



Paternity Uncertainty and Evolutionary Psychology: How a Seemingly Capricious Occurrence Fails to Follow Laws of Greater Generality

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ABSTRACT

Evolutionary psychologists aspire to show how – contrary to ‘soft’ social sciences such as sociology – ‘seemingly capricious’ occurrences in the realm of human behaviour follow biologicistic ‘laws of greater generality’ (Pinker, 2005: xii). This article is a case study of the ‘seemingly capricious occurrence’ of paternity uncertainty. According to evolutionary psychologists, paternity uncertainty arises from the fact that men are ‘hard wired’ to seek as many sexual partners as they can, and women to seek men of superior genetic quality. This account is said to be demonstrable through independent biological evidence of widespread discrepancy between putative and actual biological paternity in human populations. Yet close scrutiny of biological evidence and new evidence from representative sex surveys indicate that evolutionary psychologists consistently inflate estimates of paternal discrepancy. Evolutionary psychologists’ account of paternity uncertainty highlights their overattachment to biologicistic laws at the expense of understanding the social dimensions of human behaviour.

KEY WORDS

evolutionary psychology / fatherhood / infidelity / marriage / non-paternity / parenting / paternal discrepancy / paternity uncertainty / sexuality / sociobiology

Steven Pinker, a luminary of evolutionary psychology, describes in his Foreword to *The Handbook of Evolutionary Psychology* how he wished as a graduate student that psychology could meet the ‘standard of explanatory

elegance' set by the laws of physics, and 'show how a seemingly capricious occurrence falls out of laws of greater generality' (2005: xii). The emergence of evolutionary psychology in the 1980s answered his wishes. It provided an 'organizing framework' for the study of human behaviour. Pinker explains:

An explanatory hypothesis for some emotion or cognitive faculty must begin with a theory of how that faculty would, on average, have enhanced the reproductive chances of the bearer of that faculty in an ancestral environment. Crucially, the advantage must be demonstrable by some independently motivated causal consequence of the putative adaptation. That is, laws of physics or chemistry or engineering or physiology, or some other set of laws, independent of the part of our psychology being explained must suffice to establish that the trait is useful in attaining some population-related goal. (2005: xiv)

This article is a case study of the 'capricious occurrence' of 'paternity uncertainty', where doubt exists regarding biological fatherhood. Paternity uncertainty highlights the biologicistic framework and methodology of evolutionary psychology, and the challenge it presents to sociological understandings of human behaviour. Evolutionary psychologists understand paternity uncertainty as the outcome of differential female and male 'mating' strategies, giving rise to differential patterns of 'parental investment'. They believe they stand on especially firm ground in this field, on account of clear 'nonhuman analogues' – unlike, say, in morality and art (Tooby and Cosmides, 2005: 12). There is little room in this account for sociological considerations, notably the diverse effects of social institutions, time and place. Evolutionary psychologists demonstrate their account through biological evidence of widespread 'paternal discrepancy' – a difference between putative and actual biological fatherhood – among human populations. In turn, they have been prominent in media representations of paternity testing, unlike sociologists.

Specifically, this article considers the evidence for claims of evolutionary psychologists about paternity uncertainty. First, it introduces the broad framework of evolutionary psychology, its understanding of paternity uncertainty and its estimates of paternal discrepancy. It then examines the evidence for paternal discrepancy in Britain; drawing first upon existing biological evidence, and then upon new evidence arising from representative surveys of sexual behaviour. On this basis, the article argues that evolutionary psychologists have consistently inflated the extent and significance of paternal discrepancy, highlighting their overattachment to biologicistic laws at the expense of understanding the social dimensions of human behaviour.

Evolutionary Psychology

Since the publication of Charles Darwin's *On the Origin of Species* (1859), there have been on-going attempts to apply the theory of evolution by natural selection to human behaviour and society, invariably cast in terms of 'science'. Three waves have been especially important. The first, framed in terms of 'eugenics',

originated in the 1880s, reached its high water mark between the 1910s and 1930s, and collapsed in the wake of Nazi Germany's 'Final Solution'. The second, framed in terms of 'sociobiology', originated in the 1970s, aroused immense controversy within the academy during the 1980s, and thereafter dissipated. The final wave, framed in terms of 'evolutionary psychology', closely followed sociobiology. It coalesced as a program in the 1980s, aroused significant controversy during the 1990s, and continues to gather momentum.

Evolutionary psychologists acknowledge an intellectual debt to sociobiology, but distinguish their undertaking on several fronts. In the words of its founders John Tooby and Leda Cosmides: 'Sociobiology had focused mostly on selectionist theories, with no consideration of the computational level and little interest in mapping psychological mechanisms' (2005: 16n). The selectionist theories of sociobiology, they argue, are grounded in a 'fitness teleology' which assumes unbounded rationality on the part of humans, directed towards reproduction. In turn, sociobiological predictions fail to match observed human behaviour. For example: 'men will pay to have nonreproductive sex with prostitutes they believe and hope are contracepting, yet they have to be paid to contribute to sperm banks' (2005: 13). Similarly, those who can most afford children in wealthy nations choose to have fewer children.

