Female-biased reproductive strategies in a Hungarian Gypsy population

TAMAS BERECZKEI[1] AND R. I. M. DUNBAR[2]

[1] *Institute of Behavioural Sciences, Medical University of Pecs, Szigeti u. 12, H-7624 Pécs, Hungary*
[2] *Department of Psychology, University of Liverpool, P.O. Box 147, Liverpool L69 3BX, England, UK*

SUMMARY

Hungarian Gypsy populations invest more heavily in daughters than in sons compared to co-resident Hungarians, in conformity with the predictions of the Trivers–Willard hypothesis. These effects are shown for four different measures of parental investment (sex ratio at birth, frequency of abortion, duration of breast-feeding and length of education). Opportunities for hypergamy into the wealthier Hungarian population appears to be one factor causing Gypsies to prefer daughters over sons. We show that differential investment by sex of offspring is directly related to the fitness pay-offs that accrue for each population through both sexes of offspring.

1. INTRODUCTION

Evolutionary theory predicts that whenever offspring are likely to differ in their ability to reproduce, parents will adjust their investment in individual offspring in such a way as to maximize their own fitness. This can be expected to result in parents showing marked preferences for one particular sex of offspring if that sex is likely to achieve a disproportionately higher reproductive success than the other (Trivers & Willard 1973).

Previous studies have demonstrated significant sex biases in the postnatal survival of infants that are in line with the predictions generated by the Trivers & Willard (1973) hypothesis (e.g. nineteenth century Mormons, Mealey & Mackey 1990; eighteenth century German peasants, Voland *et al.* 1997); nonetheless, the evidence for a Trivers–Willard effect remains largely circumstantial (Sieff 1990). Although there is considerable evidence for sex biases in the way parents treat their children (with the bias being by no means universally in favour of males: reviews in Voland 1989; Sieff 1990; and Pedersen 1991), only three studies have been able to use these data to demonstrate a Trivers–Willard effect (e.g. in thirteenth century Portuguese nobility (Boone 1989), a modern U.S. sample (Gaulin & Robbins 1990) and contemporary Mukogodo hunter-gatherers (Cronk 1991)). However, none of these studies have been able to show that these biases are in direct accord with fitness pay-offs. Most have settled for demonstrating either the effect (e.g. Boone 1989; Gaulin & Robbins 1990) or its consequences (e.g. Cronk 1991), but not both together.

A large-scale demographical study of Hungarian Gypsies found a distinct female surplus at birth which appears to have been constant throughout the last century. In accordance with the Trivers–Willard hypothesis, it was suggested that Gypsies prefer daughters because they have a greater chance of marrying up the socio-economic scale, and thus having more surviving children compared to sons (Bereczkei 1993).

Some evidence to support the hypothesis is provided by the fact that Gypsy women are more likely than Gypsy men to engage in exogamous marriages (marrying a Hungarian is regarded as a way of marrying up). Although only 2.8% of rural Gypsy women married Hungarian men, 26.7% of women in the urban Gypsy population did so. One reason why these exogamous marriages might be beneficial is that the survival chances of the children from such marriages are better than those of children born to endogamously married Gypsy couples. Horvath (1973) found that the mortality rates during the first year of life for Gypsy children is three times that for Hungarian children. Gypsy women marrying Hungarian men have infants with higher birth weights, lower mortality rates and a lower incidence of developmental anomalies than those Gypsy women that marry endogamously (Bereczkei 1993).

However, the original demographic database did not allow a more detailed analysis to be undertaken, so that it was not possible to answer questions about reproductive outputs or proximate causation. We would like to know, for example, whether sons and daughters are treated unequally by parents during childhood and whether there is any difference in reproductive success between sons and daughters. If differences in reproductive output exist, what makes one sex reproductively more valuable than the other?

Here we report an attempt to answer some of these questions more directly using a detailed field study of parental investment patterns in two native Hungarian and two sympatric Gypsy populations. Because Gypsies

are of generally lower socio-economic status than Hungarians (and male Gypsies cannot therefore contribute as heavily in economic terms to parental investment as their Hungarian counterparts), we expect Gypsies in general to exhibit a preference for investing in daughters while the Hungarians invest disproportionately in their sons. Moreover, with the opportunities for hypergygny provided by living in close social proximity to Hungarians, we predict that urban Gypsy populations will invest more heavily in their daughters than their sons compared to rural Gypsy populations (among whom endogamy is the rule), and that urban Hungarian populations will show the reverse trend compared to rural Hungarian populations.

