitation although they do note this possibility as a factor which would tend to depress correlations (p. 279). A consequence of this natural fertility assumption is that there is assumed to be little, if any, correlation between the fertility of fathers and sons, since the only male mechanism considered is inherited male subfecundity: Pearson and Lee interpret the fact that the correlation between fertility of fathers and sons is higher if the analysis is restricted to marriages of more than 15 years duration as evidence of the 'exhaustion' of male fertility (p. 288).

A number of studies of more recent populations have subsequently taken place, but studies of general pre-transitional historical populations have been rarer. Langford and Wilson (1985) used 10,931 ever-married mother-daughter pairs (with the daughter as the unit of analysis so mothers could be included more than once), from reconstitution data from the Cambridge Group for the History of Population and Social Structure over the period between the mid-sixteenth to mid-nineteenth centuries. They concluded that there was no association between the fecundity of mothers and daughters. Although they computed a small (but nominally statistically significant – see Footnote 2) correlation coefficient of 0.0206, their chi-squared test showed no statistically significant relationship, and the small correlation coefficient was heavily influenced by a positive relationship in a single parish of the fourteen included. These data, however, are inevitably subject to considerable errors; Langford and Wilson draw attention to the fact that 35 per cent of second generation married women were recorded as childless as evidence of this. Fewer than 10 per cent of these records had complete information on both mothers and daughters, but when these 939 complete records are used, the correlation coefficient increased only slightly to 0.0330, and the value was not statistically significant. Moreover, the value of the correlation coefficient is more than halved if the 'outlier' parish of Earsdon in Northumberland is removed. To the extent that the populations from different parishes are heterogeneous, combining them might be expected to generate a positive correlation coefficient. However, of the 14 individual parishes, six actually have negative, albeit small, values for the correlation coefficient of fertility of mothers and daughters. In contrast, there is a correlation coefficient of 0.0968 between the ages of marriage of mothers and daughters in the overall sample, although essentially none with time spent in the married state before age 50. Since there is a positive relationship between family size and early age at marriage, and between the ages at marriage of mothers and daughters, some association between fertility of mothers and married daughters would be expected, although this would be reduced because of the lack of relationship with duration of exposure. These data cannot show whether women from large families were less likely to marry, only that those who did so married earlier on average.

This finding of a positive link between ages of marriage in successive generations was partially replicated in Levine's (1982) analysis of the village of Shepshed in Leicestershire. He looked at parent/child correlations in age at marriage and found that for those married between ages 18 to 30, ages chosen to reduce the undue influence of marriages outside the prime ages, the father-son correlation was actually negative at –0.1313 for sons marrying in the period 1825-49 (described as 'remarkably low', p. 263), and –0.115 for the middle of the eighteenth century: mother-daughter pairs showed a different pattern with the corresponding values of –0.0012 and 0.1253 respectively. Neel and Schull (1972, p. 345) computed correlations between the fertility of a group of Amish couples who married in the period 1820-79 in Ohio and Indiana and the sibship sizes of wives and husbands of 0.09 and 0.07.

These values were described as 'small' even though birth control was not used, suggesting that the relationship was only expected to be observed among non-contraceptors.

Bocquet-Appel and Jakobi (1993) studied the correlations between various kin groups, including parents and their children in the village of Arthez d'Asson in the French Department of Pyrénées Atlantiques. The population was based on once-married women in successive generations with intact marriages at age 45 for both partners, and the older generation was born between 1744 and 1789 to ensure that the whole period covered was pre-transitional (the fertility of the younger generation was centred about 1830). The formal path analytic model is concerned with wider aspects of intergenerational transmission of fertility, but from the focus of this review, they found a very small correlation, 0.015 (N=257), for fertility of parents and children (sexes were not disaggregated), whereas, the value for sibs, 0.185 (N=200), was much larger and statistically significant. They note that the emphasis on mother-daughter pairs in previous work may be misplaced and they reject a mechanism of intergenerational transmission of fertility in this pre-transitional period, not only on empirical grounds, but also on the theoretical arguments of (Jacquard 1977; 1983).

The period from the mid-nineteenth century has been investigated by Wise and Condie (1975) and Anderton *et al.* (1987). Both used data from the Mormon Genealogical Library, the former following an initial sample of 402 families with the wife born between 1825 and 1850, whose youngest and oldest married children were followed up for the next three generations, producing samples of 329, 248 and 89 families respectively. Persons who married more than once in the childbearing phase were excluded from the analysis. Thus the sample yielded about 100 marriages in each decade since 1840. It was found that the correlation between number of children of the marriage and the size of mothers' family of orientation was higher than that for fathers in four of the five cohorts in the period 1861-70 to 1901-10. However, since that date, fathers' size of family of orientation was found to exert a greater influence than that of mothers, see Figure 2 constructed from Wise and Condie's Table 3.

{Insert Figure 2 about here}

The overall correlations between fertility in the first and second generations was 0.213 and 0.234 with fathers' and mothers' families; 0.171 and 0.242 for the second and third generations; but −0.028 and −0.147 for the third and fourth generations. They conclude that there was a 'definite shift toward the tendency for those from large families to bear small families and vice versa' (p. 148). This negative relationship is not replicated in any other study, apart from two rural Japanese communities (see later), and the interpretation of these results is complicated for a number of reasons. Over the study period, the composition of this population changed from predominantly non-Mormon to Mormon; the number of observations per decade is relatively small; and the population is selected, being the oldest or youngest child for a number of generations in a population with large family sizes. No separate coefficients are given for parents with youngest or oldest children. The fact that only 89 families in the fourth generation are available, less than 25 per cent of the full sample expected from the original 402 families, means that they are likely to be very disproportionately drawn from the first-born group generation-by-generation – if the first birth was at age 20 and the last at 40, there would be very few last-born descendants of <u>any</u> generation in the sample. As will be discussed later, birth order is a variable of considerable significance in the analysis of the intergenerational transmission of fertility. I would therefore

give little weight to the later results of Wise and Condie (1975) especially since they are out of line with a number of more representative studies covering the same period.

The study by Anderton *et al.* (1987) was based on a similar population to that of Wise and Condie (1975), although only one generation was studied: women born in the period 1830 to 1870 married in the age range 10-24 with uninterrupted non-polygamous marriages up to age 45, who had at least one daughter, similar marriage restrictions were placed on their daughters. Thus the comparison is of the fertility of the older generation occurring in a broad band around 1880, with that of younger generation occurring about in an even broader band around 1910. However, the basic sample size consisting of 5,668 mothers and 8,058 daughters, was much larger than that of Wise and Condie. For some analyses, the age at marriage restriction was removed, but full dating of events was required and daughters had to have between 2 and 13 children, which gave a sample of 5,638 linked mother-daughter pairs.

In this study, the youngest cohort was childbearing around the 1890s, and their daughters were doing so around the 1920s. Therefore it does provide some information on the apparent turnaround for births occurring in the period 1921-30, among whom Wise and Condie found that the correlation coefficient between mothers' and children's family sizes became negative. Although they do not present correlation coefficients, Anderton *et al.* (1987) confirmed the positive intergenerational association in the earlier period and concluded that the relationship of mothers' to daughters' fertility is likely to have arisen mainly through correlated ages at marriage. Garn (1980) noted that there is a genetic correlation of 0.2 to 0.3 between ages of menarche of mothers and daughters.

Anderton *et al.*'s (1987 Table 2) fertility results are presented in the form of cross-tabulations of a three-fold category, high, medium and low, for mothers and daughters. For the earliest 1830-39 cohort of mothers, the χ^2 value of this 3x3 table was 10.65 (4 d.f., based on a total sample size of 837): for the latest 1860-69 cohort, the corresponding value was 57.98 (N = 3,445).[3] Allowing for the sample size differences, such as using Pearson's ϕ statistic, $\sqrt{(\chi^2/N)}$, (Bishop *et al.*, 1975, p. 380-87), there is a strengthening of the relationship over the period. A crude measure, but one which permits more direct comparison with other studies, is the correlation coefficient based on the assumption that the 'high', 'medium' and 'low' groups form an interval scale (Pearson's ϕ is identical to the standard correlation coefficient for a 2x2 table). The correlation coefficients in these two cases are 0.058 and 0.118 respectively. Thus there is clear evidence that the relationship between fertility of mothers and daughters actually become *stronger* over this period, although this fact is not noted in the paper and indeed in a later proportional hazards model, it is stated that 'birth cohorts are excluded from the model to avoid their artificially accounting for variation in other proximate fertility determinants' (p. 477).