In fact, evolutionary psychologists argue, an 'informational or computational level' mediates between selection and behaviour. To be adaptive, behaviours must respond to information. Neural circuits in the brain operate as information-processing 'programs', underpinning behaviour. Mutations may alter this neural circuitry, thereby creating alternative information-behaviour relationships. In turn, natural selection retains or discards alternative circuit designs from the species' neural architecture on the basis of their impact upon the propagation of the species. Tooby and Cosmides emphasize: 'The idea that the evolutionary causation of behaviour would lead to rigid, inflexible behaviour is the opposite of the truth: Evolved neural architectures are specifications of richly contingent systems for generating responses to informational inputs' (2005: 13).

On this basis, evolutionary psychologists argue that the human mind comes 'factory-equipped with an astonishing array of dedicated psychological mechanisms, designed over deep time by natural and sexual selection, to solve the hundreds of statistically recurring adaptive problems that our ancestors confronted' (Buss, 2005: xxiv). These mechanisms make many of our inferences and decisions effortless and reflexive; hence they can be understood as 'instincts'. The problems they are designed to solve include finding a mate, protecting children, hunting and gathering, and avoiding predators. In this context, Tooby and Cosmides describe their approach to the study of the mind as one of 'reverse engineering':

You start by carefully specifying an adaptive information processing problem; then you do a task analysis of that problem. A task analysis consists of identifying what properties a program would have to have to solve that problem well. This approach allows you to generate hypotheses about the structure of the programs that comprise the mind, which can then be tested. (2005: 16)

Unlike sociobiology, evolutionary psychology enlists support from the social and behavioural sciences, as well as the biological sciences. Above all, it garners support from psychology and anthropology, especially in the US (Buss, 2005: xix–xxii). It does not get support from sociology. Evolutionary psychologists expect that their paradigm will eventually subsume the ‘soft’ human social sciences, such as sociology. Tooby and Cosmides declare: ‘If evolutionary psychology turns out to be well-founded, then the existing superstructure of the social and behavioral sciences – the Standard Social Science Model – will have to be dismantled’ and replaced by ‘a new social sciences framework’ (2005: 6–7).

In close connection, evolutionary psychologists have institutionalized their paradigm through authoritative tomes, such as *The Handbook of Evolutionary Psychology* (Buss, 2005); journals, such as *Evolution and Human Behavior* and *Human Nature*; academic societies, such as the Human Behavior and Evolution Society (HBES); and graduate programs (see the list for US universities on www.hbes.com). Evolutionary psychologists have also actively promoted their cause to a popular audience. Best-sellers include Matt Ridley’s *The Red Queen* (1993), Jared Diamond’s *The Third Chimpanzee* (1993), Robin Baker’s *Sperm Wars* (1996), and Steven Pinker’s *The Blank Slate* (2002).

Sociologists are profoundly sceptical of core claims in the evolutionary psychology framework. Above all, they reject biologicistic explanations of human behaviour, given human capacity for learning and cultural variation across time and place. In this context, they emphasize – in the words of Stevi Jackson and Amanda Rees – ‘the fluidity and contingency of self and identity, the diversity of social practices and relationships, and the uncertainty and unpredictability characteristic of life’ in contemporary societies (2007: 917). Sociologists also draw attention to the social construction of science, and its limited capacity to provide a fully objective account of human behaviour. Yet sociologists have been slow to respond to evolutionary psychology. Jackson and Rees observe that this is notwithstanding the fact that evolutionary psychology enjoys much more influence than sociology in media representations of social life and the popular imagination. On this account, they urge sociologists to engage with evolutionary psychology, and to contest the ‘impoverished representations of social life’ playing out in the public domain (2007: 917). This article does just so.

Paternity Uncertainty

Evolutionary psychologists choose concepts – where possible – which emphasize human sameness with other animals: hence, ‘mating’ rather than ‘sexuality’. The fact that mating has an analogue across all species – unlike morality and art – makes it especially amenable to the evolutionary psychology framework. So does the fact that it is ‘so close to the reproductive engine of evolution’ (Buss, 2005: 253). In this context, evolutionary psychologists have studied human mating behaviour more than any other field, counting it as one of their ‘first empirical success stories’ (p. 251).