2. METHODS

The study involved four small communities:

(*a*) *Rural populations*

A 'Gypsy' village named Gilvanfa, inhabited by 124 adult Gypsies (56 males and 68 females; mean age = 39.1). (Note that the Hungarian Gypsy populations were forced by imperial edict to settle in villages and towns more than a century ago, and many of the older settlements remain predominantly or exclusively Gypsy in composition: for more details on the background of the Gypsies, see Bereczkei 1993.) A village named Magyarmecske, inhabited mostly by Hungarians, provided the rural native Hungarian sample. This sample consisted of 102 adults (44 males and 58 females; mean age = 48.5). This village was located just 5 km from Gilvanfa and belongs to the same administrative district.

(*b*) *Urban populations*

A relatively poor district of Pécs named Meszes inhabited by both ethnic groups provided samples for urban Gypsies and Hungarians. Individuals for the Gypsy sample were selected by random number from the lists maintained by the local social and health workers. The Hungarian sample was drawn from the same district, mainly by knocking on doors in the same blocks of flats. The urban samples consisted of 77 adult Gypsies (32 males and 45 females; mean age = 37.4), and 115 adult Hungarians (42 males and 73 females; mean age = 42.7).

All 428 individuals were interviewed. In accordance with previous studies, there were significant differences between the populations in unemployment levels, education and personal income (table 1). The differences between the Gypsies and Hungarians were quite substantial, despite the fact that most of the Hungarians living in these relatively poor areas have been as much the victims of the recent economic changes as the Gypsies. Compared with the Hungarians, the Gypsies live in a highly unpredictable environment with a relatively low resource availability.

Table 1. *Comparison of educational and economic backgrounds of study populations*

	rural populations		urban populations	
	Gypsy	Hungarian	Gypsy	Hungarian
post-primary education (%)	16.5	46.0	12.2	58.8
unemployed (%)	65.3	18.4	53.9	15.6
mean monthly income (Ft)	6346	11274	7884	14794

3. RESULTS

(*a*) *Sex ratio at birth*

In almost every contemporary human population, the sex ratio at birth shows a male surplus. Our Hungarian samples follow this trend, but the sex ratio is consistently reversed among the Gypsies: more daughters than sons were born in both Gypsy populations (table 2). The differences between the populations are significant ($\chi^2 = 27.421$, $p = 0.026$). As predicted, the Gypsy populations have more female-biased sex ratios than the wealthier Hungarian populations: within ethnic groups, the poorer rural populations had more female-biased sex ratios than the urban populations (though the differences in this last respect are marginal, if consistent).

This effect was even more clear-cut for first-born children, but the smaller samples mean that the differences are not statistically significant. However, pooling samples within ethnic groups yields a significant difference in the sex ratio of first-born offspring between Hungarians (142.9 sons/100 daughters) and Gypsies (86.7 sons/100 daughters) ($\chi^2 = 5.211$, d.f. = 1, $p = 0.023$).

(*b*) *Rates of abortion*

If one sex is reproductively more valuable, it is expected that mothers will try to manage their birth history in order to increase the number of children of this sex. They should be more willing to abort pregnancies after giving birth to a child of the desired sex than after having a child of the less valuable sex. Aborting the pregnancy results in a longer delay to the arrival of the next offspring, and thus enables a parent to invest more heavily in the current infant.

Table 3 suggests that Gypsy mothers were more likely to abort after having had one or more daughters, while Hungarians are more likely to abort pregnancies when they have had sons. Two-factor analysis of variance (ANOVA) yields a nearly significant effect for ethnic group ($F_{1,338} = 3.58$, $p = 0.059$) and no

Table 2. *Sex ratios at birth for each population*

	number of sons per 100 daughters			
	rural populations		urban populations	
	Gypsy	Hungarian	Gypsy	Hungarian
A. all children				
sample size	254	216	239	224
males/100 females	89.3	111.8	89.7	113.3
B. first-born children only				
sample size	87	85	77	102
males/100 females	81.3	157.6	94.3	131.8