The Relationship in the Early Part of the Twentieth Century

Although they do not refer to work by Pearson *et al.* (1899), 'reproductive selection' underpinned Huestis and Maxwell's (1932) analysis of the number of sibs and mother's number of sibs of 638 white female students at the University of Oregon, a generally higher status US population, comparing two generations which practised increasing family limitation. The correlation coefficients for the separate urban/rural and total populations were very similar; rural 0.104, urban 0.111, total 0.124.[4] They conclude that the 'environment',

which they appear to define as the wider socio-economic situation, rather than, for example, how the parents treated their children, is the key determinant of average fertility levels, with biological factors being weak. Pearl (1939) reviewing these two studies, called the correlations unimpressive and argued that unmeasured factors mean that 'a cautious person will find it impossible to accept this evidence for the inheritance of human fertility at *prima facie* valuation' (p. 36).

Bresard's (1950) analysis is noteworthy as the first 'modern' study using a contemporary representative sample, although only of males. It was based on a much larger sample than many more widely cited later sources, collecting information on 45,000 people in France from 3,000 male respondents aged 18 to 50 in 1948. The main focus was on intergenerational occupational mobility, but some information is presented on the association between respondents' number of sibs and the number of fathers' and mothers' sibs (collected as number of children of father and both grandfathers). This shows the relationship of childbearing taking place in the early part of the century with that of a generation earlier, centered on the decade of the 1880s. For the group of farmers and peasants ('cultivateurs exploitants'), which accounted for 34 per cent of the sample and was regarded as one with little intergenerational occupational change, the correlation coefficients were 0.265 (N=1,035) for paternal and 0.237 (N=1,036) for maternal grandfather's number of children with the respondent's number of sibs.[5] These father-son correlations are much higher than those of Pearson *et al*. (1899) and they also show no clear differential for the effect of number of mothers' and fathers' sibs on family size. The relationship was even more clear-cut at the extremes of the distribution: for fathers whose father was an only child, 28 per cent had only one child (who had to be a son because of the sample design) and only 4 per cent had 6 or more children; for fathers whose father was from a family of size 6 or more, only 9 per cent had a single son, but 23 per cent had 6 or more children. Unfortunately, these data cannot be controlled for age and it is not possible to calculate correlations for other groups or for the overall population. On the other hand, Moberg (1950) found no clear relationship between the fertility and sibship sizes of men who matriculated in 1910 and 1920 in Sweden, but this study had data problems in that respondents appeared unclear whether or not they should include themselves in the number of brothers and sisters.

For a slightly later period of childbearing of the second generation, around the 1920s and 1930s, there were studies in Britain, Berent (1953), and the US, Kantner and Potter (1954). Both were based on sample surveys, although neither was completely random, Berent's (1953) results were based on Lewis-Fanning's 1946-7 hospital-based survey undertaken for the Royal Commission on Population of 1,377 couples who were in their first marriage which was of at least 15 years duration, while Kantner and Potter used an almost identical sample size from the 1941-2 Indianapolis study of 1,444 white, native, Protestant, elementary school graduate couples who married in the period 1927-29, with wife below 30 and husband below 40, and who had lived the majority of their married lives in a large city. Berent found that there was a positive correlation between both husbands' and wives' families of orientation and their number of children, and the effect was rather larger for wives than husbands. The overall value of the correlation coefficient was 0.187, which he referred to as small. Because both 'social' and 'biological' mechanisms for the relationship had been proposed, he undertook separate analyses for birth controllers and non-birth controllers and found that the correlation was slightly higher for the former group, 0.199 as compared to 0.174. He also broke the sample down into three social classes and found the correlation was somewhat higher, 0.219, in the middle social status of skilled manual workers than for non-

manuals (r=0.154) or semi-skilled/unskilled manual workers (r=0.143) although none of these differences are statistically significant. Thus the major impression is of similarity, rather than differences, between groups.

In what appears to have been a direct response to Berent (1953), Kantner and Potter (1954) strongly emphasised the weakness of the relationship: 'the data [from the Indianapolis study] in some respects are consistent with the hypothesis that the wife's family of origin exerts a stronger influence on a couple's fertility than the husband's family of origin, but the influence in both cases is so minor as to make the comparison fairly meaningless' (p. 308-9). They do not refer to the much more substantial values reported by Bresard (1950). It should be noted, however, that their sample was highly selected and had not yet fully completed childbearing since the interviews took place about 13 years after marriage (although they claim that only minor changes in family size were likely to occur). They found a substantial relationship only for families where the number of sibs of husbands and wives were the same: in this case, the correlation coefficient with children was 0.21, compared with the overall figure of 0.11. However, with sample sizes of around 1,400 in both of these studies there is only a marginally statistically significant difference between the overall correlation coefficients of the two studies (p<.05, but p>.01), and given the selected nature of the Indianapolis sample, the existence of similar overall magnitudes in the two countries would be plausible. In their conclusions Kantner and Potter draw attention to a number of reasons why their findings are likely to be atypical, such as the divergence in urban/rural and educational backgrounds of parents and children and the very unusual 1927-41 study period. Nevertheless, they conclude 'while there are definite reasons for expecting the hypothesis [about a positive relationship between generations] to have more limited significance among Indianapolis couples than it has had elsewhere, this does not diminish the importance of the conclusion that for a group such as the one studied here, the paternal generation exercises very slight influence on the size of their children's families' (p. 311). It would be open to argue that these caveats do diminish the significance of this study. There are other points in the paper that should be noted. When separate analyses were performed, the correlation coefficient for the fertility of efficient family planners with parents' fertility was 0.09 (also 0.09 with the wife's family size but –0.05 with the husband's) whereas values for inefficient family planners were described as 'negligible' (p. 304, although the values were 0.08 and 0.07 for wives and husbands respectively, Table 8). There was a negative rather than a positive relationship for large first generation families, those with 4 or more sibs.

More Recent Populations: Theory and Explanations for the Observed Relationship

Pearson assumed that the mechanism of transmission was biological rather than social. He devoted considerable discussion to the population dynamics implications of differential fertility.[6] A consequence of this was his assumption that biological inheritance must come through the female line (although he argued that it could be passed from grandmothers to granddaughters, through fathers). The correlation for 1,000 granddaughters and their paternal grandmothers for members of the peerage both of whom had been married for at least 15 years was 0.1123 (Figure 1). Pearson argued that this reflects transmission through the intervening (male) generation, although the correlation between fathers and sons is much weaker than this value, and that the correlation between paternal grandmothers and granddaughters should be half of the value for mothers and daughters on theoretical grounds.

He concluded that this is confirmed by these data. Pearson and Lee's paper was presented two years before Mendel's classic 1865 paper came to the attention of the wider scientific community, though the work of Hugo de Vries, Car Correns and Erik von Tschermah, and it was much later that it was put onto a modern footing. The relationship between fathers and sons was partly interpreted as reflecting an attenuated mother-son effect, since it was actually a parent-son relationship. Pearson did not look at the joint relationship between, for example, fathers and mothers and their children, and nor did Williams and Williams (1974), in the latter case because of the much greater difficulty of obtaining information on women from genealogical records. The lack of attention to social factors means that some possible issues cannot be addressed. For example, noble families may have a strong interest in having a male heir in order to perpetuate the lineage. Therefore at the margin, some differentials might be expected.

Fisher (1930) estimated that the genetic component of fertility using Pearson's correlation coefficient of 0.2096 for mothers and daughters, although alternative pairs would have given much lower values (Figure 1). For a wholly genetically determined trait, this covariance would be half of the variance, so giving his figure of 42 per cent. In addition, the estimate based on grandmother/granddaughter correlation suggested a value of 39 per cent (Williams and Williams 1974). Williams and Williams (1974) only computed correlation coefficients for father-son pairs of different generations. These fell from 0.168 to 0.036 to 0.021 over the three generations studied, which were based on the grand-parental generation born in the period 1740 to 1800 (this period was chosen so as to ensure that the great majority of their grandsons would have completed their fertility by the 1880s in order to maximise comparability with Pearson and Lee's study). Thus over time they found that the relationship between sibship size and fertility became less important. However, the overall value for fathers and sons, 0.059 was almost identical to Pearson's value of 0.066. Clearly use of the father-son rather than mother-daughter data leads to considerably smaller estimated heritability effects, and Williams and Williams argued that previous studies, including Pearson *et al*. (1899) which have attempted to estimate such parameters are either flawed or produce non-significant results, a finding they attribute to the fact that the social environment is the overwhelming determinant. They cite as evidence the fact that correlations often become attenuated when controls are made for socio-economic variables, and attribute the reduced correlation over time in their study to the fact that the environment was becoming more changeable in the later period.

