ELSEVIER

Evolution and Human Behavior 29 (2008) 416–423.e1

Evolution and Human Behavior

Why do some dads get more involved than others? Evidence from a large British cohort

Daniel Nettle*

Centre for Behaviour and Evolution, Newcastle University, NE2 4HH Newcastle, UK

Initial receipt 31 March 2008; final revision received 8 June 2008

Abstract

Previous studies in developed-world populations have found that fathers become more involved with their sons than with their daughters and become more involved with their children if they are of high socioeconomic status (SES) than if they are of low SES. This paper addresses the idea proposed by Kaplan et al. that this pattern arises because high-SES fathers and fathers of sons can make more difference to offspring outcomes. Using a large longitudinal British dataset, I show that paternal involvement in childhood has positive associations with offspring IQ at age 11, and offspring social mobility by age 42, though not with numbers of grandchildren. For IQ, there is an interaction between father's SES and his level of involvement, with high-SES fathers making more difference to the child's IQ by their investment than low-SES fathers do. The effects of paternal investment on the IQ and social mobility of sons and daughters were the same. Results are discussed with regard to the evolved psychology and social patterning of paternal behaviour in humans.

Keywords: Fathers; Sons; Daughters; Socioeconomic status

1. Introduction

Human males are facultative investors in their offspring (Geary, 2000). This means that, unlike the situation in many bird species, the offspring can survive with no paternal contribution as long as there is maternal care (Sear & Mace, 2008). On the other hand, for humans, as has recently been shown for baboons (Charpentier, Van Horn, Altmann, & Alberts, 2008), paternal investment may improve developmental outcomes.

A large number of studies have investigated associations between paternal involvement or presence and offspring outcomes (Amato, 1994; Amato & Rivera, 1999; Flouri & Buchanan, 2004; Harris, Furstenberg, & Marmer, 1998; Kaplan, Lancaster, & Anderson, 1998; Yogman, Kindlon, & Earls, 1995). In their review, Amato and Rivera (1999) identified 68 studies of this type published since 1980. These studies measure a range of outcomes, including cognitive ability and academic achievement, conduct problems, psychological adjustment, and social competence, and the majority report significant positive associations of the outcomes with paternal involvement. However, there are problems of interpretation attached to such results (Amato & Rivera 1999). First, the same informant often reports on both paternal involvement and the outcome variable, meaning spurious associations can be produced by informant response style. Second, households with high paternal involvement may differ in other ways from households without, and so correlation does not guarantee causal significance. In particular, in households with high paternal involvement, SES is often different, family size may be lower, and maternal involvement may be higher. Third, if there is a causal pathway, it could be in the opposite direction, with fathers becoming more involved with offspring who are high achieving or socially skilled.

Some studies have overcome the first and second of these problems, by using independent reports for the paternal involvement and outcome variables, and by controlling adequately for other family variables, and still

* Centre for Behaviour and Evolution, Institute of Neuroscience, Newcastle University, Henry Wellcome Building, Framlington Place, Newcastle, NE2 4HH, UK. Tel.: +44 191 222 8993; fax: +44 191 222 5622.
E-mail address: daniel.nettle@ncl.ac.uk.

1090-5138/$ – see front matter © 2008 Elsevier Inc. All rights reserved.
doi:10.1016/j.evolhumbehav.2008.06.002

found significant results (Amato, 1994; Flouri & Buchanan, 2004). The third problem may be more intractable. Nonetheless, the overall implication of this large literature is that, at the very least, paternal involvement is associated with improved offspring outcomes, and quite possibly, the association is causal.

Given the above conclusion, basic evolutionary reasoning predicts that men should have evolved the behavioural flexibility to continue postbirth investment in their children up to the point where the benefit produced by an extra unit of investment does not exceed the cost. Thus, if some men are investing more than others in their children, then the explanation may be that the balance of benefits and costs differs from man to man.

In contemporary developed populations, several studies have found that fathers invest time more in sons than in daughters (Cabrera, Tamis-LeMonda, Bradley, Hofferth, & Lamb, 2000; Harris et al., 1998; Lawson & Mace, submitted for publication), and investment is related to socioeconomic status (SES), with high-SES men investing more than low-SES men (Kaplan et al., 1998; Lawson & Mace, submitted for publication). Thus, the key question is the following: why would fathers of sons and fathers from high-SES groups experience a higher benefit/cost ratio for investment than fathers of daughters and from low-SES groups?

The main cost of involvement is time, and I assume for now that time devoted to existing offspring—time which could be devoted instead to somatic or mating effort—has the same value for all men. Thus, any differences must stem from the benefits of involvement being higher for some men than for others. The benefits of involvement are determined by three variables: the return on involvement (i.e., how much difference to the child's phenotypic quality a unit of paternal involvement makes), the level of paternity confidence, and the benefit in terms of future reproductive opportunities with the child's mother that investing in the child will bring. There is good evidence that men are responsive to such variables. Cues suggesting high paternity confidence have been shown to increase men's propensity to invest in children (Anderson, Kaplan, & Lancaster, 2007; Apicella & Marlowe, 2004; Platek et al., 2004), as has the possibility of future reproduction with the child's mother (Anderson, Kaplan, & Lancaster, 1999).

