Is having a good parent more important than having good genes?

Professor Keith Kendrick

5 December 2002

Or as David Lodge put it: “Literature is mostly about having sex and not much about having children; life is the other way around.”

Simply put reproductive success is of little consequence if the children do not survive to reproduce themselves.

In the previous two lectures we have seen how male and female mammals promote their own genes through their patterns of sexual attraction and behaviour, and sexual conflict at the levels of the reproductive organs, the gametes and the genome. We have also seen that the adoption of social monogamy by a species is associated with increased amounts of parental care dedicated to offspring. The central questions for this lecture will therefore be what makes sexual partners become parents and can they continue to promote their propagation interests through educating their offspring?

For a large part of our history many scientists, philosophers and theologians have supported the view that our attitudes and behaviours are the product of our individual experiences – we are made not born. The most extreme expression of this attitude can be seen in the Behaviourist approach to Psychology and summed up by one of its leading proponents, John Watson:

“Give me a dozen healthy infants, well formed, and my own specified world to bring them up in and I’ll guarantee to take any one at random and train him to become any type of specialist I might select, doctor, lawyer, artist, merchant-chief, and yes, even beggar-man and thief, regardless of his talents, penchants, tendencies, abilities, vocations, and the race of his ancestors”. (Behaviourism, New York, 1924).

Current opinions, spurred on by support from behavioural genetics, mainly favour a downgrading of parental influence on the behaviour and life choices of their offspring and instead emphasise either genetic determinants or interactions with peers. Even Shakespeare lends support to this view when he makes Prospero say of Caliban in The Tempest

“A devil, a born devil, on whose nature nurture can never stick; on whom my pains Humanely taken, all, all lost, quite lost”. (Act IV.1 188-189).

So are the hapless parents condemned to promote their respective reproductive investments merely by taking on protective roles that might be characterised as: “putting food or money in at one end and clearing up the consequences at the other!”

The display of parental behaviour by a host of different animal species is a remarkable characteristic of living creatures. What may simply have started off as an effective protection mechanism to promote offspring survival before and immediately after birth has been extended far beyond this. One might even conclude that the defining evolutionary principles of naked self-interest have been abandoned for long periods by parents to allow a helpless, demanding and ostensibly unattractive neonate who constantly endangers their survival to become their “raison d’etre”.

From this standpoint it would seem remarkable for either sexual partner in any species to dedicate so much time and effort to their young, if they are unable by doing so to further promote their own interests through moulding their behaviours, preferences and personalities. Indeed, in some mammals, such as elephants and the great apes, mothers may continue to care for offspring for 3-5 years before even becoming

pregnant again!

This is not to say however that offspring are born, as Steven Pinker has put it, with some kind of “Blank Slate” for a brain where all subsequent behaviours are completely determined by experience, familial, social and cultural influences. Any key adaptive behaviour or skill will ultimately have a strong inescapable genetic basis but it is not simply about whether you have the specific genes or not, but how an individual’s experience of the environment fine-tunes their regulation. In essence the environment can enhance, maintain or possibly even downgrade inherited genetic advantages but it cannot give you genes you simply don’t have!

However, I will endeavour to make the case, primarily from animal studies, that parents can indeed promote their own interests through influencing some aspects of the behaviour and life-choices made by their offspring. Before doing this though we will first consider what controls parental behaviour by answering three questions:

Q: Why take on parental responsibilities?

Q: What makes animals show parental behaviours?

Q: What promotes the formation of parent-offspring bonds?

Why take on parental responsibilities?

A generic definition of parental care is: “any characteristics or actions of reproductive partners that increase the fitness of their offspring to the detriment of their own”.

It follows that if both male and female sexual partners are “selfishly” interested only in promoting their own genes then the sacrifices of parenthood must pay off by increasing survival and subsequent reproductive potential of their offspring in contrast to simply producing more young.

There are thus two basic strategies for successful reproduction of offspring:

(1) Go for hatching big numbers in the hope that a few will survive and make it through to the stage where they can reproduce themselves – no parental care required after birth.

(2) Go for small numbers and feed them and guard them against predators – parental care required from one or both reproducing partners.