A genetic interest underpinned Imaizumi *et al*.'s (1970) study of about 1,000 families in the rural Japanese community of Uto in Kumamoto prefecture using record linkage of the official *koseki* records. The fertility of five cohorts of women born between 1881-90 to 1921-30 was compared with their mother's and father's sibship sizes. Thus it includes women who were childbearing up to 1966. The study does not state whether only married women were included, but this appears likely. The data were acknowledged to be incomplete, especially for females, and the widespread practice of adoption could bias results, especially in the earlier period. However, the correlations with father's sibship size are generally small and, if anything, negative (the values from the related studies of Neel and Schull (1972) and Bocquet-Appel and Jakobi (1993) are also shown in Figure 3). For mothers, in contrast, there is a shift from negative to positive over the period of study, but how far this reflects data problems remains unclear, and the authors are particularly cautious about the negative values. However, as with Bocquet-Appel and Jakobi's (1993) later study, there is a consistent positive relationship between the fertility of sibs, although this is likely to be due at least in

part to a common shared environment. Neel and Schull (1972) undertook a broadly similar analysis of the Japanese island of Hirado but used data from a survey conducted in 1964. They related childbearing of those having children in the first three decades of his century to their sibship sizes, and the overall values were close to zero, -0.043 (N=409) for fathers, and 0.019 (N=403) for mothers.

{Insert Figure 3 about here}

Huestis and Maxwell (1932) also downplayed biological aspects compared to Pearson and Lee, stating that 'family size does run in families but not to any great degree' (p. 79). They assume the primacy of social mechanisms: 'Our conclusion ... is that family size ... is much more affected by the environment than by congenital differences in love of children or ability to have them' (p. 79) and they reject the hypothesis that there are genetic differences in the propensity to have children. Huestis and Maxwell also assert that women not men are the principal decision-makers with respect to family size, although no backing is given for this statement.

Bresard (1950) also emphasised the role of preferences but intergeneration fertility relationship was not a main topic of interest. Berent (1953) argued that if there was a transmission of a predisposition to have a particular number of children, this would be seen among successful family planners. However, the relationship for ever-users and never-users, and within every social class is very similar. He interprets the non-user data as confirming a biological hereditary component, and that among ever-users as inheritance of 'family building habits', but identified these correlation coefficients as showing a 'rather small' effect (p. 47).

Kantner and Potter (1954, p. 295) argued that intergenerational transmission in modern populations is largely determined by the older generation forming notions or instilling preferences about family formation in the younger generation. This approach reflected the emerging concentration on child socialisation as a primary mechanism of transmission of behaviour. However, a major focus of the paper was to emphasise the weakness of the relationship. They suggest that for populations such as their sample, the socio-economic characteristics of the parents and children were very different in terms of rural/urban residence and education and that this might affect the strength of transmission mechanisms. They also argue that with less variation in fertility levels, such effects would be likely to die away (even though they found the relationship to be strong only for small family sizes in the first generation and actually negative for large family sizes). We argue later and elsewhere (Murphy and Wang 1998) that the reverse is actually the case.

In the period around the 1960s in the US, there was considerable attention to the relationship between parental family size and their children's fertility intentions and attitudes, especially to the extent to which the findings of a positive association remain after various socio-economic controls were included in the multivariate approach which has come to dominate quantitative research. If intentions' data were accurate predictors, this would permit much more up-to-date analysis of intergenerational relationships because these expressed opinions could be used as a proxy for later fertility. This review will not emphasise these aspects since their validity for this purpose is unestablished. Indeed, there is evidence that for some intergenerationally-transmitted genetic effects, paradoxically, are more likely to be observed later in life (McGue *et al*. 1993). Moreover, the samples and methods used make it difficult to compare actual results with expectations data. What is valuable from such studies is their ability to generate hypotheses that may be tested with more suitable data.

Westoff *et al.*'s (1961) analysis of the 1,165 eligible couples in the 1957 Family
Growth in Metropolitan America study had similar restrictions to the Indianapolis study, and,
in addition, it was confined to women of at least parity two. This makes comparisons with
other sources problematic, but they found correlation coefficients of 0.11 and 0.10 for number
of children desired and number of sibs for husbands and wives respectively (N=938) (Westoff
et al., 1961, p. 287-292). They concluded that the relationship was likely to be stronger if the
woman had had satisfactory childhood experiences, a theme that was to become of major
interest. When this sample was re-interviewed later in 1960, there were positive correlations
of 0.08 and 0.04 between number of sibs and of wife and husband and number of pregnancies
since the second birth (Westoff *et al.*, 1963, p. 204). The sample was re-interviewed in 1962-
66 and the regression coefficient for completed parity on wife's number of sibs was 0.04, but
this actually increased to 0.06 after controlling for education and age at marriage (Bumpass
and Westoff, 1970, p. 91).

Duncan *et al.* (1965) included information about expected family size from 2,713
white wives aged 18-39 living with their husbands from the Growth of American Families
(GAF) 1955 Survey, and also their live births by Survey date, together with 8,300 wives aged
27-46 with the same characteristics, and a further 4,000 wives aged 47-61 in 1962 from the
Current Population Survey (CPS). They found a positive linear relationship between
successive generations' fertility, but no differences in the effect of fathers and mothers or
suggestions of a curvilinear relationship. The relationship was stronger for the older CPS
cohort, but the younger group is affected by censoring of experience. They present regression
coefficients, rather than correlation coefficients, and since the variance in parent's sibship
size is larger than that of children's fertility, correlation coefficients will be larger than the
regression coefficients.[7] For the older cohort, the simple regression coefficients are 0.111 for
wives' number of siblings, and 0.101 for husbands' siblings: for the younger cohort, the
values were 0.061 and 0.070 respectively. In their samples, inclusion of educational level,
farm background and duration of marriage reduces the magnitude of the sibling regression
coefficient by about half for the older cohort and two thirds for the younger group (where they
noted that this will also reflect timing influences). While there are arguments for controlling
for educational level and farm background, the assumption that duration of marriage is
somehow independent of 'fertility' is questionable: if there is a propensity for fertility to be
transmitted intergenerationally, differences in marriage is the primary mechanism through
which it would be expected to operate as Anderton *et al.* (1987) note. While Duncan *et al.*
(1965, p. 514) acknowledge the possibility that intergenerational transmission could involve
'physical inheritance of some trait associated with low fecundity (e.g. blood type)',
socialisation mechanisms are emphasised and it is suggested that intergenerational stability is
necessary for such mechanisms to operate. While they report that the relationship is stronger
than average among 'fecund planners', the implications of this for how the relationship might
evolve over time is once more not explored.

Hendershot (1969) followed up Duncan *et al.*'s (1965) hypothesis that socialisation
was the key mechanism for transferring fertility through generations. He argued that this
pattern was more likely to be observed in children who were 'satisfied' with their upbringing
and who were 'conformist'. The sample was highly selected, 389 freshmen women in
Midwest liberal arts colleges, a largely upper middle-class group. He concluded that attitudes
to family size were positively related to parent's family size, but also that this was stronger
among women who felt closer to their families and was stronger for first-born women.
Westoff and Potvin's (1967) survey of 15,000 freshmen and senior women in US colleges

which showed that for all religious groups, especially Catholics, there was a direct linear relationship between number of siblings and desired family size, reinforced this conclusion. One interesting aspect of Hendershot's study was that conformism was assumed to be more common among first-born women and the relationship was found to be stronger among first-born women. However, McAllister *et al*. (1974) using a sample of 635 tenth graders (male and female) from four Southern counties, a generally lower socio-economic status group found no relationship between size of family of orientation or a special role for first-borns. They were able to replicate Hendershot's results only for the comparable group of white females who expected to attend college. Thus they conclude that such continuities are likely to be found only in selected groups where little change in lifestyle is anticipated.