Specifically, evolutionary psychologists argue that physiological differences between men and women give rise to distinctive – and antagonistic – adaptations and behaviours. The minimum reproductive effort is much less for men (copulation) than women (pregnancy); gestation, parturition and lactation guarantee maternity certainty; ‘concealed ovulation, internal fertilization and continuous female receptivity’ underpin paternity uncertainty (Campbell, 2005: 635). In this context, men and women pursue both short and long-term mating strategies. Men’s short-term strategy ‘is based on obtaining large numbers of partners’, whereas women’s strategy involves ‘obtaining men of high genetic quality’ (Schmitt, 2005: 280). The science writer Matt Ridley declares:

There has been no genetic change since we were hunter-gatherers, but deep in the mind of the modern man is a simple hunter-gatherer rule: Strive to acquire power and use it to lure women who will bear heirs; strive to acquire wealth and use it to buy other men’s wives who will bear bastards ... Likewise, deep in the mind of a modern woman is the same basic hunter-gatherer calculator, too recently evolved to have changed much: Strive to acquire a provider husband who will invest food and care in your children; strive to find a lover who can give those children first-class genes. (1993: 244)

In this context, evolutionary psychologists have directed particular attention to what they describe as ‘sperm competition’. Sperm competition is sexual selection *after* copulation. It arises ‘whenever a female mates with multiple males in a sufficiently short period of time so that live sperm from two or more males are present in her reproductive tract’ (Shackleford et al., 2005: 373). Among species where this is rare, such as gorillas, males have relatively small testes and low sperm counts; among those where it is common, such as chimpanzees, males have relatively large testes and high sperm counts. Humans are intermediate, suggesting that sperm competition matters somewhat (p. 375). The British biologists Mark Bellis and Robin Baker pioneered this line of inquiry. Drawing upon a survey of women recruited through a popular magazine, they reported that ‘extra-pair copulations’ were significantly concentrated within the fertile period, and were less likely to involve contraception than ‘in-pair copulations’ (1990: 997–8). In their wake, a growing literature examined the effects of sperm competition upon sexual behaviour – and ‘selection pressure on females to mate polyandrously’, without which ‘selection pressures on males to produce voluminous and competitive sperm would never have been at work in the first place’ (Hrdy, 2000: 77).

Differential mating strategies, evolutionary psychologists argue, give rise to differential investment in children. For most species, males invest more in mating than in parenting, and females invest more in parenting than in mating. Human males invest in paternity to the extent that it optimizes the passage of their genes to the next generation. On the one hand, they abandon offspring where paternal investment has little effect on offspring survival, mates are readily available, and paternity certainty is low. On the other, they adopt a ‘mixed reproductive strategy’ – paternal investment combined with the pursuit of other sexual opportunities – where paternal investment improves offspring survival, mates are dispersed, and paternity certainty is high (Geary, 2005: 407).

Following this logic, some evolutionary psychologists have calculated paternal discrepancy rates on the basis of kin investment data (Gaulin et al., 1997: 139). Specifically, they take the solicitude of aunts and uncles as a proxy of misattributed biological paternity, on the assumption that the degree of solicitude reflects the degree of certainty about biological relatedness.

On the basis of their ‘task analysis’ of mating and paternal investment, evolutionary psychologists predicted high rates of paternal discrepancy – and this is precisely what they found. During the 1990s estimates converged around 10 per cent, perhaps more. In 1990 Bellis and Baker reported that blood group studies in Britain indicated levels of between 5 per cent and 30 per cent, while their own study of magazine readers predicted between 6 per cent and 13.8 per cent. ‘There is no indication here,’ they observed, ‘that the level of EPC [extra-pair copulations] reported in our nationwide study is either unrepresentative or high’ (1990: 998). In 1996 Baker’s *Sperm Wars* declared, ‘World wide, it has been calculated from studies of blood groups that about 10 per cent of children are in fact not sired by the man who thinks he is their father’, and that ‘this is also the level found in industrial Western societies’ (2000[1996]: 64). In the same year anthropologists from the University of Pittsburgh used survey data from undergraduates about kin investment from aunts and uncles to estimate that ‘between 13% and 20% of children are not the offspring of their putative father’ (Gaulin et al., 1997: 139). More recently, David Geary states in *The Handbook of Evolutionary Psychology*, ‘Definitive conclusions cannot be reached, but it appears that men are cuckolded about 10% of the time’ (2005: 492).

Yet evolutionary psychologists have lately modified their claims. Two meta-studies illustrate the point in different ways. One was coordinated by Mark Bellis in the UK, arising from his research into sperm competition. The other was conducted by Kermyt Anderson, a US anthropologist interested in paternal investment. Both meta-studies draw together published evidence since the advent of serological testing for paternity in the mid 20th century. The published evidence takes many forms, including refereed journal articles, conference transcripts, letters to the editor, parliamentary papers and industry reports.