Both of these are adopted very effectively by different species but as a general rule of thumb all species that live in difficult and challenging environments get stuck in the parent trap. Thus, while examples of species with parental care can be seen in pretty much every class of animal on the planet, for both birds and mammals, which arguably have the most challenging environments to deal with, nearly every species uses a parental care strategy.

One added advantage of adopting parental care is that it has allowed for more prolonged periods of development and the evolution of more sophisticated and flexible strategies for dealing with challenging environments. The main advantage that parent-based systems allow is slower development of more complex brains so that offspring can learn about dealing with the challenges of their environment over a prolonged training period. This avoids some of the limitations of having to pre-programme everything in a very inflexible and limiting manner. Not surprisingly therefore offspring born to the most advanced species are generally born incompletely developed and incapable of surviving without parents.

Another main advantage of adopting a parental care strategy is that from it has evolved the characteristic of the social bond initially through the family unit and gradually widening out to encompass even species members outside of it. In a very real sense therefore the evolution of social behaviour starts with parenting.

A finally pay-off, of course, is that the close bonds established through parenting will encourage social cooperation from offspring – so mum and dad may occasionally be able put their feet up in future!

While it is easy to see the ultimate advantages of developing parental care to improve individual flexibility to cope with environmental challenges clearly there must have been a graded evolutionary change to achieve this huge step.

So how did parental care first develop?

The obvious starting point to the developmental of this sacrificial strategy would have been where a safety in numbers strategy became unsustainable for some species. The first step on the road to parenthood must therefore have simply been the development of an egg-guarding strategy to ward off predators. Initially, this probably developed from strategies of caching eggs in protected burrows or nests but leaving offspring to fend for themselves post-hatching. This could then have been extended to incubating eggs and subsequently to guarding and maintaining the nest site post-hatching to protect offspring for a further period. Either or both sexes could do this but a big advantage would be that females could produce fewer eggs and so expend less effort on egg production and shift instead towards using spare capacity on parental care.

Where simple guarding of offspring still failed to promote survival of sufficient offspring then the next phase would have been to feed them and keep them warm after they were born so that they would stand the best possible chance of developing towards independence and be able to reproduce themselves as quickly as possible. This would then have been extended to playing with them and teaching them survival skills.

The drivers for promoting growth of young through parental nurturing are the same as those promoting development of internal fertilisation and giving birth to live young, with the mother fulfilling a more extensive nurturing role in utero before continuing it after birth.

Who does the parenting and why?

In the animal kingdom every combination of parental involvement has been tried. Obviously by far the strongest representative strategy is that mum does is all. This is especially true of mammals where only the mother can provide essential milk for the offspring. Interestingly, it would not take much of an adaptation for male mammals to produce milk (indeed paternal male fruit bats actually do produce milk) but the simple fact is that, for male mammals in particular, parenthood does not seem to be on the agenda.

Not surprisingly adopting a bi-parental care strategy has been shown to improve the chances of offspring survival in a number of species, compared with uni-parental care, although the advantages are not that large in most cases.

Only 3-5% of all mammalian species show true direct paternal behaviour towards offspring, as distinct from just guarding their mates to prevent other males gaining sexual access. The main examples of these where male commitment can be equal to, or even greater than that of the female, are prairie and pine voles, the Californian mouse, hamsters, Mongolian gerbils, fruit bats, meerkats, foxes, wolves, hunting dogs, marmosets, tamarins, titi monkeys and of course humans. In the majority of these cases monogamy is the norm, and as we have seen in my last lecture, this is very rare amongst mammals by comparison with birds. Indeed, just as 90% of birds are ostensibly monogamous so the vast majority of the males in these species take on paternal responsibilities.

However, one does need to qualify the notable absence of paternal care in most mammals by saying that unless they have close bonds with the females producing the young they actually have very little reason or opportunity to take on a paternal role towards offspring.

In any event, looking at the issue purely from the “selfish” gene propagation standpoint it clearly makes sense for males who have almost limitless amounts of sperm to opt out of parenting where they can get access to multiple females for sex. Spending time looking after kids is clearly time wasted in terms of working on the essential problem of finding and having sex with other females, getting them pregnant and thereby promoting your genes. With monogamy males do not have easy access to multiple females so it makes more sense to protect investment in offspring through parental care after birth.