However, it seems unlikely that either of these variables could explain the SES and sex-of-child patterns. For paternity certainty, for example, there is only weak evidence that it varies by SES (Anderson, Kaplan, & Lancaster, 2006), and there is no plausible reason it should vary by sex of the child. Instead, this paper focuses on the first term, the amount of difference that paternal investment makes. Kaplan et al. (1998) note that the SES gradient of paternal involvement observed in their study is consistent with the idea that high-SES men have a greater effect when they choose to invest. However, they do not directly demonstrate that this is the case. To do so requires demonstrating not just a main effect of paternal involvement on child outcomes, but also a significant interaction between paternal SES and paternal involvement.

The purpose of this study was to examine the effect of father involvement on outcomes for a large British cohort, the National Child Development Study. Positive effects of paternal involvement on offspring outcomes have been found using this cohort before (Flouri & Buchanan, 2004). These researchers showed that, controlling for other variables, mother's report of paternal involvement at age 7 weakly but highly significantly predicted offspring educational attainment at age 20. My analysis extends on Flouri and Buchanan's work in a number of ways; principally, investigating whether paternal involvement varies by sex of child and SES, which is not reported in their paper; investigating IQ as an outcome; pursuing outcomes into adulthood rather than only to age 20; and, crucially, testing for an interaction effect between SES of father and his degree of involvement, not just a main effect as is usually tested for in this literature.

I analyse the effects of paternal involvement on three offspring outcome variables. The first is general ability (GA) score, a measure of IQ at age 11. IQ has been chosen as it is a measure of general nervous system efficiency and is predictive of socially important consequences such as educational and occupational outcomes and long-term health (Gottfredson & Deary, 2004; Nettle, 2003). Although attention tends to focus on the heritable component of IQ, studies consistently find a significant environmental contribution as well (Bouchard & McGue, 2003; Sampson, Sharkey, & Raudenbush, 2008), in which parental behaviour may be significant (Johnson, McGue, & Iacono, 2007). I also extend the analysis on through the life course by measuring social mobility at offspring age 42. This measure is derived by comparing the cohort members' SES to that of their fathers. Social mobility, too, has been found to be affected by postbirth environmental factors (Bjorklund, Lindahl, & Plug, 2006). Finally, I examine the number of children that the offspring have by age 46, since by investing in offspring quality, men may be increasing their number of grandchildren.

The objectives of this study are thus (1) to establish whether in this population, as in others, paternal involvement varies by SES and sex of child; (2) to determine whether the degree of paternal involvement has an effect on cohort members' childhood IQ, social mobility in adulthood, and number of children; and (3) to test for interaction effects which would explain the pattern, such that higher-SES fathers and fathers of sons have greater impact on their offspring than low-SES fathers and fathers of daughters.

2. Methods

2.1. Study population

The National Child Development study is an ongoing longitudinal investigation of all the children born in Britain

in a single week in March 1958 (N=17,146). The comprehensive medical and sociological assessment at the time of the cohort's birth has been followed up by a succession of assessments and interviews over the years, most recently in 2004–2005 when the cohort were 46 years old. The current study uses data from 1965 (NCDS1, N=15,051), 1969 (NCDS 2, N=14,757), 1974 (NCDS 3, N=13,917), 2000 (NCDS 6, N=10,979), and 2004–2005 (NCDS 7, N=11,939), in addition to the original 1958 survey. Since only individuals with complete and valid records for all relevant variables are used in a particular analysis, sample sizes vary and, particularly where comparing variables from different years, can be substantially lower than the figures shown above. Degrees of freedom are reported for all analyses.

2.2. Measures

The main paternal involvement measure used here is a maternal response from 1969 to the question 'how involved is the father in the management of the child?' (henceforth, father role 11). The responses available were (1) 'inapplicable' (n=782), (2) 'leaves it to mother' (n=1329), (3) 'significant role but less than mother' (n=3073), and (4) 'equal to mother' (n=8552). Paternal investment is a multidimensional construct (Cabrera et al., 2000), and some previous researchers have combined responses to several questions into an index (Flouri & Buchanan, 2004). However, doing this involves treating responses which are in fact categorical as continuous scales, which may not be justified. It is not clear, for example, that the difference between the 'inapplicable' response and the 'leaves it to mother' response is quantitatively equivalent to the difference between a 'significant' role and one 'equal to mother'. Thus, the single overall involvement item is used here and, except for display purposes in Fig. 1, not treated as a continuum.