The meta-study coordinated by Bellis identifies 35 published studies. Of these, 16 are based upon ‘disputed paternity testing’, where tests were precipitated by disputed paternity; 17 are based upon ‘other testing’, mostly for medical conditions; and two are based upon ‘behavioural estimates’, including Bellis and Baker’s own study of magazine readers (1990). Bellis et al. attach most weight to those studies based upon ‘other testing’, for which the median rate of paternal discrepancy (PD) is 3.7 per cent. In turn, this figure suggests that the ‘widely used (but unsubstantiated) figure of 10% PD may be an overestimate for most populations’ (2005: 750). Even so, the authors call for ‘urgent’ attention to its prevalence. They explain:

A 4% PD would affect far more than 1 in 25 families. Given an average of two children per family, more families will be affected within just a single generation;

although it is probable that PD will cluster in some family groups. Typically, however, many families have three or more living generations. Consequently, the proportion of families affected will increase further when other relationships (for example, between parents and grandparents) are also considered. (2005: 752)

Anderson's meta-study draws a wider net, identifying 67 published studies. Of the studies, 22 involve 'men with relatively high paternity confidence' (many of them medical-based studies); 31 involve 'men with relatively low paternity confidence' (reflected in disputed paternity); and 14 studies involve 'men whose paternity confidence is unknown'. The median level of paternal discrepancy in circumstances of high paternity confidence is 1.7 per cent; in circumstances of low paternity confidence it is 29.8 per cent; and in circumstances where paternity confidence is unknown it is 16.7 per cent. Anderson proceeds to combine studies where paternity confidence is high with those where it is unknown, arriving at a median of 3.3 per cent. For the level to be 10 per cent as commonly cited, he calculates that 75 per cent of men in the general population would have high paternity confidence, and 25 per cent would have low confidence (2006: 516). Anderson's own study of men in Albuquerque, New Mexico, found that respondents 'do not believe that they are the father of 1.46% of pregnancies attributed to them, implying a total nonpaternity rate for that sample of 3.7%' (2006: 517) – the same figure as that arrived at by Bellis et al.!

Anderson's meta-study received little media coverage, perhaps because its conclusions were somewhat opaque. The study of Bellis et al., though, received heavy coverage, focussing entirely upon the extent of paternal discrepancy. *The Telegraph* (2005), for example, reported, '1 in 25 men in dark as they raise others' children'; *BBC News* (2005) reported, 'One in 25 fathers "not the daddy"'; *New Scientist* (2005) reported, 'Paternity uncertainty revealed in 1 in 25'; *China Daily* (2005) reported, 'Is your child really your child?'. Moreover, fathers' rights groups forged links with the article through their websites (Canadian Children's Rights Council, 2007; Dads in Distress, 2007). So did a Kent-based paternity testing broker, quoting the suggestion that paternity testing opens a 'Pandora's box' (International Biosciences, 2007).

Biological Testing

The discovery of blood groups in the early 20th century created the scope for biological paternity testing. In the 1970s, serological testing became much more sophisticated. Then, from the late 1980s DNA testing largely took its place. In fact, none of these techniques prove biological paternity per se. Rather, they establish biological nonpaternity, by 'excluding' men whose body substances – blood type, HLA antigens or DNA polymorphisms – are incompatible with biological paternity. In turn, a man is said to be the biological father on the basis of probability, drawing upon assumptions about the frequencies of biological markers in the general population. The probability of 'exclusion' using ABO blood types alone is about 17 per cent; for more sophisticated serological testing

it is in excess of 95 per cent; and for DNA testing it is more than 99.99 per cent. DNA testing is not only more precise than serological techniques, but faster and cheaper (Richards, 2001: 676–7). In this context, a commercial paternity testing industry has emerged worldwide, mostly grounded in disputed paternity (Gilding, 2006: 91–3). During the same period, paternity testing has also become more widespread in the context of medical procedures, such as organ transplant and genetic screening (Lucassen and Parker, 2001: 1033).

Notwithstanding the proliferation of testing, there are no reliable population-based studies about the extent of paternal discrepancy. All test-based studies involve bias of some kind. On the one hand, there is bias towards high levels of paternal discrepancy in the context of disputed paternity by definition. On the other, there is bias towards low levels in many medical contexts, where participation is voluntary and presumably avoided by women fearful of disclosure. In other circumstances, bias is unknown, on account of lack of information about the sample employed in the study.

Bellis et al. and Anderson take bias into account in the course of estimating the extent of paternal discrepancy. As already noted, Bellis et al. distinguish between ‘disputed paternity’, ‘other testing’ and ‘behavioural estimates’; Anderson distinguishes between contexts where there was ‘high paternity confidence’, ‘low paternity confidence’, and ‘unknown paternity confidence’. The researchers then calculate medians for their various categories. Yet this course of action obscures methodological considerations; specifically, ambiguities in the course of classification, and differences in the quality of studies within categories. It also disregards differences in patterns of paternal discrepancy by time and place.