From the female point of view their already huge time investment in producing small numbers of highly valuable eggs makes it sensible to extend this still further through parental care of their individual offspring.

However, there are some non-mammalian species, particularly birds and some fish and amphibians, where the female leaves dad to do all the work. Perhaps the most famous of these examples is the sea horse where the male seems capable of taking on total responsibility for both pregnancy and parental care. Here the female transfers her fertilised eggs into a male’s egg-pouch. This then swells as the young grow, giving the male a very pregnant look. He will then effectively give birth to his offspring and continue to look after them even though the mother is still around.

Males may end up being the primary carers for offspring where females are either better resource

providers than males, or are simply too worn out from having to produce the eggs. However, it has also been suggested to correlate with the females adopting a polyandrous mating strategy – i.e. where they will chose to mate with multiple males. The argument in this case is that looking after the kids cramps a polyandrous life style where the female needs to dedicate the maximum amount of time to mating with numerous males in order to have her eggs fertilised by the fittest one (through sperm competition). Thus, females in these cases may be using the same excuse as males normally do to give parenthood a miss in favour of playing the field.

True polyandry is not really exhibited by mammals. However, since humans are the only mammals where relatively exclusive paternal care can occur, this might perhaps present an additional concern for house-husbands thinking that their roles were completely determined by the balance of resource provisioning favouring the wife as the breadwinner!

Being a house-husband may have an unexpected bonus in terms of increased life-expectancy however. In primates, such as the titi monkey, where the male can take on more parental care than the mother, they normally outlive their mates (Allman et al., 1998)

What makes animals show parental behaviours?

There are two distinct phases of a parental response. The first of these is a preparatory phase that occurs before the babies are born and where nests are built or prospective mothers progressively detach themselves from their existing social groups. They can also become very aggressive towards intruders, particularly males. The second phase is the parent's response following the birth of young.

When you look at most mammals, other than primates, male and female adults exposed to babies initially find them highly aversive and avoid them at all costs. This builds on instinctive neophobia that can have strong survival advantages. For this reason the contrast between neophobic/aggressive and attraction/parental response to a neonate is remarkable and the transition between these two states can occur in seconds.

One of the most remarkable things about babies in any species is that it is difficult to ignore them. In mammals this is particularly true and in a large number of species simply exposing an adult male or female to exclusive proximity with young will, over a period of time, lead to one of two outcomes – either they will kill them or attempt to care for and nurture them. Babies will thus bring out either the best or the worst in adults, ignoring them is not an option.

Indeed, just as it is difficult to ignore the cries of a human body the babies of a whole range of animals also use specific vocalisations to get the full attention of their parents.

There is one fail-safe mechanism associated with parenting which is that if the going gets really tough for the parents they can always recoup their energetic losses by cannibalising their young. This can and does occur in a number of mammals although mainly only under extreme circumstances.

What controls a female's maternal response?

Following the implantation of a fertilised egg in the womb at the initiation of pregnancy a regulated pattern of changes occurs in the sex hormones progesterone and oestradiol and the lactation support hormone, prolactin.

The pattern of these changes is of a gradual increase throughout pregnancy with progesterone declining shortly before birth and oestradiol reaching its highest peak at this time. The changes in these hormones both promote the production and storage of milk in the mammary glands and prepare the uterus for labour. Work with nest-building mammals, such as rabbits, rodents and pigs, suggests that this behaviour is also stimulated by the changing levels of these hormones during pregnancy. The time when nest-building starts is somewhat variable between species but is generally in the last few days before birth. In marmoset monkeys these hormonal changes also stimulate heightened interest in having contact with other babies even 2-3 weeks before they actually give birth to their own.

In general, the main purpose of the hormonal changes during pregnancy is to facilitate the eventual expression maternal behaviours towards babies after birth by priming the brain mechanisms involved. Thus, while it is true that given time most female mammals will act maternally towards offspring, following

constant exposure to them, and this process is greatly accelerated by hormone changes during pregnancy, in most mammals it may still take several days for this to happen even with the hormones on-board. In this time babies could die while waiting for mum to get her act together. Thus, additional changes that occur during birth itself promote a rapid surge of maternal feelings that can take only a few seconds to kick in when the sensory cues from newborn babies are detected.