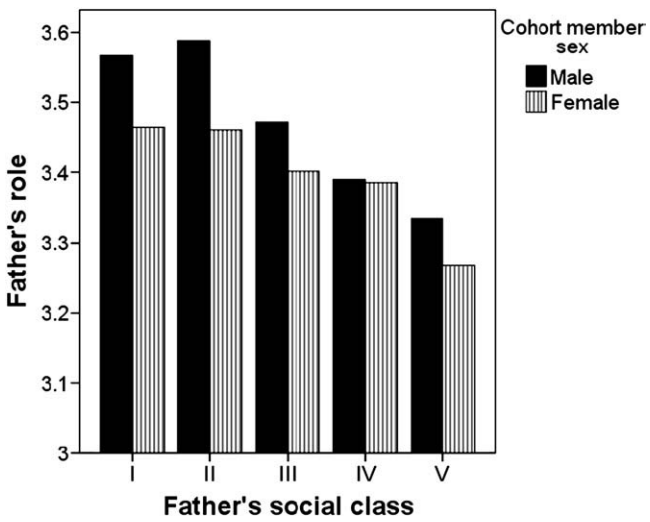

Fig. 1. Mean level of father role 11, broken down by father's social class and cohort member sex.

However, a number of other measures of paternal involvement are available in the NCDS data. The same item on involvement of father in management of the child was also administered in 1965 at cohort age 7 (father role 7). In addition, the 1965 survey asked how often the father read to the child (reading), and how often he took outings with the child (outings), with responses chosen from a similar four-category set. Though the main analyses of this paper all use father role 11, I also report, as a check on the robustness of the measure, the associations of father role 11 with these other variables from age 7.

Cross-checking elsewhere in the data shows that in the majority of cases (86.1%) where 'inapplicable' was chosen, the father was not living in the household. Thus I retain the 'inapplicable' cases, assuming them to indicate no paternal involvement at all. Results are unaffected by deleting them instead. Note that father role 11 is not entirely reducible to co-residence, since many resident fathers were classified as 3 (n=1256), and many nonresident ones were classified as 1 or 2 (n=265).

A limitation of paternal effect research is that high-investing men may be married to high-investing women, and so the effects detected may reflect maternal rather than paternal inputs (see Introduction). Father role 11 partly mitigates this problem in that the item assesses paternal involvement relative to the amount that the mother does.

SES is assessed using a system of five occupational classes common in British national statistics (I Professional, II Managerial and technical, III Skilled, IV Partly skilled, V Unskilled; Supplementary information, Table S1). Though these classifications are ultimately based on the social prestige of the person's occupation, they effectively stratify society by educational achievement, job control, health outcomes, and, more weakly, income. Social class is treated as categorical rather than as a scale. Social mobility was assessed by comparing the cohort member's social class in 2000 with that of his or her father in 1958 and by calculating the number of steps moved up or down the hierarchy. This yields a continuous variable with a range of −3 to +4. The mean is nonzero (mean 0.33, S.D. 1.11) because of changes in the occupational structure of the economy over time. Note that this is a more meaningful measure for the male than for the female cohort members, since women are compared to their fathers rather than to their mothers. There is no alternative to this since most of the 1958 mothers did not work outside the home and maternal occupation was not recorded.

The IQ measure is a GA score from 1969 (mean 42.94, S.D. 16.15), which is detailed elsewhere, and whose correlations with educational and occupational attainment suggest high validity (Nettle, 2003). Number of children by 2004 (mean 1.92, S.D. 1.30) was assessed by summing responses relating to new children from several different response years.

2.3. Analysis

Analysis is by general linear model (GLM) where the dependent variable is continuous (e.g., GA score), and multinomial logistic regression where it is categorical (e.g., father role 11). The number of brothers and sisters that the cohort member has (co-resident in 1974) is included as covariates where appropriate, since these may vary by SES and also have effects on paternal behaviour and child outcomes (Downey, 1995; Lawson & Mace, submitted for publication; Steelman, Powell, Werum, & Carter, 2002), thus introducing a potential source of confound. The brothers and sisters variables are truncated so the few cases with numbers larger than 3 are scored as 3 (Supplementary information, Table S1).

3. Results

3.1. Associations between paternal involvement measures

The associations between the four paternal involvement measures are all significant and substantial in magnitude (Table 1). Given that father role 11 was taken 4 years after the other three, this suggests some temporal consistency in father behaviour. The strong relationships between the overall father role items and the more specific items on reading and outings suggest that the women's responses to the father role items are strongly driven by how much time the man habitually spent doing things with the child.

3.2. Patterns of paternal involvement

The distribution of father role 11 across the five social classes is shown in Supplementary information, Table S2. The proportion playing a role 'equal to mother' declines from 65% in Class I to 59% in Class V, whilst the proportion who 'leave it to mother' increases from 4% in Class I to 14% in Class V. To investigate this further, a multinomial logistic regression was performed, with father role 11 as the dependent variable, cohort member sex and father's social class as factors, and number of brothers and sisters as covariates. The overall model is significant (χ^2=158.33, df=21, p<.01), with the likelihood ratios for all four independent variables significant (p<.01).

Examination of the odds ratios (Supplementary information, Table S3) revealed that the cohort member being a girl made it more likely that the father would be in one of the lower-investing categories (e.g., OR for a girl rather than for a boy for 'leaves it to mother' compared to 'equal to mother'=1.43, for 'inapplicable' compared to 'equal to mother'=1.58). Greater numbers of brothers and sisters were associated with lower paternal involvement (e.g., for each additional brother, the odds ratio for 'leaves to mother' vs. 'equal to mother'=1.25, and for each additional sister=1.22).