Johnson and Stokes' (1976) analysis, based on 901 women who had been followed up since being sophomores in rural Pennsylvania high schools in 1947, deserves special attention. They were once married and living with their husband in 1971 and almost all were aged 40 to 44 years. Information had been collected on number of sibs in 1947 and this was related to the number of their own children (including those who were childless). Analyses were presented mainly in the form of regression models, but the standardised regression coefficients are simple Pearson product moment correlation coefficients that may be compared with other studies. The overall correlation coefficient was 0.140, and number of sibs was described as 'weakly related to marital fertility, particularly when compared to the influences of other variables' (p. 181) although no other coefficients are presented. In part, this conclusion was based on the fact that the regression coefficient was 40 per cent lower than the correlation coefficient but this simply reflects the ratio of standard deviations of the distribution of fertility of the two generations (Footnote 7, see also Murphy and Wang 1998).

This study population has many advantages: the number with completed fertility is large; the population is relatively homogeneous, but not at the extremes of the socio-economic continuum; and longitudinal information is available. Johnson and Stokes provide both theoretical arguments and empirical evidence that the relationship is stronger for three particular groups: first-born for whom the correlation coefficient was 0.256 compared with 0.132 for later born; those who had similar lifestyles to their parents (operationalised as the closeness of number of years of schooling) 0.218 compared with 0.118 for the change group; and those who had expressed satisfaction with their family life at age 16 ($r = 0.175$ compared with 0.022 for dissatisfied). For first-borns without a change in lifestyle, the correlation coefficient was 0.419. However, while less than one quarter had no change in lifestyle, over 80 per cent expressed themselves as satisfied. The link between size of family of orientation and fertility is once more confirmed at least for women, and the 'sociological' explanation that similarly of, and satisfaction with, life as child is the key mechanism which underpins the relationship is consistent with many of the more general theories of the importance of socialisation of children.

Since the primary focus in this review is on demographic factors, attention will be concentrated on the birth order variable (the topic of wider birth order demographic effects will be covered in a later review paper). The fact that the reported correlation coefficient for first-born women is twice the value for later-born women is striking. The theoretical justification is based on the greater conformity associated with first-born children (Schachter 1964); see also Sulloway (1996) for more recent developments. However, these comparisons do not control of <u>size</u> of family. For Johnson and Stokes' study population the average number of sibs of those who are first-born, just over two, is only half the number of sibs of

those who are later-born. This is because all of those from one-child families are first-born, but, for example, only one in ten of those in a 10-child family, whereas for a later-born child, none are from a one-child family and there is a 90 per cent chance that a random child from a 10-child family will be later-born. Thus the interpretation of a birth order effect will tend to be confounded with family size unless the relationship is linear across all birth orders. This point is also relevant to the interpretation of Wise and Condie's (1975) results, in addition to the over-representation of first-borns discussed earlier.

The pervasive influences of economic models at this time was also evident, especially the Easterlin approach which appears to give a particular emphasis to the childhood environment as an influence on subsequent behaviour. Ben-Porath (1975) used this framework as the basis for investigating the relationship between generations, particularly the role of income. The data source was the 1968-70 files of the Panel Study of Income Dynamics (PSID). The analysis was based mainly on 973 white non-Catholic wives aged 35 and over. Catholics and blacks were rejected because it was stated that their fertility could not be regarded as approximately completed (no controls for age were included in the analysis), although they also appear to conform less well to the economic rationality model proposed. The correlation coefficient between number of wife's siblings and children was 0.177 (very similar in absolute magnitude to the correlation coefficients for husband's and wife's education and number of children of –0.194 and of –0.159 respectively). Although the first sentence of the paper's abstract states that the predicted income of the husband's father is inversely related to the family's number of children, the t-statistic for this variable is only 0.96 (p = 0.34) when farm background is included in the paper's final analysis (Table 6), a very weak relationship. However, the number of wife's siblings variable remains much stronger (t = 1.89, p = 0.059). Thus on the basis of this empirical analysis, the role of economic factors would appear to be inconsequential compared with number of sibs.[8]

Duncan *et al.* (1965) had suggested that stability of lifestyle might promote intergenerational transmission of fertility. Anderton *et al.* (1987) accept the socialisation framework but noted that the role of the family appeared to be more important than external influences, and that the key factor is relative rather than absolute fertility (i.e. if the mother has below average fertility compared with her peers, then her daughter is also likely to do so). They reflect the dismissive attitude to biological mechanisms stating that 'Early studies ... even attributed transmission of fertility norms and preferences to heredity'). Kantner and Potter (1954) is quoted to show the negligible relationship compared with Berent's 'weak' results, but as argued earlier, these values probably do not differ significantly at the 1 per cent level. In their review of contemporary studies, Anderton *et al.* (1987, p. 468) used 'weak' four times, 'modest' twice, and 'negligible' once to categorise the nature of the relationship, with nothing to suggest the existence of any substantial effect exists. In a systematic investigation of relative explanatory power of different types of variables, Murphy (1987) considered 15 aspects of family formation for women aged 30-39 and 40-49 in the 1976 British Family Formation Survey (Dunnell 1979). The variable of number of wife's and husband's sibs combined was found to be statistically significantly related to 63 per cent (N=19) of these. A series of 17 variables measuring various aspects of socio-economic status, educational level and employment experiences were constructed, and 15 of these 17 had lower scores than the sibs variable: the two with higher values referred to the current (i.e. post-reproductive) status of the woman.

However, even if variables related to socialisation factors, including stability of lifestyle and childhood satisfaction, are related to subsequent fertility, this would not mean that the causal role of socialisation had been confirmed, unless it can be shown how socialisation is correlated to the genetic and environmental backgrounds of the 'biological' and 'sociological' parents. The only designs that would provide discrimination between such factors do not lie in ever-more detailed replications of panel or longitudinal studies, but rather designs such as of twin and adoption studies that permit the relative contribution of genes, environment and their interaction to be determined. A very recent study based on Danish twins born in the period 1900-23 suggests a substantial genetic component to fertility (Kohler and Christensen 1999).

More recently, attention has been given to this topic as an aspect of intergenerational relations and social policy aspects of an ageing society. Pullum and Wolf (1991) present data on correlations between living sibs and children for Canada, using the 1985 General Social Survey for 5-year age groups from 55-59 to 85+ based on sample sizes of about 400 in each age group. The largest correlation coefficients, about 0.32 are for those around age 60, with values declining at older ages (although since these are based on living sibs, death of siblings will increasingly affect values). US data from the Longitudinal Study of Aging are for sisters and daughters only, with correlation coefficients typically just under 0.1, and therefore not comparable with other data discussed here. Pullum and Wolf also present correlation coefficients from the 1981-2 German Life History Survey for ever-born siblings and children for cohorts born 1949-51 (who will not have completed childbearing) of 0.2127 for the 1939-41 cohort (N = 727) and 0.1552 for the 1929-31 cohort (N = 709). They also quote a 1974 study from Israel of women aged 35 and over for whom the correlation coefficient is 0.286 (N = 708), however over one third of this sample was of Asian or African ancestry with much higher average levels of fertility than the others which is likely to inflate correlation coefficients (Danziger and Neuman 1989).

Two additional sets of results will now be presented. Table 1 shows data from the 1976 British Family Formation. They show the relationship of the fertility of women with the number of their own and their partner's sibs, and the number of sibs for all women regardless of their marital status. The influences of husbands' and wives' family sizes are essentially equal, and there is no evidence of change in the strength of the relationship over time. However, correlation coefficients are considerable larger if the average of husbands' and wives' sibs is used rather than each taken separately: this holds even when the number of sibs is different. Perhaps surprisingly, the correlation for all women is slightly larger than for women with a partner (the great majority of whom were husbands).

{Insert Table 1 about here}

Table 2 shows correlations from the 1987-8 US National Survey of Families and Households (NSFH), for number of children and number of sibs who the respondent lived with while growing up. This shows an increase in the correlation coefficient value for younger cohorts, the value for the youngest cohort being twice that for the oldest one shown. For these two recent data sources, the correlation coefficients are mostly in the range 0.15 to 0.20.

{Insert Table 2 about here}

Summary and Conclusions

Figure 4 and Table 3 show the trend in reported correlations between number of siblings and children for the majority of studies discussed earlier. There is a clear tendency for the value to increase steadily over time (results shown separately earlier in Figures 1 to 3 by Pearson and Lee, Wise and Condie, Imaizumi *et al.*, Neel and Schull, and Bocquet-Appel and Jakobi are not given here).