Table 3. *Percentage of all pregnancies aborted as a function of the sex of the previous offspring*

	percent of pregnancies aborted			
sex of previous offspring	rural populations		urban populations	
	Gypsy	Hungarian	Gypsy	Hungarian
son	12.5	14.8	18.7	27.7
daughter	28.6	7.4	37.5	14.5
total pregnancies	56	54	48	83

Table 4. *Duration of breast-feeding for first-born offspring*

	duration of breastfeeding (months)			
	rural populations		urban populations	
	Gypsy	Hungarian	Gypsy	Hungarian
sons				
mean duration	11.5	7.3	9.9	8.3
sample size	22	33	15	46
daughters				
mean duration	16.5	6.2	16.3	7.1
sample size	29	21	24	31

effect due to sex of previous offspring ($F_{1,338} = 0.89$, n.s.), but a highly significant effect for the interaction between these two variables ($F_{1,338} = 6.69$, $p = 0.01$).

One possible confounding variable in this case is that older women might be more likely to abort pregnancies once they have achieved their ideal family size. If Gypsy women reproduce for longer than Hungarian women for reasons associated with a traditional culture, then we would expect Gypsy mothers to be older than Hungarian mothers, on average. However, this turns out not to be the case. Gypsy mothers are, on average, younger than Hungarian mothers, making this an unlikely alternative explanation for the results.

(*c*) *Sex-biased postnatal investment*

We considered suckling and schooling as two important measures of parental effort. The duration of lactation was measured as a 'direct' form of investment given by the mothers. The end of breast-feeding was defined (following local medical practice) as the point at which the infant was breast-fed less than three times each day (the rest of its intake being made up of solid foods). Most mothers seemed to know exactly when they terminated breast-feeding and few were uncertain or hesitant when answering this question. The number of years of schooling completed was regarded as a measure of long-term parental investment because post-primary schooling is not compulsory in Hungary and the marginal costs of maintaining a child at school are considerable for parents on low incomes. The mean length of schooling was calculated for those children who had already finished school.

There were no significant differences between sons and daughters or ethnic groups for the length of breast-feeding for all offspring. However, there were very

Table 5. *Length of education received by children in the different populations*

	duration of education (years)			
	rural populations		urban populations	
	Gypsy	Hungarian	Gypsy	Hungarian
sons				
mean duration	8.3	10.8	8.3	10.9
sample size	33	48	44	65
daughters				
mean duration	9.1	9.7	9.5	10.0
sample size	45	36	40	47

significant effects if only first-born offspring are considered (table 4). An ANOVA reveals that there was no significant effect due to sex of offspring in the mean duration of lactation ($F_{1,232} = 1.82$, n.s.), but there was a significant effect due to ethnic group: Gypsy women suckle their offspring for longer than Hungarian women do ($F_{1,232} = 18.00$, $p < 0.001$). More importantly for our present analysis, there was a significant interaction effect ($F_{1,232} = 4.08$, $p = 0.043$): the two ethnic groups do not treat their sons and daughters in the same way. Within-population comparisons confirm that Hungarian mothers breast-fed their sons for slightly (but not significantly) longer than their daughters (rural group: $t_{52} = 0.54$, n.s.; urban group: $t_{75} = 0.71$, n.s.), whereas Gypsy mothers breast-fed their daughters for longer than their sons (rural group: $t_{49} = -1.40$, $p = 0.167$; urban group: $t_{37} = -2.06$, $p = 0.049$). The Gypsy data are significantly more biased in favour of daughters than would be expected by chance (Fisher's procedure: $\chi^2 = 12.38$, d.f. = 4, $p < 0.02$). Moreover, the one individually significant result is for the urban Gypsy population, the one population for whom hypergyny is most achievable.

As predicted, the number of years of education completed by children was higher for Gypsy girls and Hungarian boys compared to Gypsy boys and Hungarian girls, respectively (table 5). The differences between populations were significant ($F_{5,412} = 3.07$, $p < 0.01$). The differences between the length of education for sons versus daughters were significant in the case of the rural Hungarians (favouring sons: $t_{82} = 2.11$, $p = 0.038$) and the urban Gypsies (favouring daughters: $t_{82} = -2.29$, $p = 0.024$), with non-significant trends in the appropriate direction for urban Hungarians ($t_{110} = 1.61$, $p = 0.111$) and rural Gypsies ($t_{76} = -1.45$, $p = 0.152$). In most cases, the difference in length of education between the two sexes was typically more than one year (table 5).