Table 1
Measures of association (contingency coefficients) between four measures of paternal involvement

	Father role 7	Reading	Outings
Father role 11	0.53*	0.44*	0.48*
Outings	0.69*	0.69*	
Reading	0.66*		

* p<.01.

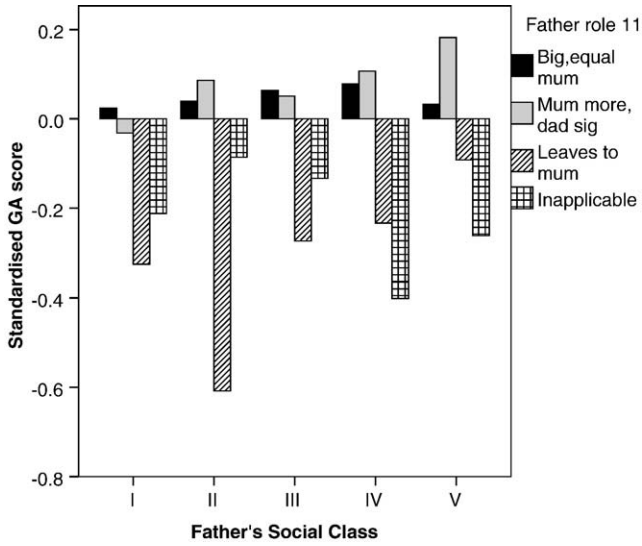

Fig. 2. GA Score at 11 (standardised for father's social class) broken down by amount of paternal involvement received.

The odds of being in a low-investing category are sharply increased for low-class compared to high-class fathers (e.g., OR for father in Class V compared to Class I for 'leaves it to mother' vs. 'equal to mother'=3.57, for 'inapplicable' vs. 'equal to mother'=1.99). The sex by social class interaction was not significant. Thus, fathers invested more the higher their social class, the smaller the number of other children, and more when the cohort member was a boy than a girl. Fig. 1 shows the social class and sex effects graphically, treating father role 11 as a continuous scale for this purpose.

3.3. Effects of paternal involvement on IQ at age 11

In a full-factorial GLM with GA score at age 11 as the independent variable; cohort member sex, father's social class, and father role 11 as independent variables; and numbers of brothers and sisters as covariates, there were significant effects of father's social class ($F_{4,8433}$=45.73, p<.01), sex of cohort member ($F_{1,8433}$=8.30, p<.01; girls scoring higher than boys), number of brothers ($F_{1,8433}$=173.65, p<.01, more brothers associated with lower scores, B=−2.13), and number of sisters ($F_{1,8433}$=123.80, p<.01, more sisters associated with lower scores, B=−1.85). These were expected findings given the social stratification of IQ scores, girls' greater maturity at age 11, and the known relationships between IQ and family size. There was also a significant main effect of father role 11 ($F_{3,8433}$=15.12, p<.01), and a significant interaction between father role 11 and father's social class ($F_{12,8433}$=2.98, p<.01).

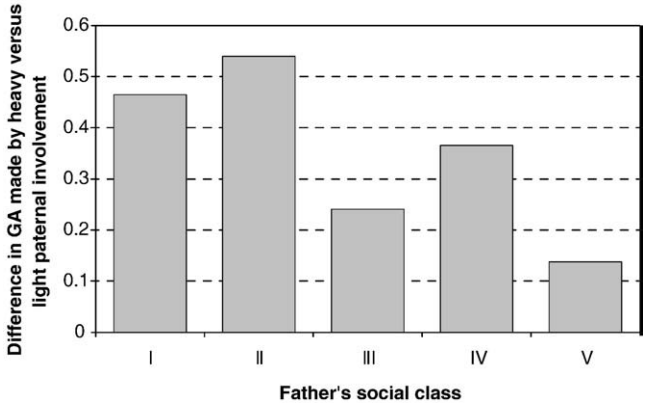

Fig. 3. The difference in mean GA score (sex and brothers and sisters having been controlled for) between cohort members whose fathers were heavily vs. lightly involved, by father's social class. The units are for-class standard deviations of GA score.

No other interactions were significant. Full model results are shown in Supplementary information, Table S4.

Fig. 2 compares the standardised GA scores for cohort members within each social class of origin, broken down by father role 11. Within every class, those who receive a substantial amount of father involvement have GA scores above the mean for their class, whilst those whose fathers were uninvolved had lower scores. Inspection of Fig. 2 suggests that the key difference is between father's role being 'significant' or 'equal' on the one hand, and 'leaves to mother' or 'inapplicable' on the other. This dichotomy is confirmed by statistical comparisons within the GLM, which reveal that father's role 'equal to mother' differs significantly from 'leaves to mother' and 'inapplicable' ($p<.01$), but does not differ from 'significant but less than mother'. We can thus with some justification collapse the classification of fathers, in terms of effects on GA score, into two categories: heavily involved ('equal to mother' and 'significant but less than mother') and lightly involved ('leaves to mother' and 'inapplicable').