Thus for parental generations born in a band about the middle of the 19th Century and the second generation born around the turn of the Century, a large number of studies based on different data sources report correlation coefficients between numbers of parents and children. These dates are approximate, in that, for example, children born about 1900 are assumed to have parents born around 1870. In the case of broad age coverage such as the Berent (1953) study, women covered the age range from about 35 in 1946, and so it is assumed that their birth dates were around 1900 on average. Taken as a whole, these data show a high level of consistency with values of about 0.15 for countries such as the US and Britain, but higher for the particular French population, and similar values for those childbearing up to the 1940s. However for the 1960s, values around 0.2 are more typical. The largest reported values are from France, Canada and Israel, and values appear to be increasing over recent periods.

{Insert Figure 4 and Table 3 about here}

This paper has summarised the demographic and related literature over the past 100 years on the topic of the correlation of fertility between parents and children and highlighted a number of issues that will be summarised here.

Trends Over Time

No definitive answer can be given about the strength of the relationship in pre-transitional historical populations since there is some doubt about the quality of the reconstitution data such as those used by Langford and Wilson (1985), but both empirical evidence and theoretical arguments suggest that the value was close to zero. Occasional studies have reported a decline in the strength of the relationship with time (William and Williams 1974; Wise and Condie 1975). Virtually none have reported a stronger relationship either on the basis of comparisons of different studies or from individual studies. Moreover, although a number of studies find the relationship is stronger or no weaker for more 'modern' groups such as family planners compared with more 'traditional' groups, the conclusion that the relationship may become more substantial as the proportion of 'modern' groups increases has not been drawn. However, I argue that both comparative analysis such as Figure 4, and generalisable individual studies such as those of Anderton *et al.* (1987), Imaizumi *et al.* (1970), and of NSFH data show that this relationship is becoming stronger through time.

Relative Influence of Mothers and Fathers

Investigation of the relative role of fathers' and mothers' influence generally show rather greater influence of mothers than of fathers, although full investigations of their joint influences are rare. However, Pearson and Lee's differentials between males and females are so out of line with other studies as to suggest either a very highly selected population, or some

13

systematic bias in their data. The suggestion by Kantner and Potter (1954) that there appears to be an interaction term when fathers and mothers come from the same size families remains an untested hypothesis. Such considerations raise the more general point of the role of homogamy on population dynamics. Effects tend to be greater in cases where the children's characteristics do not differ substantially from their parents, such as children who have broadly similar levels of education to their parents (and an additional hypothesis is that this would be even stronger if the parents themselves were alike in their characteristics). Intergenerational similarly of lifestyle tends to increase the strength of the observed relationship, but whether the relationship can be explained in terms of a particular proximate determinant such as intergenerational continuities in age at start of childbearing remains unclear. Only relatively few studies have considered the role of marriage, but Anderton *et al*. (1987) suggest that observed correlations in fertility between generations are largely a consequence of similarity in ages at marriage. Most 'biological' analyses have implicitly assumed that fecundability is the key parameter, with the role of other intermediate fertility variables not considered.

Other Socio-demographic Influences

Work on birth order effects provides further insights into possible mechanisms at work (Johnson and Stokes 1976). The particular time period over which the analysis was undertaken and the possibly specialised nature of the population used raises the question of how far these findings hold in the wider context. One topic that has not been addressed is the patterns of non-marriage according to size of family of orientation. In some of the historical populations considered here, perhaps a third of women may never have married and in the early 20th Century and only one half may have had more than a single child. If mother-daughter correlations were thought to be relevant to discussion of population dynamics, then inclusion of non-breeders would be important. Most studies have confined the second generation to married couples, usually those in intact first marriages, but such restrictions are no longer tenable within the fluid lifestyles experienced today.

The relationship is becoming stronger in developed societies, but this conclusion is mainly based on comparing completed fertility of the younger generation with that of their parents, rather than analysis of contemporary childbearing. Younger generations are now more likely to adopt an individualistic approach to demographic decisions, and, moreover, the pace of socio-economic change would be expected to attenuate any intergenerational trends (Lesthaeghe and Meekers 1986). On the other hand, the B la carte menu of the post-Second Demographic Transition epoch, and the wider set of options available, could provide an extended social space for such patterns to manifest themselves.

Research Designs

Little attention has been given to the relationship of fertility between sibs, apart from the genetically-orientated studies of Imaizumi *et al*. (1970) and Bocquet-Appel and Jakobi (1993). Yet if a mechanism is generates similarities between parents and children, then it should also generate a correlation between sibs. The literature on birth order tends to assume that differences are due to socialisation in that, for example, first born girls from large families in the past may be reluctant to follow their mother's footsteps because they had to undertake some childcare responsibilities. With such smaller families, this may be less relevant.

One key issue that remains has still not been satisfactorily addressed is the hypothesis dismissed by Huestis and Maxwell (1932) that there may be an inherited (i.e. genetic) propensity to have a given family size 'there are probably genetic differences in the desire for children as well as the ability to have them, comparable to differences in height, body build and the like' (p. 77). In contrast to earlier work which assumed that any relationship was only likely to be found in non-contracepting populations, it is more plausible that it will be manifested in post-transitional ones and that any likely genetic mechanism will be behavioural rather than physiological. However, none of the studies considered so far, including longitudinal ones, apart from Kohler and Christensen, are able to distinguish between genetic and socialisation factors, and their interactions. One possible way to address this issue in addition to the classic twin and adoption studies would be to look at the outcomes for sibs of different levels of genetic similarity if there are sufficient numbers who are brought up in different environments. The most obvious group to take might be the children of men who have children by more than one partner.

For contemporary industrialised county populations, biological ability (or fecundability) is less relevant as a topic of study, only in interaction with behavioural factors such as the reduced ability of women who choose to start childbearing at older ages to be able to do so. Age at first marriage has been found to be an important proximate determinant of the correlation between generations[9], and so has familial satisfaction. One is a proximate and the other a remote determinant, and their relationship could be clarified. However, early age at marriage is also associated with parental divorce and, for example, more couples now divorce than have three or more children in developed countries such as Britain, so the scope for partnership behaviour to be a major confounding factor is now present.

The Scientific Context

The attention and explanations given to the relationship between fertility of successive generations mirrors the prevailing scientific orthodoxies of the period. Pearson was interested in biological inheritance, at a time when eugenic issues were emphasised. In the 1940s and 1950s, interest in family planning led to work on differences between users and non-users of contraception, with an assumption that the analysis of these groups separately would lead to differentiation of 'biological' and 'social' influences. There was also a move to downplay intergenerational differences as other influences because of greater interest. However, intergenerational fertility transmission was later absorbed within the boundaries of socialisation theory, and rather than being interpreted as a biological phenomenon, it was used as evidence to show that early socialisation of children tended to be repeated in the following generation. Indeed size of family of orientation appeared sometimes to be considered only a noisy proxy indicator for the parents' norms and attitudes that were passed down through their children.

The repeated tendency for authors to refer to the small value of the intergenerational effect has already been commented upon. Yet, for example, Berent (1953) shows that the average number of children for women in the highest sibship group (14 per cent of the sample) had an average of 4.41 children, compared with 2.63 for those in the smallest group (12 per cent of the sample). Any classification, which found such differences between broad groups, would usually be described as substantial in the context of contemporary fertility studies, yet they arise from an underlying relationship that is described as small. The reason may be that those researchers undertook most analysis from tabular material where

differences between groups were discussed. Micro-level calculations were rarely undertaken (Pearson refers to having spent a week with a colleague to calculate two correlation coefficients!), and the fact that apparently small micro-level differences lead to large differences in tabulated data was insufficiently appreciated.

Kincade Oppenheimer (1994) has pointed out that part of the popularity of variables such as female employment and education in current demographic analysis is that they are seen as positive in themselves and compatible with other desirable outcomes such as female autonomy. The stress on the weakness of the relationship contrasts with most other areas where researchers are anxious to emphasise the strength of the relationships found, suggesting a preference in many cases for alternative explanations. Most social scientists have been traditionally suspicious of biological and genetic explanations, and even analysis of intergenerational socialisation factors, such as the effects of children's experiences on subsequent behaviour, is largely confined to groups defined as 'problematic', such as teenage and single mothers whose life is assumed to be much more determined by background than among the emancipated educated classes. I suspect that relatively few (including this author) would subscribe to hypotheses about intergenerational fertility behaviour such as: 'at the same time, we know that hundreds of millions of people ... have chosen to have fewer than two children. It would not be implausible to argue that such people are genetically different with respect to wanting children from, say, Nigerians who have six children' (Potts, 1997, p. 5) and probably even fewer would do so if the groups contrasted were Black and White Americans, or if the variable in question was IQ.