When labour contractions occur they send signals via the spinal cord to parts of the brainstem that affect widely distributed neurotransmitter pathways which target key areas of the brain to facilitate arousal, attention, maternal behaviour and reduce anxiety and pain responses. They also promote the release of pituitary hormones that facilitate further labour contractions and milk-let down.

What guarantees a strong and immediate maternal response when the young are born is the influence that labour contractions have on a tiny region of the hypothalamus at the base of the brain, the paraventricular nucleus. This acts very much like the conductor of an orchestra by sending its projections specifically to the main brain regions governing the different cascade of behavioural changes associated with the maternal response. This is done through its control of a co-ordinated release of a specific neuropeptide, oxytocin, within the brain. This peptide is also released into the blood from the posterior pituitary through a separate set of projections from this area. In this case it promotes milk-let down from the mammary glands so that offspring will receive milk when they suckle.

The way oxytocin acts is to modulate the release of classical transmitters like noradrenaline, dopamine and gamma-aminobutyric acid within the brain centres controlling maternal responses. These have already been activated non-specifically by labour contractions but they are boosted further by oxytocin just within the brain regions controlling all aspects of the maternal response (Kendrick, 2000).

Other lactation hormones, like prolactin, also seem to facilitate the expression of maternal behaviour as do changes in the brain's endogenous opiate system occurring at the time of birth.

Blocking the birth-induced oxytocin release mechanism through epidural anaesthesia or caesarean section delivery will delay, or even prevent in some cases, the induction of post-partum maternal behaviour. Release of oxytocin also occurs in the human brain during birth and this is also prevented by epidural anaesthesia or caesarean section delivery. Indeed, there is some indication that this may result in women delaying bonding responses with their babies although there is no evidence that maternal responses per se are seriously impaired. Indeed, the experience of severe pain and distress in the absence of these interventions could have greater disruptive effects.

Maternal experience also appears to make both hormonal mechanisms for maternal behaviour induction and the impact of neonates per se even more effective. Indeed, in many species highly experienced mothers will often steal neonates from other mothers or simply foster orphans. The drive is so strong that in some cases females will even adopt offspring from other species. A classic recent example of this is the much-publicised lioness that has repeatedly stolen calves from Oryx mothers.

A question not asked so often is what stops mothers from being maternal? In most animal species the death or weaning of offspring will lead to a rapid decline in maternal responses – usually within a few days. From a biological viewpoint this obviously makes sense because the mother needs to get on with producing another baby. It seems likely therefore that in the absence of suckling, lactation hormones (prolactin and oxytocin) decline and allow the females to start cycling again and be sexually receptive to males.

From my own work with sheep it would appear that sex and maternal behaviours are in opposition even though they share many of the same patterns of hormonal stimulation. Prolactin may be the main key in this process since it both interferes with sex steroid hormone actions and inhibits brain dopamine systems, both of which are important for sexual behaviour. However, oxytocin may also act to inhibit female sexual responses in some instances.

What controls a male's paternal response?

With so few mammals exhibiting paternal care it is not surprising that we still know relatively little about how it is controlled.

What we do know revolves around the same lactogenic hormone that is important for maternal behaviour, prolactin. In both birds and mammals, males displaying paternal behaviour tend to have elevated blood

prolactin levels. There are often associated changes in blood testosterone levels, although their direction can vary somewhat between species. In the California mouse paternal behaviour is also associated with increased conversion of testosterone to oestrogen in the brain.

Interestingly, male changes in prolactin levels can occur even several weeks before their partner gives birth and, at least in birds, preventing these changes with drugs also stops the expression of paternal care. In voles the release of vasopressin in the brain may be important for stimulating paternal care in the same way as it appears to be important for stimulating bonding with a female partner (as discussed in my previous lecture).

In human dads decreased testosterone and increased oestrogen and prolactin levels occur both prior to and after their partner giving birth.

It remains a possibility that paternalistic feelings towards offspring occur spontaneously as a result of prolactin, or other factors, turning down the testosterone-dependent sex and aggression drives and the males being exposed constantly to neonates.