Consider, for example, the studies employed by Bellis et al. in arriving at an estimated paternal discrepancy rate of 3.7 per cent, grounded in ‘other testing’ – mostly for medical ends. The oldest study was published in 1957; the most recent studies were published in 1999. Five studies were done in the US, four in the UK, two each in France and Mexico, and one each in Canada, New Zealand, Switzerland, and among the Yanomama tribe of southern Venezuela and northern Brazil. In turn, these studies vary widely in their estimates of paternal discrepancy: from 0.8 per cent in a 1994 Swiss sample, to 30.0 per cent in a 1973 English sample. Given the variation, it is elementary to observe that great care should be observed in applying a median to these studies.

The four British studies based upon ‘other testing’ – published in 1957, 1973, 1991 and 1999 – illustrate the point. The first, published in a medical journal (Edwards, 1957), reported on an earlier study of heterospecific pregnancy based on ABO blood testing of 2578 families at a West London hospital in 1949–50 (Johnstone, 1954). The study included all live-born infants during the period of investigation, but no information was provided about the demographics of those who attended the hospital. Paternal discrepancy was observed for 17 babies. Given ABO testing, Bellis et al. and Anderson agree that the actual number of cases was almost 100, or 3.7 per cent (95% CI 3.0–4.4%). Yet they disagree about the bias. Bellis et al. describe the bias as ‘unknown’, presumably guided by lack of information about the sample. Anderson describes

paternity confidence as 'relatively high', presumably guided by the testing of all live-born infants.

The 1973 study was more ambiguous than the 1957 study, and more influential. In 1991 it was described as the 'most commonly quoted UK reference' on the subject, routinely employed to justify estimates of 10–15 per cent in medical and genetics textbooks (MacIntyre and Sooman, 1991: 870). The actual data were neither published nor refereed. What was published were passing remarks made by Elliott Philipp, a medico, in the transcript of a symposium on the ethics of artificial insemination by donor. Philipp described blood testing 200 to 300 women and their husbands in 'a town in south-east England'. 'From our results,' he stated, 'we suddenly realized that 30% of the children could not have been fathered by the men whose blood group we analysed' (Wostenholme and Fitzsimons, 1973: 63). Moreover, serological testing meant that the actual paternal discrepancy rate was much greater than 30 per cent. A passage in the transcript suggests that the families tested might have been ones where births occurred outside of marriage, and another medico described the sample as 'highly biased' (p. 66). Again, Bellis et al. and Anderson classify the study differently. Bellis et al. observe a bias towards a lower 'paternal discrepancy rate' on account of 'poor test sensitivity' (2005: 751). Anderson includes the study among those where paternity confidence is unknown, presumably because of insufficient information about the sample.

The 1991 study was a letter to the editor of *The Lancet*, written in response to an article which suggested that high levels of paternal discrepancy had 'taken on the character of urban folk tales – pieces of conventional wisdom which are widely believed but have little basis in fact' (MacIntyre and Sooman, 1991: 869). Two medicos from the University of Edinburgh reported on a carrier testing programme for cystic fibrosis (CF) during pregnancy at the main Edinburgh maternity hospital, and for eight other DNA diagnostic laboratories around the UK (two each in London and Manchester, and one each in Belfast, Cardiff, East Anglia and Oxford). Of 521 families tested, there were seven results (1.4%; 95% CI 0.4–2.3%) incompatible with biological paternity. The medicos also reported another CF carrier testing trial, which provided an indication of bias arising from women avoiding the tests on account of paternity doubt. In this trial, women unsure of the father or whose partners were unavailable were asked not to participate. Of 1619 women, 17 (1.05%) disqualified themselves because they were unsure of the father, while another 31 (1.9%) did not participate for other reasons. The medicos concluded: 'We believe that cited rates of non-paternity are somewhat exaggerated, and that the true rate lies closer to 1%' (Brock and Shrimpton, 1991: 1151). Bellis et al. and Anderson agree that this study is biased towards those with high paternity confidence.

Finally, the 1999 study was an article in a medical journal directed towards the identification of genetic markers for multiple sclerosis (MS). The study involved a volunteer sample of 821 affected individuals from across the UK with living parents willing to take part. The mean age of onset was 36 years. By implication, the findings pertain to paternal discrepancy among those born in

the 1970s and earlier (assuming adult participants only). Of the 821 individuals, 12 results (1.6%; 95% CI 0.7–2.5%) were incompatible with biological paternity (Chataway et al., 1999: 210). Again Bellis et al. and Anderson agree that this study is biased towards those with high paternity confidence.