(*d*) *Sex-biased investment and fitness*

If sex-biased investment is an adaptive strategy, we ought to be able to show that the favoured sex produces a greater fitness pay-off for the parent. Unfortunately, few of the parents in the samples were old enough for the reproductive success of their offspring to be measured. However, we can gain some

Table 6. *Fitnesses of the grandparental generation, measured as the mean number of grandchildren born to each sex of offspring*

	mean number of grandchildren			
	rural populations		urban populations	
sex of offspring	Gypsy	Hungarian	Gypsy	Hungarian
male				
mean	2.87	2.73	2.63	2.55
sample size	30	49	30	49
female				
mean	3.29	2.58	3.76	2.65
sample size	45	52	45	52

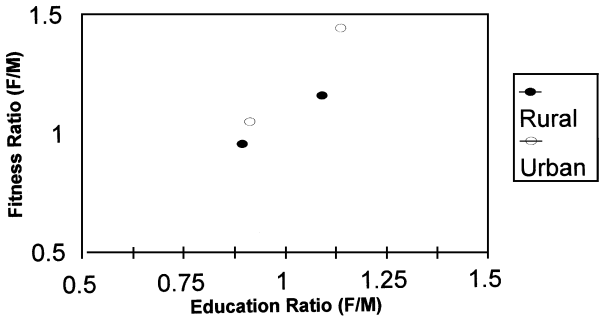

Figure 1. Ratio of fitness gained via the two sexes of offspring (measured in the grandparental generation) plotted against the ratio of investment in education for males and females (measured in the offspring generation) in the four populations.

insight into this by examining the fitness of their own parents (the grandparental generation) on the reasonable assumption, given the long-term demographic data (see Bereczkei 1993), that the current parental generation is behaving in a similar way to the previous one. The hypothesis predicts that Gypsies will have higher fitness (measured in terms of numbers of grandchildren) through their daughters, whereas the Hungarians will have higher fitness through their sons.

Table 6 shows that, in general, the Gypsies do have higher fitness via their daughters, and that the differential is particularly large for the urban Gypsies (the population that benefits most by hypergyny). In contrast, the differences for the Hungarians are marginal and inconsistent.

One caveat, of course, is the fact that our measure of male reproductive success does not take account of any covert male mating strategies. However, although we have no way of determining whether males of either ethnic group gain significant numbers of illicit fertilizations, this effect would have to be significantly larger among the Gypsies than among the Hungarians to reverse the results shown in table 6. With the social pressures against illegitimate offspring in traditional societies like those of the Gypsies, it seems intrinsically unlikely that Hungarians would have significantly lower levels of infidelity than the Gypsies. So although we recognize the perennial problem created by male infidelity, we are inclined to assume that its magnitude is unlikely to be large enough to reverse the conclusions implied by the data in table 6.

Taken at face value then, these data suggest that the Gypsies do gain higher fitness through their daughters than through their sons, and that the reverse is true for the Hungarians. Figure 1 plots the ratio of fitness pay-offs between the sexes (mean reproductive success of daughters divided by that for sons, from table 6) against the equivalent ratio for investment in education (from table 5) for the four sample populations. The data suggest that the relative investment in daughters by each population is directly scaled to the expected fitness gain they provide. Although the sample is too small for meaningful statistical analysis, the slope coefficient of the least-squares regression equation for these data:

$$\ln(\text{fitness ratio}) = 0.108 + 1.312 \ln(\text{education ratio})$$

($r^2 = 0.83$, $t_2 = 3.12$, $p = 0.089$) is close to 1, just as it should be if parents are using expected pay-off as a guide to investment pattern. The other two principal investment variables (natal sex ratio and duration of breast-feeding) yield similar distributions when ploted against fitness.