Certainly, as in females, high prolactin levels decrease the male sex drive and we are all aware as humans that having babies can seriously damage your sex life!

If this is the case then it is likely that many male mammals would be capable of showing paternal behaviour if circumstances permitted. Indeed, it is possible to make the non-paternal male rat act paternally with artificial treatments that raise prolactin levels.

What promotes the formation of parent-offspring bonds?

As far as parents forming bonds with their children goes then there are two basic approaches. In the same way that the evolution of parental behaviours allowed for fewer offspring to be produced, so bonding with individual offspring seems to only occur in parental species that normally produce one or two offspring at a time. Rodents and pigs that have lots of babies do not, for example, appear to bond strongly with them at an individual level and it is relatively easy to interchange litters between mothers. Mothers in these cases are also considerably less affected emotionally by the disappearance of one of their offspring.

With the species that do bond with their individual offspring this would appear to have a number of consequences:

In the first place it increases the level of parental commitment towards offspring and less are therefore produced.

The exclusivity of the bond means that the mother will normally only dedicate her food resources to her own offspring and will not easily be convinced to hand them out to others. She will also become very distressed if she loses one of them. It also binds individuals together socially far beyond the point of straightforward parental nurturing prior to weaning.

The emotional bond between parent and offspring is clearly a two way process that has the combined effect of maximising the opportunity for the parent to influence the behaviour of their offspring and, of course, to engender and reinforce the rewarding aspects of being social.

As outlined in my previous lecture on monogamous bonds between the sexes, the major female social bonding hormone is the same peptide, oxytocin, which is stimulating maternal responses at the time of giving birth. Biological systems are highly effectively and efficiently organised in this respect. It does this both by stimulating the parts of the brain that learn to recognise the specific sensory cues the female uses to identify another individual, and by linking them to activating the parts of the brain dealing with pleasure – notably through dopaminergic pathways. There may also be similar links with brain opioid pathways that are also important for the rewarding aspects of social bonding. In animals that do not bond individually with their offspring it would appear that these links between individual recognition and reward systems in the brain are not so well established.

Do parents have any influence on their children apart from through their genes?

This whole area is both wide-ranging and awash with controversy, so I will mainly limit myself to considering where systematic work with other animal species can be considered along side less well

controlled work with humans. With this qualification (which will exclude, for example, consideration of parental effects on gender identity and sexual orientation) then let us consider some answers to three basic questions:

(1) What happens if you don't have parental care?

(2) What kinds of generic influences can parents have?

(3) What impact can different parenting styles have?

What happens if you don't have parental care?

The absence of parental care can have profound effects in animals such as with rhesus monkeys raised in social isolation with artificial surrogate mothers who grew up to be to total social misfits. Similarly, hand-reared animals in zoos, notably those used in the past for "chimpanzee tea-parties", tend to grow up totally social incompetents as far as their own species are concerned.

A recent study has also found in monkeys that stress responses and alcohol abuse are significantly increased in young animals raised with juveniles instead of their parents.

Indeed, animals from number of mammalian species when raised in juvenile groups without normal parental care show problems with sociosexual adjustment and dealing with stress. They may also themselves turn out to be poorer parents.

Thus total deprivation of early experience of social bonds with parents would appear to be strongly associated with impaired social behaviours and stress management and increased susceptibility towards drugs of abuse.

While it is difficult to generalise to humans, similar kinds of social and stress adjustment problems have been seen in orphaned or abandoned children raised from an early age in Institutions.

What kinds of generic influences can parents have?

The most widely explored idea is that offspring are unconsciously influenced by the appearance and personalities of their parents to make it more likely that they will choose social and sexual partners that resemble them. As I discussed in my first lecture dealing with sexual attraction, this idea has its foundations in the fact that both we and other species are generally attracted to individuals like ourselves. This is a good way of promoting our genes because the more similar a partner is to us the more of our genes they are likely to share. We may therefore use our parents as templates for determining which individuals are most like us – bearing in mind that self-recognition may be very limited in species other than humans. If parents can really have this effect on their offspring then it is, of course, a further powerful strategy that they can make sure their own genes continue to be promoted in successive generations.