The bottom line is that these studies are not of equal merit, and it is misleading to summarize their findings – in the manner of Bellis et al. and Anderson – through the median. The 1973 report does not include enough information to warrant consideration. The 1957 study is better, but based upon what are now rudimentary techniques and an unknown sample. The 1991 and 1999 studies are better again, on account of fuller information and better methods. It is revealing that Bellis et al. and Anderson disagree about the bias of the earlier studies, but agree on the later ones. Yet the 1999 study pertains to individuals born across decades, and offers no guide as to bias arising from a volunteer sample. The 1991 study, on the other hand, pertains to a birth cohort born in the early 1990s, and does provide an indication of the possible extent of bias on account of the sample. It thereby provides the most realistic, albeit conservative, estimate of paternal discrepancy based on testing procedures in the UK.

Sex Surveys

Given the bias of all studies based upon testing, alternative sources of evidence on paternal discrepancy warrant closer attention. Bellis and Baker's survey of sexual behaviours suggests a promising line of inquiry. The obvious problem with this survey is its volunteer sample. Volunteer surveys are notorious for over-estimating sexual activity of most kinds (Michael et al., 1994: 15–25). Yet there is now a large body of representative survey evidence on sexual behaviour, with potential to yield reliable evidence on paternal discrepancy rates. The National Survey of Sexual Attitudes and Lifestyles (Natsal) – first done in Great Britain in 1990–91 (Natsal 1990) and replicated in 1999–2001 (Natsal 2000) – is the most comprehensive British sex survey. Natsal 1990 (18,876 respondents, weighted by gender, age and region) makes a useful point of departure (Johnson et al., 1994: 42–67): partly because it was conducted before paternity testing was widely known and used, and partly because it coincides with the most reliable of the UK medical studies.

Natsal 1990 shows that 9.6 per cent (95% CI 8.9–10.3%) of sexually active women in their childbearing years (16–44) reported sex with two or more heterosexual partners in the past year. Sex with two or more heterosexual partners is a pre-condition of paternal discrepancy. If it is assumed that all women of childbearing years are equally likely to have offspring in a given year, then 9.6 per cent provides an upper limit for paternal discrepancy on the basis of this type of evidence (Table 1).

Yet sex with two or more heterosexual partners in a year is a necessary but not sufficient condition of paternal discrepancy. The true extent of paternal discrepancy must be well below 9.6 per cent, for three reasons. First, sex with two

Table 1 Females with 2 or more heterosexual partners in the last year by age group and marital status, as percentage of all females with at least one heterosexual partner (weighted by age, gender and region), Great Britain, 1990

	16–24 (%)	25–34 (%)	35–44 (%)	All ages
Marital status				
Married	1.5	2.2	2.4	2.2
Cohabiting	10.4	6.5	7.8	8.3
Other nonmarital	29.8	23.6	18.8	26.4
Total	20.5	7.0	4.6	9.6
Weighted, unweighted base	1670, 1483	2610, 2904	2299, 2246	6580, 6633

Source: Field, J. et al., National Survey of Sexual Attitudes and Lifestyles, 1990 [computer file]. Colchester, Essex: UK Data Archive [distributor], August 1995. SN: 3434.

partners must occur during the same time frame, or be separated by no more than a month or so. Natsal 1990 did not examine partnership history, but Natsal 2000 did, thereby providing some guidance on this point. Of women with two or more heterosexual partners in the past year, 41 per cent of the relationships were serial, 42 per cent concurrent, and 17 per cent unspecified (NCSR, 2005). If the 2000 sexual history data (taking into account age and marital status) are applied to the 1990 data on heterosexual partnerships in the past year, and it is assumed – improbably – that only concurrent relationships present risk of paternal discrepancy, then the baseline paternal discrepancy rate is 4.0 per cent (95% CI 3.5–4.5%). By this reckoning the percentage of women whose sexual behaviour presents risk of paternal discrepancy is somewhere between 4.0 and 9.6 per cent (95% CI 3.5–10.3%).

Second, paternal discrepancy requires that sex – with more than one man within the time frame of a month or so – leads to pregnancy, and that pregnancy results in live birth. The same variables – marital status and age – that inform sexual behaviour also inform having offspring, but in different ways. Whereas married women in 1990 were less likely to report sex with more than one man in the past year than unmarried women (2.2 versus 21.0%), they were more likely to have offspring (in 1990 they had 72% of all births). Similarly, whereas women aged 25–34 were less likely to report sex with more than one man than those aged 16–24 (7.0 versus 20.4%), they were much more likely to have offspring (58% of all births in 1990, versus 33%). The key dynamic here is the social institution of marriage – above and beyond the desire to maximize viable reproductive output. The ‘powerful’ effects of marriage are a common thread in representative sex surveys (Michael et al., 1994: 105). Most women (and men) get married; once they marry, most become sexually exclusive and have children; and most remain sexually exclusive as long as their marriages remain intact. On this account, it is important to address the distribution of births by age and marital status in calculating the extent of paternal discrepancy.