Relatively little attention has been given to the role of transmission of fertility from the discipline of evolutionary biology, which has been particularly useful in showing the impact of biological factors in core demographic areas of interest such as mortality (Christensen and Vaupel 1996) and partnership (McGue and Lykken 1992). This is strange to the extent that such approaches are driven by the concept of biological fitness, i.e. the capacity to reproduce successfully. If one group had a high propensity to reproduce, and this propensity was inherited, then in a long-term fixed demographic regime, such a group would eventually come to be numerically dominant. It appears that such a propensity would not easily have been expressed in earlier periods, not only because the stochastic variability of birth processes was such as to overwhelm such a tendency, but also because of the theoretical arguments of Jacquard (1977; 1983). However, these arguments do not hold for contemporary populations.

Postscript

For studies with reliable data, there is a clear tendency for a positive association to be found which is of greater substantive import than often claimed. Moreover, there is as yet no evidence for the withering away of this relationship, rather the reverse. This is in contrast to many of the 'traditional' variables such as religion or urban/rural residence where effects do appear to have declined or disappeared. The assumption that the relationship is 'weak' and disappearing cannot be sustained.

16

Acknowledgements

Thanks are due to the Economic and Social Research Council who partially funded this work as part of a project *Evolving trends in British kin distributions and family life experience* Ref R000237076; to the Office for National Statistics for access to the 1976 Family Formation Survey, used with the permission of the Controller of HM Stationery Office; to the Data Archive for supplying the data; to the Center for Demography and Ecology, University of Wisconsin for access to NSFH data; and to the Danish Center for Demographic Research at Odense University for hospitality while this work was undertaken.

REFERENCES

ANDERTON, D. L., N. O. TSUYA, L. L. BEAN, and D. G. P. MINEAU. 1987. Intergenerational transmission of relative fertility and life course patterns. Demography **24:** 467-480.

BEN-PORATH, Y. 1975. First generation effects on second generation fertility. Demography **12:** 397-405.

BERENT, J. 1953. Relationship between family sizes of two successive generations. Milbank Mem. Fund Quart. Bull. **31:** 39-50.

BISHOP, Y., S. FEINBERG, and P. HOLLAND, 1975. Discrete Multivariate Analysis: Theory and Practice. MIT Press, Cambridge, Mass.

BOCQUET-APPEL, J.-P., and L. JAKOBI. 1993. A test of a path model of biocultural transmission of fertility. Ann. Hum. Biol. **20:** 335-347.

BRESARD, M. 1950. Mobilité sociale et dimension de la famille. Population **Juil-Sept:** 533-566.

BUMPASS, L. L., and C. F. WESTOFF. 1970. The later years of childbearing. Princeton Univ. Press, Princeton, N. J.

CHRISTENSEN, K., and J. W. VAUPEL. 1996. Determinants of longevity: genetic, environmental and medical factors. J. Intern. Med. **240:** 333-341.

DANZIGER, L., and S. NEUMAN. 1989. Intergenerational effects on fertility - theory and evidence from Israel. J. Pop. Economics **2:** 25-37.

DUNCAN, O. D., R. FREEDMAN, J. M. COBLE, and D. P. SLESINGER. 1965. Marital fertility and the size of family of orientation. Demography **2:** 508-515.

DUNNELL, K. 1979. Family formation 1976. OPCS, HMSO, London.

FISHER, R. A. 1930. The genetical theory of natural selection. Clarendon Press, Oxford.

GARN, S. M. 1980. Continuities and change in maturational timing, p. 113-162. *In* O. G. J. Brim, and J. Kagan (eds.), Constancy and change in human development. Harvard Univ. Press, Cambridge, Mass.

HENDERSHOT, G. E. 1969. Familial satisfaction, birth order and fertility values. J. Marriage Fam. **31:** 27-33.

HUESTIS, R. R., and A. MAXWELL. 1932. Does family size run in families? J. Hered **23:** 77-79.

IMAIZUMI, Y., M. NEI, and T. FURUSHO. 1970. Variability and heritability of human fertility. Ann. Hum. Genet. **33:** 251-259.

JACQUARD, A. 1977. Concepts en génétique des populations. Masson, Paris.

------. 1983. Heritability: one word, three concepts. Biometrics **39:** 465-477.

JOHNSON, N. E., and C. S. STOKES. 1976. Family size in successive generations: the effects of birth order, intergenerational change in lifestyle and familial satisfaction. Demography **13:** 175-187.

KANTNER, J. F., and R. G. POTTER Jr. 1954. Social and psychological factors affecting fertility XXIV - the relationship of family size in two successive generations. Milbank Mem. Fund Quart. Bull. **32:** 294-311.

KINCADE OPPENHEIMER, V. 1994. Women's rising employment and the future of the family in industrial societies. Pop. Development Rev. **20:** 293-342.

KOHLER, H. P., and K. CHRISTENSEN. 1999 (forthcoming). Genetic influences on fertility behavior: Findings from a Danish twin study. *In* J.L. Rodgers (ed.), Genetics of fertility, sexuality, and related processes.

LANGFORD, C. M., and C. WILSON. 1985. Is there a connection between a woman's fecundity and that of her mother? J. Biosoc. Sci. **17:** 437-443.

LESTHAEGHE, R., and D. MEEKERS. 1986. Value changes and the dimensions of familism in the European Community. European J. Pop. **2:** 225-268.

LEVINE, D. 1982. For their own reasons: individual marriage decisions and family life. J. Fam. History **7:** 255-264.

MCALLISTER, P., C. S. STOKES, and M. KNAPP. 1974. Size of family of orientation, birth order, and fertility values: a re-examination. J. Marriage Fam. **36:** 337-342.

MCGUE, M., T. J. J. BOUCHARD, W. G. IACONO, and D. T. LYKKEN. 1993. Behavioral genetics of cognative ability: a life-span perspective, p. 59-76. *In* R. Plomin, and G. E. McClearn (eds.), Nature, nurture and psychology. American Psychological Association, Washington, D. C.

MCGUE, M., and D. T. LYKKEN. 1992. Genetic influence on risk of divorce. Psychol. Sci. **3:** 368-373.

MOBERG, S. 1950. Marital status and family size among matriculated persons in Sweden. Pop. Stud. **4:** 115-127.

MURPHY, M. 1987. Differential family formation in Great Britain. J. Biosoc. Sci. **19:** 463-485.

-------. and D. WANG. 1998. Family-level continuities in childbearing in low-fertility societies. Paper presented at the Lowest Low Fertility Workshop, Max Planck Institute for Demographic Research, Rostock, Germany, 10-11 December 1998.

NEEL, J. V., and W. J. SCHULL. 1972. Differential fertility and human evolution. Evolutionary Biol. **6:** 363-379.

PEARL, R. 1939. The natural history of population. Oxford Univ. Press, Oxford.

PEARSON, K., A. LEE, and L. BRAMLEY-MOORE. 1899. Mathematical contributions to the theory of evolution. VI - genetic (reproductive) selection: inheritance of fertility in man, and of fecundity in thoroughbred racehorses. Philosophical Trans. Roy. Soc. London **A192:** 257-330.

POTTS, M. 1997. Sex and the birth rate: human biology, demographic change, and access to fertility-regulation methods. Pop. Development Rev. **23:** 1-39.

PULLUM, T. W., and D. A. WOLF. 1991. Correlations between frequencies of kin. Demography **28:** 391-409.

SCHACHTER, S. 1964. Birth order and sociometric choice. J. Abnormal Soc. Psychol. **68:** 453-456.

SULLOWAY, F. 1996. Born to Rebel. Little Brown and Co., London.

WESTOFF, C. F., R. G. POTTER Jr., and P. C. SAGI. 1963. The third child: a study in the prediction of fertility. Princeton Univ. Press, Princeton, N. J.