The main support for such ideas has come both from the teachings of Freud and from the animal world through the phenomenon of "imprinting" originally studied by Konrad Lorenz and Nikko Tinbergen in birds. They showed that many species of bird have an inbuilt capacity to recognise the first salient visual object (usually a parent although it can be a human or even an inanimate object) they are exposed to post-hatching. They then slavishly follow them and in adulthood will only be sexually attracted to individuals that resemble the one they were originally imprinted on.

Showing that this kind of parental influence occurs in humans, or other mammals, has been difficult. Indeed, many considered that such a simplistic and inflexible dependence on signals provided by a carer would be unlikely to occur in any mammal let alone humans.

In 1992 I, and a colleague from the University of Pretoria, Professor John Skinner decided to test this possibility by a large-scale study using sheep and goats. We chose these two species because we had the ability to control their maternal behaviour and because, like humans, they form an extremely strong attachment bond with their offspring.

The hypothesis was simply that if parents really did influence the social and sexual preferences of their offspring, then if goat kids were raised by sheep mothers they should grow up to act more like sheep and to find sheep more socially and sexually attractive. On the other hand, lambs raised by goats should do the reverse. From the outset we decided that the most effective test was not simply to raise the cross-fostered

young in isolation, with only their foster mothers for company, but to give them access to adults and juveniles of their own species at all times. Similarly, to test for competing or additive influences of sibling bonds we also raised some animals with a sibling of their own species, and others with a sibling of the same species as their foster mother. To act as controls we had normally raised sheep and goats kept in the same social environment as the fostered ones (i.e. exposed to both species). We thus hopefully had all the angles covered and could be confident of showing how much influence the bond between mother and offspring, as opposed to other bonds, could have.

The first observable change in the animals was in terms of their juvenile behaviours. Goats play and groom themselves much more than sheep and there was a significant shift in the fostered offspring towards the phenotype of their foster species – i.e. lambs raised by nanny goats played and groomed more than usual, and kids raised by ewes played and groomed much less than usual. However, a large number of other species-specific behaviours – patterns of vocalisations, browsing shrubs, climbing etc were totally unaffected – implying strong genetic inheritance of these traits.

When the animals reached sexual maturity they were given daily choice tests between tethered male and female sheep and goats. The results were almost unbelievable in that males almost exclusively chose to socialise and mate with members of their foster-mother's species. Importantly, however, it was not that they would never mate with their own species since they could and did so on occasion – especially if given no option. The bottom line was that when they had a choice their preference was not for their own species but they still considered members of their own species to be socially and sexually attractive. Females also showed a significant shift in preference towards the foster species, but ended up choosing equally between members of the two species. The presence of a sibling of the same species did not weaken this dramatic effect. Having a sibling on the same species as the foster mother did not strengthen any effects. Normally raised animals in the same social environment only chose to socialise and mate with their own species in spite of having been exposed to both species from birth.

Because these species, like us, use visual cues from the face to recognise, and be attracted to, each other (which will be a major topic of my fourth lecture in this series) we also tested their attraction to photographs of faces from the two different species. This showed exactly the same level of behavioural preference, with goats raised by sheep preferring sheep faces and sheep raised by goats preferring goat ones.

We could find no evidence for either goat or sheep mothers treating their male offspring differently from females, which might have explained the sex difference in maternal impact. We also found that the differential effects on social preference were not even dependent upon the presence of testosterone during the tests. Indeed, it seems most likely that the prenatal organising influences of testosterone on the male brain are responsible for enhancing the mother's effect on the social and sexual preferences of their sons.

Of course, were this maternal influence to be transient in these animals then its significance would be of less consequence. For the next four years we therefore kept all the animals in flocks containing only members of their own species. We then re-tested their social and sexual preferences annually. For males their preference for their foster species was almost completely maintained, whereas for females they changed to preferring their own species sexually within 1-2 years although they still maintained a social interest in their foster species (Kendrick et al., 1998,2001).

While no other large scale study of this kind has been carried out on other mammals similar observations have been made in cross-fostered macaque monkeys by Fujita in Japan where visual preference for images of members of the foster mothers' species were seen.