Fig. 3 illustrates the interaction between father role 11 and father's social class by showing the difference in the marginal mean of GA score (controlling for sex and numbers of brothers and sisters) made by having a father who was heavily vs. lightly involved, for children whose fathers were from each of the social classes. The units on the vertical axis of the figure are standard deviations of GA score for that class. As the figure shows, heavy paternal involvement makes a positive difference in every class, but the increments of GA score vary. The largest effects of heavy involvement (around half a standard deviation) are found in Classes I and II, professional and managerial occupations, whilst the smallest (around 0.14 standard deviations) is found in Class V, unskilled occupations. Thus, for IQ scores at age 11, paternal involvement does make a difference, and it makes more of a difference if the father is of high social class than if he is of low social class. It makes the same amount of difference to boys as to girls.

3.4. Effects of paternal involvement on social mobility

In a full-factorial GLM with cohort member sex, father's social class, and father role 11 as independent variables; number of siblings as a covariate; and class mobility score as the outcome, there were expected significant effects of cohort member sex ($F_{1,5734}=13.47$, $p<.01$; men more upwardly mobile than women), father's social class ($F_{4,5734}=401.87$, $p<.01$; this large effect is due to class of origin determining the possible direction of class mobility), number of brothers ($F_{1,5733}=34.14$, $p<.01$; more brothers associated with less upward mobility, $B=-0.07$), and number of sisters ($F_{1,5733}=21.21$, $p<.01$; more sisters associated with less upward mobility, $B=-0.05$). In addition, there was a narrowly significant effect of father role 11 ($F_{3,5733}=2.64$, $p<.05$). The interaction between father's social class and father role 11 was not significant ($F_{12,5733}=0.87$, ns). These results are not altered by using a dichotomous classification of heavy vs. light paternal involvement instead of the four-category variable (data not shown).

Fig. 4 illustrates the effect of father role 11 on class mobility by showing the mean class mobility score standardised for father's social class, for cohort members receiving different amounts of paternal involvement. Within every class, those whose fathers left it to mother are substantially less upwardly mobile than those receiving strong paternal involvement.

Since the social mobility score is more meaningful for men than for women (see Methods), the above analysis was rerun with just the men. The effect of father's role becomes more strongly significant ($F_{3,3006}=3.84$, $p<.01$), but the

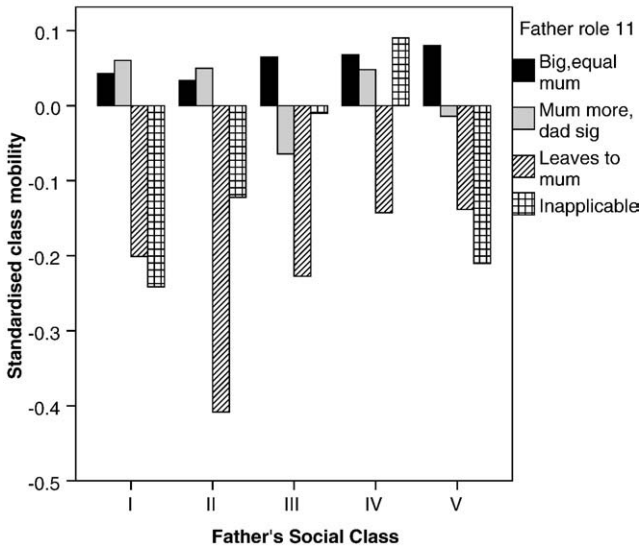

Fig. 4. Social mobility by age 42 (standardised for father's social class) broken down by amount of paternal involvement received.

father's role by father's social class interaction remains nonsignificant ($F_{12,3006}$=1.39, ns). For social mobility by age 42, then, fathers do make a difference. However, the amount of difference they make is not related to the father's social class. Both sexes benefit equally. However, since the measure is a less noisy one for men than for women, the significance of the effect is greater in the male half of the cohort.

3.5. Effects of paternal involvement on cohort member's number of children

In a full-factorial GLM with cohort member's children as the outcome measure, the only significant predictors were numbers of brothers ($F_{1,4867}$=26.05, p=.01) and sisters ($F_{1,4867}$=25.71, p=.01), with individuals with large numbers of siblings having more children (B=0.10 for both brothers and sisters). Neither cohort member sex, father's social class, nor father role 11 had significant effects (Supplementary information, Table S4). However, the variance in number of children was greater for men than for women (standard deviations: men 1.32, women 1.28; Levene's test for equality of variances $F_{1,7889}$=28.66, p<.01). Thus, there is no evidence that high-investing men are thereby increasing the number of their grandchildren in this cohort.

4. Discussion

The main father role measure used here was a single item taken on a single day in 1969, giving the mother's overall assessment of the level of involvement by the father. This is clearly a very crude index of long-term paternal involvement. However, there was a high correlation between this item and a similar measure taken 4 years earlier, and also with more specific responses to items about reading and going on outings. This suggests some temporal stability in father involvement, and that variation in the overall involvement measure is driven by variation in how much time the father spends on more specific types of investment. Flouri & Buchanan (2004) previous study using the NCDS cohort used the measures from age 7 rather than from 11, so the fact that many of our results are similar is a useful cross-check and suggests some robustness of the measures.