------. R. G. POTTER Jr., P. C. SAGI, and E. G. MISHLER. 1961. Family growth in metropolitan America. Princeton Univ. Press, Princeton, N. J.

------. and R. H. POTVIN. 1967. College women and fertility values. Princeton Univ. Press, Princeton, N. J..

WILLIAMS, L. A., and B. J. WILLIAMS. 1974. A re-examination of the heritability of fertility in the British peerage. Soc. Biol. **21:** 225-231.

WISE, J. M., and S. J. CONDIE. 1975. Intergenerational fertility throughout four generations. Soc. Biol. **22:** 144-150.

Notes

[1] This paper comprises three parts with different authors. The first part, pages 258 to 278, by Pearson is a theoretical discussion of the measurement of heritable factors; the second by Pearson and Lee, pages 279 to 290 and 316 to 323, is concerned with the heritability of human fertility; and the third by Pearson with the assistance of Bramley-Moore, pages 290 to 315 and 324 to 330, deals with inherited fecundability by thoroughbred mares. The biological emphasis is therefore apparent.

[2] Values were calculated for 'weighted' and 'unweighted' cases, in the former case with a family containing n children, each mother will be included n times, as compared to the latter case where each mother appears only once. Studies which use random samples of parents as the unit of analysis (i.e. collect information about number of own sibs and of children) use the latter approach, whereas designs such as record linkage that collect information on all children in families (i.e. collect information about number of parent's sibs and own sibs) may use the former approach. Some studies collect information from children on their parents' number of sibs, but this cannot provide information on those members of the older generation who remain childless. Simulation shows that the correlation coefficients for fertility of successive generations computed from these two designs are very similar in practice, although Pearson and Lee's study shows different values for unclear reasons. If the sample design involves collection of data from siblings, the non-independence of the responses would mean that the standard errors would be greater than for a random sample.

[3] These calculations are not affected by the fact that the rows and columns of these tables should be reversed, see the correction in Demography 25(3) p. 475.

[4] There appears to be an error in Table 1, the figures for mothers and daughters in city families seem to have been transposed. This has the effect of considerably reducing population heterogeneity.

[5] These were calculated from Bresard 1950 Table XXVI p. 557. I assumed that the average family size of 4 or 5 child families was 4.5, and 6.5 for 6 or more child families. The results are insensitive to the exact choice.

[6] Unfortunately, he failed to consider the proportion of those who do not marry and the implications of this. Given the considerable attention to the possible assumed harmful effects of differential fertility in the eugenics and policy debates of the early part of the 20th Century which was substantially distorted by failure to consider the effect of differential non-reproduction, it is interesting to speculate how far this might never have become such an issue if Pearson had emphasised the importance of looking at those who do not marry, rather than appearing to dismiss it in a simple footnote stating he found no relationship between family size and propensity to marry.

[7] The simple linear regression coefficient is given by $r\hat{\sigma}_y/\hat{\sigma}_x$. In practice, the standard deviation is similar to the corresponding mean, so a reasonable approximation is to use the ratio of numbers of sibs and children. For the 27-47 year-old CPS sample, the value computed from Table 2 is 1.61, so the regression coefficient is 0.099 in that case.

[8] The model does not allow for the fact that the number of children will also affect the child's standard of living. Easterlin assumes that it is the children's experience, not their parents', which is relevant.

[9] As with most fertility studies, the proximate determinants framework is a natural one to adopt. To do so might clarify many of the issues raised in the literature discussed here.

Table 1 Correlation Coefficients between Number of Children and Numbers of Parents' Sibs, GB 1976

	Age of Woman		
	35-39	40-44	45-49
Wife's No. sibs	0.119	0.139	0.134
	(868)	(837)	(828)
Partner's No. sibs	0.145	0.154	0.135
	(868)	(837)	(828)
Average of wife's & partner's No. sibs	0.175	0.190	0.174
	(868)	(837)	(828)
Wife & partner same No. sibs	0.193	0.274	0.126
	(141)	(142)	(142)
Average of wife's & partner's No. sibs if different	0.172	0.175	0.181
	(727)	(695)	(686)
Woman's No. sibs	0.130	0.131	0.143
	(906)	(891)	(875)

Note: Sample sizes in brackets.

Source: 1976 Family Formation Survey.

Table 2 Correlations between Number of Siblings and Children, by Age of Parent; NSFH, 1987-8

Age-group	NSFH	
	r	N
35-44	0.229	2,731
45-54	0.177	1,528
55-64	0.154	1,356
65-74	0.143	1,200
75+	0.104	797