There is no problem in taking age into account, using national birth statistics (GRO, 1991; ONS, 1991–2005). It is more difficult to take marital status

into account, because national statistics do not distinguish between births to cohabiting couples and those to women on their own. There are such statistics for Scotland though, and the pattern of childbirth by marital status is 'broadly similar' across England, Wales and Scotland (Kiernan and Smith, 2003: 28). The data begin in 1996, at which time 55 per cent of nonmarital births were to cohabiting couples, rising to 62 per cent in 2000 (GRO, 2000). If linear regression is applied to this data, then 44 per cent of nonmarital births in 1990 were to cohabiting couples. On this basis, the number of births 'at risk' of paternal discrepancy as a percentage of all births in 1990 – taking age and marital status into account – is somewhere between 3.0 and 6.8 per cent (95% CI 2.6–7.4%).

Finally, paternal discrepancy requires not only sex with more than one man within the time frame of a month or so, leading to pregnancy and live birth; it also requires that the offspring is attributed to the man who is not the biological father. As it happens, the paternity testing industry provides some guidance here, given its tests occur in circumstances where men have cause to doubt paternity. The most comprehensive data come from the US. There the American Association of Blood Banks (AABB) conducts an annual survey of laboratories, mostly in the US but some also in Canada and Europe. Since the first survey in 1991, 'exclusions' where the putative father was not the biological father have ranged between 23 and 30 per cent (AABB, 1991–2004). There are no authoritative British data, but the representative of a major laboratory stated in confidential communication to the author that he would 'concur' with an exclusion rate of between 25 and 30 per cent.

If the 25 per cent exclusion rate is applied to the baseline percentage of 'at risk' births in 1990, then the baseline paternal discrepancy rate is 0.7 per cent. If the 30 per cent exclusion rate is applied to the topline percentage of 'at risk' births in 1990, then the upper limit for the paternal discrepancy rate is 2.0 per cent. In other words, Natsal 1990 indicates that the paternal discrepancy rate was somewhere between 0.7 and 2.0 per cent (95% CI 0.5–2.4%). This is far below the 10 per cent once routinely cited, and also much lower than the median figure of '1 in 25' suggested by Bellis et al. and widely reported in the media. It is consistent, though, with the best of the test-based studies in the UK, which suggested that in the early 1990s the figure was 'closer to 1%' (Brock and Shrimpton, 1991: 1151).

The same logic can be applied to Natsal 2000 (11,161 respondents, weighted by gender, age and region) with more confidence: partly because Natsal 2000 distinguished between serial and concurrent relationships, and partly because the Scottish data on cohabitation are not inferential. On this basis, Natsal 2000 indicates a paternal discrepancy rate somewhere between 1.3 and 3.4 per cent of births (95% CI 1.0–3.5%). The trend is upwards on account of two interrelated trends. First, more women reported two or more heterosexual partners in the previous year; rising from 9.6 per cent of all heterosexually active women aged 16–44 in 1990, to 16.1 per cent (95% CI 15.1–17.1%) in 2000 (Table 2). This upward trend occurred irrespective of age and marital status. Second, more births occurred outside marriage, especially in

Table 2 Females with 2 or more heterosexual partners in the last year by age group and marital status, as percentage of all females with at least one heterosexual partner (weighted by age, gender and region), Great Britain, 2000

	16–24 (%)	25–34 (%)	35–44 (%)	All ages (%)
Marital status				
Married	5.2	4.1	5.8	5.0
Cohabiting	15.9	7.4	9.1	10.2
Other nonmarital	40.4	37.9	28.5	37.4
Total	31.4	13.0	9.8	16.1
Weighted, unweighted base	1130, 1130	1911, 2306	1784, 2093	4825, 5529

Source: National Centre for Social Research et al., National Survey of Sexual Attitudes and Lifestyles II, 2000–2001 [computer file]. Colchester, Essex: UK Data Archive [distributor], August 2005. SN: 5223.

the context of cohabitation. Specifically, marital births declined from 72 per cent to 60 per cent of all births between 1990 and 2000, mostly on account of more cohabitation (ONS, 1998, 2005). Again, the common dynamic here is the social institution of marriage, and its weakening hold on behaviour – both in terms of having sex and giving birth.