In humans there have, of course, been stories for generations suggesting that men are attracted to women who look like their mothers. Indeed, there is the classic joke stating that: "men who marry women who like their mothers don't do so the second time around". The first study I have seen which tried to examine this in at least a quasi-scientific manner came up with two main conclusions:

(1) There was no consistent trend for men to have partners they considered to be similar to their mothers.

(2) A much greater proportion of men who did consider their partners to be similar to their mothers expressed themselves to be happier with their marriage arrangement.

More recently there have been a number of studies by David Perrett's group in the University of St Andrews that have shown significant correlations between parental age and eye and hair colour and that of a chosen partner. For both sexes these studies have shown that if your opposite sexed parent is older then you are more likely to be attracted to older partners. The same also appears true in terms of hair and eye

colour. This group is now trying to establish the true extent of parental as opposed to biological influences by establishing whether similar observations can be found in children with adopted as opposed to birth parents (visit: www.perceptionlab.com if you want to participate in this or other human facial attraction experiments).

What impact can different parenting styles have?

As far as human work is concerned this is the largest and most highly controversial field and there are not that many studies on other animal species that really qualify.

Impact of parental style on the stress and parenting responses of offspring

One of the most dramatic examples of the impact of a specific aspect of parenting on the behaviours of offspring has been shown in rats. Work particularly by Michael Meaney's group at McGill University in Canada identified two different styles of mothering in rats characterised by either high or low tactile contact (grooming) and licking of offspring. Rat pups receiving low levels of tactile stimulation developed enhanced responses to stress and carried on the trend by giving low level of tactile stimuli to their own pups (Liu et al., 1997).

There have not really been any major studies of this in humans although many would claim that "touchy-feely" type individuals are relatively outgoing and that this of often a family characteristic. However an important caveat to this is that the animal studies have shown that the early tactile stimulation does not actually have to be provided by a mother and can even be simulated by being handled by a human.

Impact of parental style on the intelligence of offspring

Rats raised by attentive mothers that provide them with high levels of licking and grooming also develop better learning skills and enhanced levels of synaptogenesis in the hippocampus of the brain (an important region for memory)(Liu et al., 2000). However, this may not to be entirely experience dependent. Whereas if pups born to less attentive mothers were raised by highly attentive ones they developed superior learning skills, those pups born to attentive mothers but raised by less attentive ones did not lose their enhanced learning skills. Thus in this case one might conclude that good parents can both improve intellectual skills through their genes and by education, whereas bad ones can't make you lose any genetic advantages you are born with. However, the work does also raise an intriguing possibility that the single experience of an attentive mother may not only improve your learning skills but also allow you to immediately pass on some of that advantage to your own offspring through your genes!

There is, of course, no direct equivalent test of this in humans although one is tempted to assume that a similar pattern of results might be achieved. Studies in humans have however shown that if both parents are in full time work, between the ages of 1-5 years of a child's life, this impacts negatively on attainment of A level grades irrespective of parental educational background (Ermisch and Francesconi 2001).

Impact of parental style on personality traits

The main area worked on here is in relation to aggression. Cross-fostering experiments in animals involving strains of rodents characterised by high or low levels of aggression have shown strong parental influences. Thus in a recent cross-fostering experiment between aggressive monogamous California mice and less aggressive promiscuous White-footed mice, fostered offspring took on the aggressive characteristics of their parents rather than their sub-species. They also developed the same patterns of vasopressin concentrations (Bester-Meredith and Marler, 2001) – this peptide is strongly associated with aggression as well as with monogamy and paternal care in other contexts.

Some studies in humans have also reported enhanced aggression in children brought up by families with high levels of aggression.

A related area to this is the influence of parental importance in their social hierarchy on the dominance behaviour of their offspring. In most social mammals there is what amounts to a social class structure whereby if your mum is a force to be reckoned with so will you be. If she is at the bottom of the pecking order you are also likely to adopt a submissive social attitude. This is not a simple matter of genetic inheritance because it seems to matter more who acts as your mother rather than simply whether your

biological mother was high or low ranking. While this has a lot to do with how, by association, you are treated by all the other members of your social group, it may also reflect what young learn from the reactions of their mothers to other group members.