4. DISCUSSION

We have shown that Gypsy families (i) have a higher proportion of daughters than sons compared to sympatric Hungarian populations; (ii) that they invest more heavily in their daughters than Hungarian families do; and (iii) that these differentials were particularly marked in that Gypsy sub-population which was most able to benefit from opportunities for hypergyny. Investment differentials were demonstrated in respect of higher abortion rates after daughters, longer breast-feeding and longer periods of education for daughters among the Gypsies. We have also shown that these strategies appear to pay in terms of maximizing fitness: on average, Gypsies gain more grandchildren through their daughters than through their sons, and gain disproportionately more if their daughters have the opportunity to marry up into the Hungarian population. The fitness benefits of exogamous marriages for Gypsies may be further reinforced by higher offspring survival rates. These data thus provide strong evidence in support for the existence of a Trivers–Willard effect in at least one contemporary human population.

Figure 1 suggests that each group may be adjusting its investment pattern to approximate the expected pay-off differentials between local male and female reproductive opportunities. We should emphasize that we do not necessarily want to interpret this result as implying that a particular level of investment in, say, daughters will generate a particular pay-off in terms of numbers of descendants for individual parents. Rather, we interpret the causal relationships involved in a more teleonomic fashion: individuals are aware that, in their particular socio-economic environment, the fitness returns on one sex are higher than those for the other, and they therefore tend to bias their investment patterns accordingly. Since it is likely that the parental generation uses the success of the grandparental generation (modified by its own assessment of the

current situation) as a guide to how it should behave, our analysis comparing investment by the parental generation against the fitness returns to the grandparental generation may not be entirely inappropriate.

Our analyses suggest that it is the differentials created by future reproductive opportunities that drive the behavioural response (see also Kaplan *et al*. 1995; Voland & Dunbar 1995). These results, however, emphasize the fact that even though it is fitness considerations that drive the reproductive decisions of humans, this does not necessarily mean that behaviour itself is under direct genetic control. Rather, the choices that individuals make are highly contingent on circumstances (see also Waynforth & Dunbar 1995).

The limited opportunities for exogamy for rural Gypsy women mean that the value of investing in daughters should be negligible if exogamy is the only route by which parents gain higher fitness through daughters. Yet, these women invest disproportionately in daughters (though to nothing like the extent of their urban counterparts). Why should rural Gypsy women also prefer to invest more heavily in daughters? There are two possible reasons for this. One is that daughters are generally the more productive (or at least less risky) sex because sons are more likely to move away in search of work or to die during adolescence and early adulthood. Table 6 suggests that daughters are in fact more productive than sons even in the rural population, thus offering some support for this suggestion. This suggestion would still be consistent with a Trivers–Willard effect, but would imply that the effect is exacerbated in the urban populations by the availability of hypergyny in addition to the more conventional mechanisms.

The second possibility is that daughters provide a valuable service as 'helpers-at-the-nest' (Turke 1989). This second suggestion would provide an alternative explanation to a direct Trivers–Willard effect. Extended kinship relations and family bonds play a particularly important role in traditional Gypsy society and continue to do so even among the more urbanized populations. Mothers normally expect their older girls to assist with childcare and encourage them to do housework from a relatively young age.

Bereczkei (unpublished data) found that Gypsy girls (especially those living in rural villages) are more likely than Gypsy boys or Hungarian girls to help their parents in taking care of children. This study revealed that in the Gypsy households where at least one older girl and one other younger child cohabited, 72.3% of the girls regularly participated in childcare-related household duties, compared to the 28.9% of Hungarian girls living in a neighbouring village. They engaged in various kinds of tasks such as nursing babies, playing with children, cooking, etc. Many of these activities continue even after the girls are married. This same study found that 61.3% of Gypsy girls stay at home for more than 1 year after marriage (or cohabitation), compared to only 23.4% of Hungarian girls.

Gypsy parents reported that they habitually expect their girls to help them around the house, especially in bringing children up. Having a first-born daughter may increase the mother's reproductive success significantly because she can transfer the resulting spare time and energy to producing and raising additional children (see also Turke 1989). The female surplus at birth and the female-biased childcare observed in the rural Gypsy population might therefore be designed to increase the number of the parents' children rather than being designed to implement a Trivers–Willard effect.

Even if this interpretation is correct, the urban population at least can be seen to be playing a game that is strongly influenced by a Trivers–Willard effect as a result of the local advantages offered by hypergyny. This would then imply that the Gypsy populations may be fine-tuning their reproductive strategies in response to a number of considerations (a not too surprising conclusion, perhaps).

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