Yet the logic applied to Natsal 1990 cannot be applied to Natsal 2000. In 1990 the paternity testing industry was barely established, and paternity uncertainty did not commonly lead to paternity testing. The passage of the Child Support Act 1991 increased the cost of biological paternity, giving suspicious and disaffected husbands cause to act upon their uncertainty. By the mid 1990s there was growing resort to paternity testing in this context. A Child Support Agency official reported to the House of Commons in 1997 that, in 1996–7, 18,007 cases of disputed paternity were received by the Agency; of these, 5420 cases were ‘referred for discounted DNA testing’, upon which ‘paternity was established in 89% of cases’ (Boardman, 1998). A 2005 press report, presumably based upon industry sources, estimated that there were about 10,000 paternity cases per annum in the UK (*The Telegraph*, 2005). If the industry had grown by 6 per cent per annum since 2000 (the same as the US market), then the number of cases in 2000 would have been about 7500. The Child Support Agency figures suggest that most of these would have involved new-born babies. If this was the case, then the estimated range for the paternal discrepancy rate in 2000 becomes 1.0–3.1 per cent (95% CI 0.7–3.6%). In other words, the trend towards more births at risk of paternal discrepancy is moderated by the availability of paternity testing in the context of paternity uncertainty.

Using sex surveys to arrive at estimates of paternal discrepancy in the population is problematic. It involves painstaking consideration of multiple data sets and making a variety of assumptions. Then again, using studies based upon biological testing for the same purpose is also problematic. In these circumstances, combining evidence from diverse sources provides the most robust

foundation for estimates of paternal discrepancy. The Natsal data confirm the findings of a growing number of test-based studies that earlier estimates of paternal discrepancy were heavily inflated.

Paternity Uncertainty and Evolutionary Psychology

According to evolutionary psychologists, the neural circuitry of the brain directs human mating behaviours that give rise to paternity uncertainty. Men seek as many sexual partners as they can; women seek men of superior genetic quality. They do so because in ancestral environments such strategies optimized their reproductive chances. In this context, paternity uncertainty is a 'seemingly capricious occurrence', which in fact 'falls out of laws of greater generality' (Pinker, 2005: xiv). Biological evidence of widespread paternal discrepancy in human populations provides the independent evidence for this account. In the 1990s estimates of paternal discrepancy were in the region of 10 per cent, often higher. In recent years some evolutionary psychologists have modified their claims to around 4 per cent, but their basic framework is unaffected. These estimates have been embraced by the mass media, fathers' rights activists and commercial providers of paternity tests – all groups with a bias towards relatively high estimates (Gilding, 2005: 7–9).

Yet paternity uncertainty is a more 'capricious occurrence' than evolutionary psychologists imagine, insofar as it fails to follow their predictions. There is strong evidence that estimates of paternal discrepancy have been routinely inflated. The best evidence based on scientific testing in the UK indicates a paternal discrepancy rate in 1991 of about 1 per cent. Evidence from representative sex surveys is consistent with this estimate, indicating a rate of 0.7–2.0 per cent in 1990, and 1.0–3.1 per cent in 2000. Sex survey evidence also highlights the pivotal influence of marriage as a social institution in regulating sexual behaviour and having offspring. The weakening hold of marriage in the course of the 1990s underpins rising estimates of paternal discrepancy rates. It is consistent with sociological accounts of 'the fluidity and contingency of self and identity, the diversity of social practices and relationships, and the uncertainty and unpredictability characteristic of life' in contemporary societies (Jackson and Rees, 2007: 917).

Evolutionary psychologists will probably find ways to reconcile more modest estimates of paternal discrepancy with their framework. After all, recent meta-studies have argued the case for much lower estimates than earlier studies without deviating from their broader analysis. As mounting evidence forces estimates further down, evolutionary psychologists might argue that selection pressures on females to mate polyandrously are less than what they had supposed; or, alternatively, that ecological pressures towards long-term mating strategies are salient in more circumstances than they had understood. Yet such analysis is post hoc, far removed from evolutionary psychology's predictive aspirations. In close connection, it fails to provide guidance in understanding

patterns of paternity uncertainty in specific contexts of time and place. For example, following the logic of evolutionary psychology, it might be expected that women's reduced capacity to conceal paternal discrepancy on account of paternity testing would be an ecological disincentive to covert sex, giving rise to lower rates of paternal discrepancy. Yet evidence from sex surveys indicates that the reverse occurred.

More fundamentally, evolutionary psychologists' inflated estimates of paternal discrepancy highlight deeper problems in their approach. Mating behaviour is supposed to be relatively firm ground for evolutionary psychologists, but the 'black box' of neural circuitry means that their approach involves a high degree of speculation – notwithstanding 'reverse engineering' and 'general laws'. In this context, hypothesis testing must be scrupulous. Yet evolutionary psychologists have routinely marshalled evidence in *support* of their hypotheses about mating behaviour, paternal investment and paternity uncertainty, rather than using it to *test* their hypotheses. They have also routinely deflected contrary evidence onto a variety of contingencies and considerations. In other words, they have shown too much attachment to their biologicistic 'laws of greater generality', and not enough curiosity about the 'seemingly capricious' evidence. In turn, they have consistently overlooked the social dimensions of human behaviour, and the diverse effects of social institutions, time and place.

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