While many human societies have reduced the importance of social hierarchies it is still not hard to see this kind of social status influence of parents being passed on to their children.

Impact of parental style on dietary preferences

Social effects on dietary preferences are widespread in mammals, including humans. Rats and mice for example can pass on a preference for a particular food just from another animal smelling it on their breath for a few seconds. In humans peers are generally thought to be more influential on dietary habits than parents. However it would appear that parents might have the greatest initial effects.

In sheep, and a number of other mammals dietary preferences and aversions acquired from experience with mothers are stronger and longer lasting than those acquired in other social contexts. The sheep work has even reported such individual preferences and aversions enduring 3-years after the lamb has been taught by its mother but has not had experience of the food since.

Similar work in humans has also shown that the diets provided by parents can have effects on dietary preferences of their children (Escobar, 1999). It is a sobering statistic that children raised by non-obese parents have only a 7% chance of becoming obese whereas if a single parent is obese this rises to 40% and all the way up to 70% if both parents are obese. There can still be genetic inheritance contributions here but the likelihood is that it is more to do with the type of diet given to the children by their parents permanently enhancing their preferences for sugar and high fat foods.

Parental influences on diet are not of course simply restricted to learning likes and dislikes but also extend to learning how to obtain desired foods. Again animal parents are highly instrumental in teaching their offspring how to find and hunt for food and this process can go on for a number of years while they struggle to become proficient.

Some general final conclusions on the significance of parental care :

Parental care has allowed highly adaptable and complex species to evolve with greater capacity for dealing with even the most difficult environments

It has provided the basis for species to develop social, emotional and co-operative ties

It has allowed greater social transmission of survival skills and even social and sexual attraction to the opposite sex.

Other fundamental aspects of everyday living such as what foods you like and how to get them are also strongly influenced.

Having good attentive parents will enhance social competence and dealing with stress

They may even help you make the most of your intellectual skills.

However, levels of aggression and social dominance may also be passed on.

The beauty of it all is that no matter what children may think of their parents when they grow up, the influences they can have on them are mainly only during the earliest periods of their lives.

So “Is having a good parent more important than having good genes?”:

Perhaps my general answers to this are that while having good genes is a very important starting point:

(1) Having good parents is important for creating a strong social and emotional base upon which to exploit fully the advantages of having inherited good genes.

(2) There is not much point having good genes if a lack of positive early experiences with parents make you unable to cope with the life and society they need to be exploited in.

(3) Just as parents have a capacity for enhancing the genetic advantages of their offspring they can also promote the expression of more negative behaviours.

References

Selected references:

Allman J et al. (1998) Parenting and survival in anthropoid primates: caretakers live longer. Proceedings of the National Academy of Sciences USA 95:6866-6869.

Bester-Meredith JK and Marler CA (2001) Vasopressin and aggression in cross-fostered California mice (peromyscus californicus) and white-footed mice (peromyscus leucopus). Hormones and Behavior 40: 51-64.

Clutton-Brock TH (1991) The Evolution of Parental Care. Princeton University Press, New Jersey, USA.

Ermisch J and Francesconi M (2001) The effect of parents' employment on childrens lives. Family Policy Studies Centre (ISBN 1 901455602).

Escobar A (1999) Factors influencing children's dietary practices: a review. Family Economics and Nutrition Review 12: 45-55.

Kendrick KM et al., (1998) Mothers determine sexual preferences. Nature 395:229-230.

Kendrick KM (2000) Oxytocin, motherhood and bonding. Experimental Physiology 85S 111S-124S.

Kendrick KM et al (2001) Sex differences in the influence of mothers on the sociosexual preferences of their offspring. Hormones and Behavior 40:322-338.

Liu D et al., (1997) Maternal care, hippocampal glucocorticoid receptors systems and the development of individual stress responses to stress. Science 277:1659-1662.

Liu D et al (2000) Maternal care, hippocampal synaptogenesis and cognitive development in rats. Nature Neuroscience 3:799-806.

Perrett DI et al., (2001) Facial attractiveness judgements reflect learning of parental age characteristics. Proceedings of the Royal Society London B 269:873-880.