As several previous studies in developed societies have also found (Cabrera et al., 2000; Harris et al., 1998; Kaplan et al., 1998; Lawson & Mace, submitted for publication), paternal involvement is patterned by SES and by sex of the child, with high-SES fathers more involved than low-SES ones, and sons receiving more paternal involvement than daughters. High paternal involvement is associated with significantly increased IQ scores at age 11 in this large British cohort, even when family SES and number of other siblings are controlled for. This result is consistent with previous findings for IQ and educational attainment measures from this (Flouri & Buchanan, 2004) and other (Kaplan et al., 1998) cohorts.

The data suggest that co-residence is not sufficient for paternal benefits to appear. The children in the 'leaves to mother' families, where the fathers are generally co-resident, do at least as badly as the children in the 'inapplicable' families, where the fathers are generally absent (see Fig. 2), suggesting that father needs to be not just present but motivated to get involved. This means that simply measuring father absence from the household, which is often done in studies of human development, may not be very informative, and data on paternal behaviour will be more revealing.

This study shows for the first time an interaction effect with father's SES, with professional and managerial fathers making more difference to child IQ scores when they invest than unskilled fathers do (see Fig. 3). High-SES fathers may have more skills to enrich and improve the environment of the child's development than low-SES fathers do. As Kaplan et al. (1998) suggested might be the case, high SES fathers seem to be more efficient at embodying human capital in their children than low-SES fathers are. This gives a powerful potential explanation of why low-SES groups are characterised by low paternal effort. The returns to effort are low, and therefore men have no incentive for higher effort.

The study pursued outcomes further into adulthood than previous research has. Paternal involvement does not just have a temporary effect in early life. Instead, cohort members who had received high paternal involvement were more upwardly mobile than those receiving low involvement, and the difference was still detectable at age 42. However, the interaction effect with father's SES was no longer detectable in social mobility at age 42. Why this should be is not clear, given the strong link between childhood IQ and adult social mobility in this population (Nettle, 2003). It may be that the simple class mobility measure is too crude, or that the attenuation of complete sample size over the years (around 5700 at 42 compared to 8400 at 11) makes the interaction impossible to detect.

High-investing fathers did not have more grandchildren than low-investing fathers in this cohort. This does not necessarily mean that investment is not adaptive, since evolution favours strategies that maximise the contribution of the lineage to the population at an indefinitely far point in the future, and strategies can be adaptive even if their mean payoffs do not exceed the average for several generations (McNamara & Houston, 2006). High-investing fathers, especially from high SES backgrounds, did improve the quality and final social status of their children, and given that social status generally predicts marriage and fertility, at least for men (Fieder & Huber, 2007), it is quite plausible that they thereby reduce the risk of lineage extinction in the longer term. On the other hand, it may be that in this low-fertility, high parental investment, post demographic transition society, investment strategies that

might have had an adaptive basis in ancestral environments have become decoupled from realised (grand) offspring numbers.

The study found no evidence that investments by fathers in sons were more effective than those made in daughters. However, although the absolute improvement in social status produced by paternal investment in a son was about the same as for a daughter, male reproductive success is much more strongly linked to social status than female reproductive success is, in modern as well as traditional societies (Fieder & Huber, 2007; Hopcroft, 2006). Thus, a given increment of extra social status achieved for a son over a daughter would tend to bring a bigger increase in fitness for the investing father. Consistent with this possibility, the variance in male reproductive success is significantly larger than that in female reproductive success in this cohort.

There were clear effects of number of siblings on cohort member outcomes. Men invested less in the cohort member when there were more siblings, and more siblings were associated with lower IQ and less upward social mobility, even after controlling for SES of origin and paternal involvement. Similar effects have been documented before (Downey, 1995; Steelman et al., 2002). Such findings are clear indications that humans, like many other organisms, face a trade-off between the quality and the quantity of their offspring (Lawson & Mace, in press).

This dataset, though large and socially representative, does have limitations, which mean that caveats are in order. The crudeness and skewedness of the measure mean significant variation in paternal investment will go undetected, though this tends to militate against finding effects rather than making it likely that they will be spuriously detected. The Introduction mentioned three main methodological issues which studies of this type tend to face: reliance on the same informant for the independent and outcome variables, associations of paternal involvement with other family characteristics, and reverse causality from offspring characteristics to paternal behaviour. This study is not prone to the first problem, as paternal involvement was assessed from mothers' reports, whilst IQ was independently tested and adult outcomes are reported by the cohort members themselves. As for the second problem, the father's role item is worded in such a way as to mitigate the confound with level of maternal involvement, and other differences such as family size and SES were statistically controlled. However, the possibility remains that undetected third variables are driving the associations. The third problem, reverse causality, is the hardest possibility to exclude: men could become less involved with children whose cognitive development is slower. Even with the finest-grained longitudinal data, such an effect would be difficult to identify. Possibly the best chance of testing for it would come from a within-family design with siblings of different cognitive abilities, though even this is made problematic by the reduction in men's involvement as family size increases.