Source: National Survey of Families and Households

Table 3 Summary of Studies Shown in Figure 4

| Study	Author(s)	r	Sample size	Approx. birth year of younger generation
LW	Langford and Wilson	0.0206	10,931	1730
WW	Williams and Williams	0.0590	1,003	1840
And1	Anderton *et al.* cohorts 1830-39	0.0580	837	1905
HM	Huestis and Maxwell	0.1240	638	1912
Bre	Bresard	0.2650	1,035	1915
Ber	Berent	0.1870	1,377	1928
Dun1	Duncan *et al.* cohorts 1901-15	0.1000	4,000	1930
And2	Anderton *et al.* cohorts 1860-69	0.1180	3,445	1933
MW1	Murphy and Wang NSFH ages 75+	0.1040	797	1935
KP	Kantner & Potter	0.1100	1,444	1936
PW1	Pullum and Wolf Canada ages 70-74	0.1874	507	1941
MW2	Murphy and Wang NSFH ages 65-74	0.1430	1,200	1945
PW2	Pullum and Wolf Canada ages 65-69	0.2407	401	1946
Dun2	Duncan *et al.* cohorts 1916-38	0.1000	11,000	1948
PW3	Pullum and Wolf Canada ages 60-64	0.3266	311	1950
BP	Ben-Porath	0.1770	973	1951
DN	Danziger and Neuman	0.2860	708	1952
M1	Murphy FFS ages 45-49	0.1740	828	1953
MW3	Murphy and Wang NSFH ages 55-64	0.1540	1,356	1955
PW4	Pullum and Wolf Canada ages 55-59	0.3138	315	1956
M2	Murphy FFS ages 40-44	0.1900	837	1958
PW6	Pullum and Wolf Germany cohorts 1929-31	0.1552	709	1960
MW4	Murphy and Wang NSFH ages 45-54	0.1770	1,528	1965
M3	Murphy FFS ages 35-39	0.1750	868	1968
PW7	Pullum and Wolf Germany cohorts 1939-41	0.2127	727	1970
MW5	Murphy and Wang NSFH ages 35-44	0.2290	2,731	1975
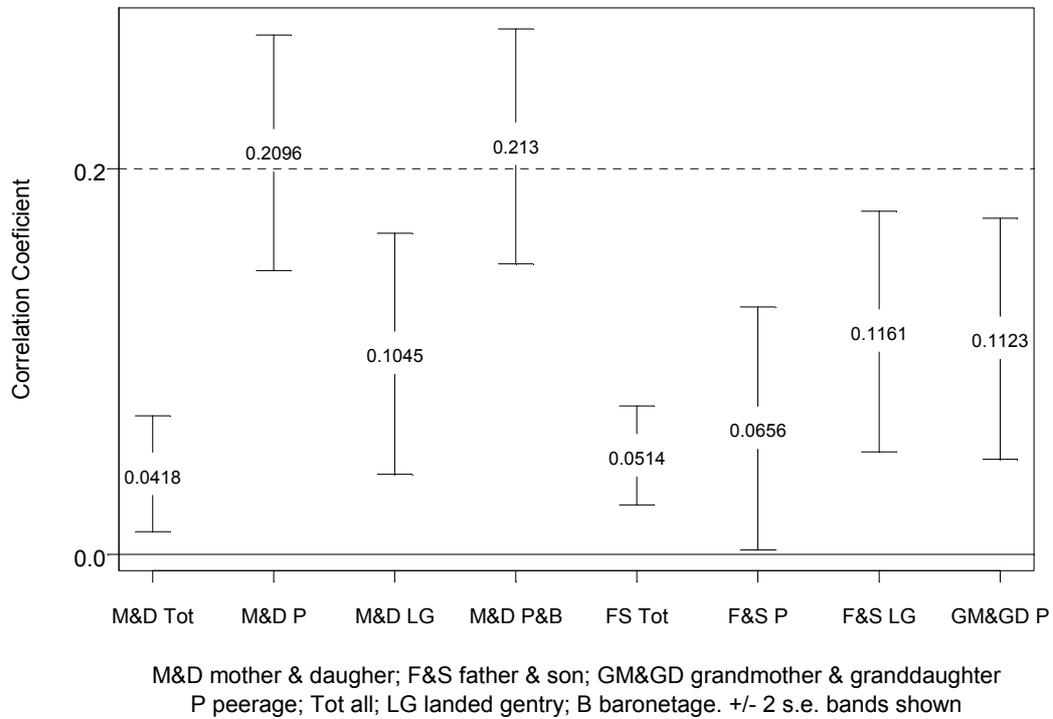
Figure 1 Intergenerational Fertility Correlation Coefficients from Pearson and Lee (1899)
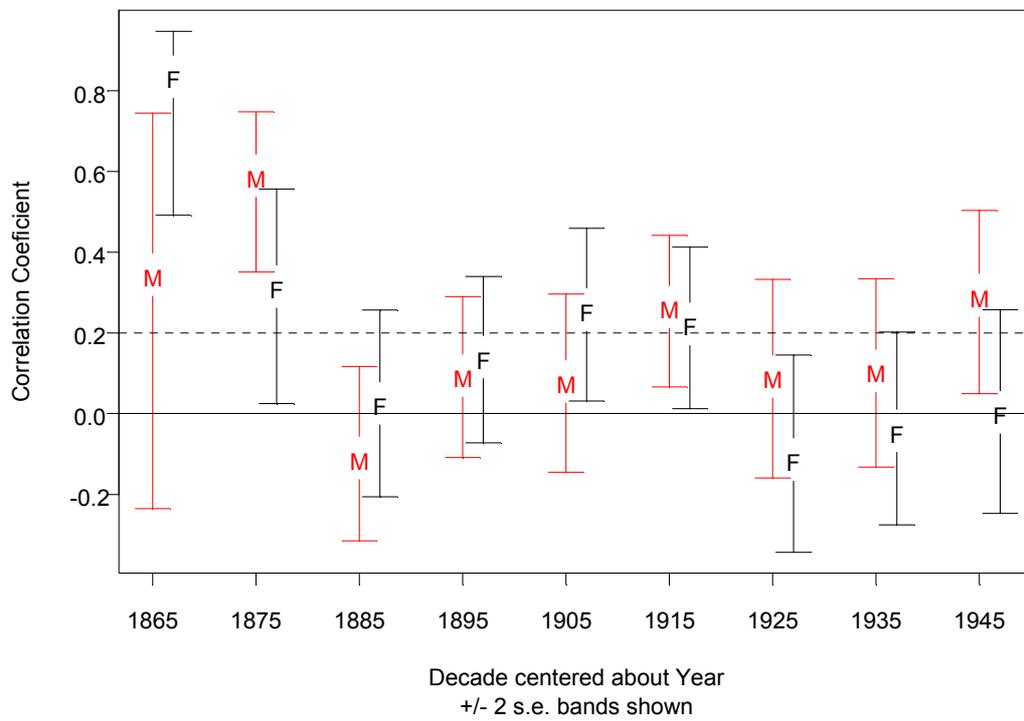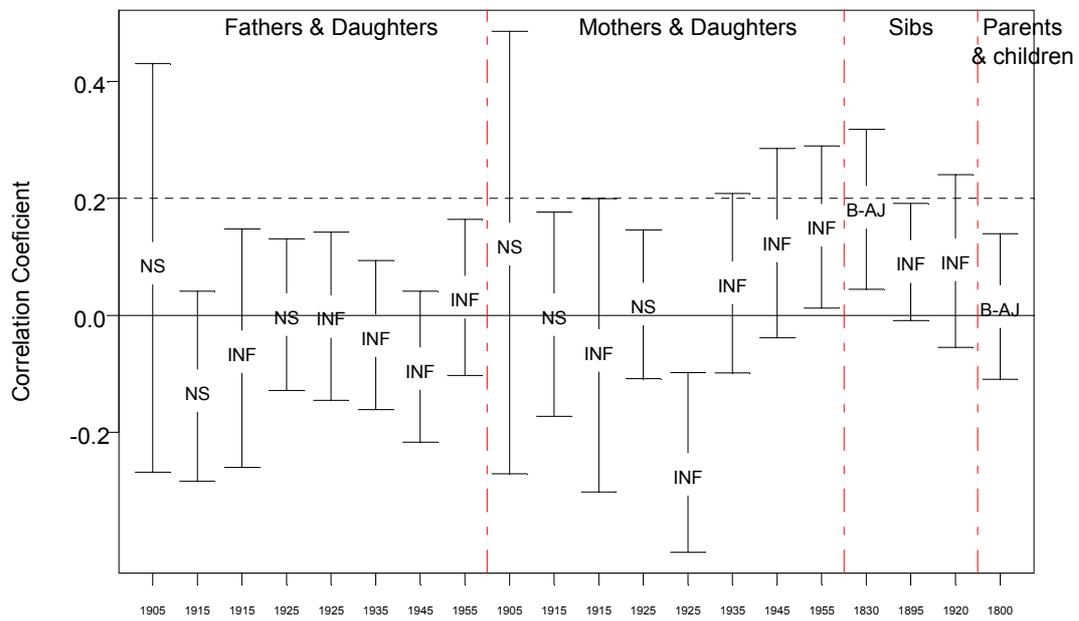
5

Figure 2 Intergenerational Fertility Correlation Coefficients by Sex and Decade, Wise and Condie (1975)

Approx date of Second Generation Childbearing (non-uniform scale)
IMF Imaizumi et al, NS Neel & Schull, B-AJ Bocquet-Appel & Jakobi; +/- 2 s.e. bands shown

Figure 3 Intergenerational Fertility Correlation Coefficients from Imaizumi *et al*. (1970), Neel and Schull (1972), and Bocquet-Appel & Jakobi (1993) by Date and Type
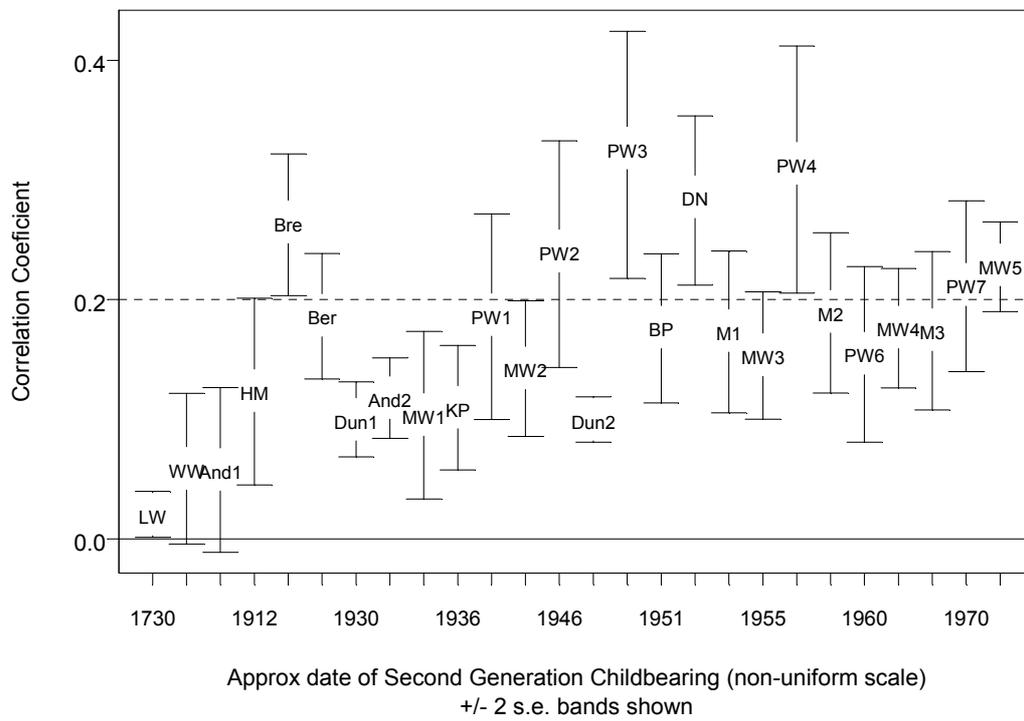
Figure 4 Summary of Intergenerational Fertility Correlation Coefficients, Alternative Studies