However, if the associations found here are interpreted as reflecting the consequences of paternal investment, they suggest that the relatively low-investment behaviour of low-SES men, rather than being aberrant, is in some sense adaptive, since the benefit–cost ratio for their investment is less favourable than that experienced by higher-SES men. Adaptive does not of course mean either desirable or immutable. On the contrary, the account presented here predicts that if men's educational or socioeconomic attainment can be improved, then the benefits will be felt not just by them but also by their children, who will receive more, and more effective, paternal input, leading them to have greater attainment, be higher-investing fathers, and so on, in a cyclical manner. Thus, the study suggests the cycle of disadvantage in low-SES groups could be considerably ameliorated by any measures aimed at improving attainment by young low-SES men.

Although the data here suggest basically adaptive patterns of paternal investment, they shed no light on what the proximate mechanisms are that men use to make investment decisions. They could be following an evolved heuristic based on doing more with their children the more evidence they receive that their skills are socially valued, or that the children are benefiting. Alternatively, they could mostly be copying their own fathers' behaviour or that of the most prestigious individuals in their local social networks. Any of these strategies could, in principle, lead to adaptive behaviour much of the time, but they predict different time lags for men's behaviour to change if their attainment, skills, or social status improves. Thus, further research is needed to elucidate the psychological mechanisms underlying the patterns of behaviour and consequence found here.

References

Amato, P. R. (1994). Father–offspring relations, mother–child relations, and offspring psychological well-being in early adulthood. *Journal of Marriage and the Family*, *56*, 1031–1042.

Amato, P. R., & Rivera, F. (1999). Paternal involvement and children's behavior problems. *Journal of Marriage and the Family*, *61*, 375–384.

Anderson, K. G., Kaplan, H., & Lancaster, J. (1999). Paternal care by genetic fathers and stepfathers: I. Reports from Albuquerque men. *Evolution and Human Behavior*, *20*(6), 405–431.

Anderson, K. G., Kaplan, H., & Lancaster, J. B. (2006). Demographic correlates of paternity confidence and pregnancy outcomes among Albuquerque men. *American Journal of Physical Anthropology*, *131*(4), 560–571.

Anderson, K. G., Kaplan, H., & Lancaster, J. B. (2007). Confidence of paternity, divorce, and investment in children by Albuquerque men. *Evolution and Human Behavior*, *28*(1), 1–10.

Apicella, C. L., & Marlowe, F. W. (2004). Perceived mate fidelity and paternal resemblance predict men's investment in children. *Evolution and Human Behavior*, *25*, 371–378.

Bjorklund, A., Lindahl, M., & Plug, E. (2006). The origins of intergenerational associations: Lessons from Swedish adoption data. *Quarterly Journal of Economics*, *121*(3), 999–1028.

Bouchard, T. J., & McGue, M. (2003). Genetic and environmental influences on human psychological differences. *Journal of Neurobiology*, *54*, 4–45.

Cabrera, N. J., Tamis-LeMonda, C. S., Bradley, R. H., Hofferth, S., & Lamb, M. E. (2000). Fatherhood in the twenty-first century. *Child Development*, *71*, 127–136.

Charpentier, M. J. E., Van Horn, R. C., Altmann, J., & Alberts, S. C. (2008). Paternal effects on offspring fitness in a multimale primate society. *Proceedings of the National Academy of Sciences of the USA*, *105*, 1988–1992.

Downey, D. B. (1995). When bigger is not better: Family size, parental resources, and children's educational performance. *American Sociological Review*, *60*, 746–761.

Fieder, M., & Huber, S. (2007). The effects of sex and childlessness on the association between status and reproductive output in modern society. *Evolution and Human Behavior*, *28*, 392–398.

Flouri, E., & Buchanan, A. (2004). Early father's and mother's involvement and child's later educational outcomes. *British Journal of Educational Psychology*, *74*, 141–153.

Geary, D. (2000). Evolution and proximate expression of human paternal investment. *Psychological Bulletin*, *126*, 55–77.

Gottfredson, L. S., & Deary, I. J. (2004). Intelligence predicts health and longevity: But why? *Current Directions in Psychological Science*, *13*, 1–4.

Harris, K. M., Furstenberg, F. F., & Marmer, J. K. (1998). Paternal involvement with adolescents in intact families: The influence of fathers over the life course. *Demography*, *35*, 201–216.

Hopcroft, R. L. (2006). Sex, status and reproductive success in the contemporary US. *Evolution and Human Behavior*, *27*, 104–120.

Johnson, W., McGue, M., & Iacono, W. G. (2007). Socioeconomic status and school grades: Placing their association in broader context in a sample of biological and adoptive families. *Intelligence*, *35*, 526–541.

Kaplan, H., Lancaster, J., & Anderson, K. G. (1998). Human parental investment and fertility: The life histories of men in Albuquerque. In A. Booth, & A. Crouter (Eds.), *Men in families. When Do they get involved? What difference does it make?* (pp. 55−109). Mahwah, NJ: Erlbaum.

Lawson, D. W., Mace, R. (in press). Sibling configuration and childhood growth in contemporary British families. *International Journal of Clinical Epidemiology,* ePub ahead of print, doi: 10.1093/ije/dyn116.

Lawson, D. W., Mace, R. (submitted for publication). Trade-offs in modern parenting: A longitudinal study of sibling competition for parental care. *Evolution and Human Behavior.*

McNamara, J. M., & Houston, A. I. (2006). State and value: A perspective from behavioural ecology. In J. C. K. Wells, S. Strickland, & K. Laland (Eds.), *Social information transmission and human biology* (pp. 59−88). London: Taylor & Francis: Taylor & Francis.

Nettle, D. (2003). Intelligence and class mobility in the British population. *British Journal of Psychology*, *94*, 551–561.

Platek, S. M., Raines, D. M., Gallup, G. G., Mohamed, F. B., Thomson, J. W., Myers, T. E., et al. (2004). Reactions to children's faces: Males are more affected by resemblance than females are, and so are their brains. *Evolution and Human Behavior*, *25*(6), 394–405.

Sampson, R. J., Sharkey, P., & Raudenbush, S. W. (2008). Durable effects of concentrated disadvantage on verbal ability among African-American children. *Proceedings of the National Academy of Sciences of the USA*, *105*, 845–852.

Sear, R., & Mace, R. (2008). Who keeps children alive? A review of the effects of kin on child survival. *Evolution and Human Behavior*, *29*, 1–18.

Steelman, L. C., Powell, B., Werum, R., & Carter, S. (2002). Reconsidering the effects of sibling configuration: Recent advances and challenges. *Annual Review of Sociology*, *28*, 243–269.

Yogman, M. W., Kindlon, D., & Earls, F. (1995). Father involvement and cognitive/behavioral outcomes of preterm infants. *Journal of the American Academy of Child and Adolescent Psychiatry*, *34*, 58–66.

Appendix A
Supplementary information for Why do some dads get more involved than others? Evidence from a large British cohort

Table 1
Descriptive statistics for control and demographic variables

Cohort member sex	Male	9593
	Female	8960
Brothers	0	3333
	1	4264
	2	2270
	3+	1631
Sisters	0	3621
	1	4350
	2	2114
	3+	1380
Father's social class	I	746
	II	2133
	III	9983
	IV	1995
	V	1616

Table 2
Distribution of main paternal involvement variables by father's social class (figures in parentheses are percentages)

	Father's social class				
	I	II	III	IV	V
Father role 11					
Inapplicable	24 (5)	62 (4)	376 (5)	79 (5)	87 (7)
Leaves it to mother	22 (4)	98 (6)	723 (10)	184 (12)	166 (14)
Significant, less than mother	142 (27)	406 (25)	1674 (22)	338 (22)	228 (19)
Equal to mother	347 (65)	1094 (66)	4780 (63)	939 (61)	697 (59)
Father role 11 dichotomised					
Light	46 (9)	160 (10)	1099 (15)	263 (17)	253 (22)
Heavy	489 (91)	1500 (90)	6454 (85)	1277 (83)	925 (78)

Table 3
Odds ratios for father involvement 11 being in a category other than 'equal to mother', by sex of cohort member, father's SES, and numbers of brothers and sisters

	Odds ratio	p_{wald}
'Inapplicable'		
Intercept	-	<0.01
Each additional brother	1.22	<0.01
Each additional sister	0.98	ns
Cohort member is girl	1.58	<0.01
Father's social class = I	0.50	ns
Father's social class = II	0.41	<0.01
Father's social class = III	0.63	<0.05
Father's social class = IV	0.40	<0.01
Father's social class = V	1	-
'Leaves it to mother'		
Intercept	-	<0.01
Each additional brother	1.25	<0.01
Each additional sister	1.22	<0.01
Cohort member is girl	1.43	<0.01
Father's social class = I	0.28	<0.01
Father's social class = II	0.40	<0.01
Father's social class = III	0.55	<0.01
Father's social class = IV	0.69	<0.05
Father's social class = V	1	-
'Significant, less than mother'		
Intercept	-	<0.01
Each additional brother	1.15	<0.01
Each additional sister	1.05	ns
Cohort member is girl	1.32	<0.01
Father's social class = I	1.11	ns
Father's social class = II	1.31	ns
Father's social class = III	1.10	ns
Father's social class = IV	1.12	ns
Father's social class = V	1	-

Table 4
Results of full-factorial General Linear Models (1) with GA score as the dependent variable, father's social class, cohort member sex, and father role 11 as factors, and numbers of brothers and sisters as covariates; (2) as (1), but with class mobility as the dependent variable; (3) as (1), but with cohort member's number of children as the dependent variable

	Dependent variable					
	(1) GA score		(2) Class mobility		(3) Number of children	
Independent variable	df	F	df	F	df	F
Father's social class	4	45.73*	4	401.87*	4	0.94
Cohort member sex	1	8.30*	1	13.47*	1	0.23
Brothers	1	173.65*	1	34.14*	1	26.05*
Sisters	1	123.80*	1	21.21*	1	25.71*
Father role 11	3	15.12*	3	2.64†	3	0.96
Father role 11 × Father's social class	12	2.98*	12	0.87	12	0.42
Father role 11 × CM Sex	3	0.01	3	1.44	3	1.46
Father's social class × CM Sex	4	1.43	4	0.56	4	0.87
Three-way interaction	12	0.50	12	1.13	12	0.95
Error	8433		5734		4867	

* $p<.01$.
† $p<.05$.