Sexual Selection, Physical Attractiveness, and Facial Neoteny

Cross-cultural Evidence and Implications[1]

by Doug Jones

Physical attractiveness and its relation to the theory of sexual selection deserve renewed attention from cultural and biological anthropologists. This paper focuses on an anomaly associated with physical attractiveness—in our species, in contrast to many others, males seem to be more concerned than females with the attractiveness of potential sexual partners, perhaps because humans show far more age-related variance in female than in male fecundity. The resulting selection for male attraction to markers of female youth may lead incidentally to attraction to females displaying age-related cues in an exaggerated form. This paper reports cross-cultural evidence that males in five populations (Brazilians, U.S. Americans, Russians, Ache, and Hiwi) show an attraction to females with neotenous facial proportions (a combination of large eyes, small noses, and full lips) even after female age is controlled for. Two further studies show that female models have neotenous cephalofacial proportions relative to U.S. undergraduates and that drawings of faces artificially transformed to make them more or less neotenous are perceived as correspondingly more or less attractive. These results suggest several further lines of investigation, including the relationship between facial and bodily cues and the consequences of attraction to neoteny for morphological evolution.

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The first publication by Darwin to discuss human evolution at length bears the double title "The Descent of Man, and Selection in Relation to Sex" (1981[1871]) and consists of two works back to back. The first work discusses human evolution and argues "that man is the modified descendant of some pre-existing form" (p. 9). The second presents the topic of sexual selection—a form of natural selection resulting from "the advantage which certain individuals have over other individuals of the same sex and species, in exclusive relation to reproduction" (p. 256). Darwin yoked human evolution and sexual selection together in a single volume because he believed that sexual selection had played a major role both in the descent of humans from earlier forms and in the differentiation of human races.

In the half-century after Darwin published this work, a number of authors took up the topic of physical attractiveness across cultures. Many, such as Westermarck (1921) and Ellis (1926), followed Darwin's lead in trying to relate the development of standards of physical attractiveness in humans to the theory of sexual selection. Subsequently, however, the social sciences grew increasingly divorced from evolutionary theory and from the study of physical variation (Degler 1991). Almost 20 years ago, Berscheid and Walster (1974:158) summarized the consequences of this divorce for the study of physical attractiveness: "Most social scientists have shown a studied professional disinterest in . . . how our physical appearance influence[s] our relationship with others."

More recently, there has been a revival of interest in the topic of attractiveness and an explosion of social psychological research on the subject, demonstrating significant agreement across raters in judgments of attractiveness and significant social consequences of attractiveness. This literature has been surveyed at book length by Patzer (1985), Hatfield and Sprecher (1986), Bull and Rumsey (1988), and Jackson (1992). There is also considerable ethnographic material on standards of attractiveness in non-Western societies, for example, Malinowski (1961[1929]), Berndt (1951), Weiner (1976), Gregor (1985), Boone (1986), Euba (1986), Munn (1986), Grinker (1990), and Jankowiak (1993). However, existing research still suffers from several limitations. First, the work of social psychologists is heavily empirical and descriptive, with little in the way of theory that would explain why people find particular features attractive or even why they experience physical attraction at all. Second, cultural anthropologists have rarely made research on standards of attractiveness and their consequences a major objective of fieldwork; the ethnographic literature records few if any attempts to quantify agreement be-

tween individuals about standards of attractiveness, to assess the social and life-history consequences of being perceived as attractive or unattractive, or to compare standards of attractiveness across societies. Thus the study of attractiveness in the social sciences is underdeveloped in important respects—undertheorized in psychology and both undertheorized and underresearched in cultural anthropology.

In biological anthropology too, the topic of physical attractiveness and its possible evolutionary causes and consequences has been relatively neglected. This neglect is part of a wider neglect of the theory of sexual selection in the field of evolutionary biology between the 1930s and the 1970s—a period that West-Eberhard (1983:156) calls "the Forgotten Era" of sexual selection theory (see also Cronin 1991). In the 1930s and '40s, evolutionary biologists formulated the "modern synthesis"—a synthesis of Darwin's theory of evolution and the new science of genetics. The pioneers of the modern synthesis had their hands full investigating adaptation to ecological constraints. They were less concerned with the evolution of social behavior and had little use for Darwin's theory of sexual selection.

Why did the theory of sexual selection take so long to win acceptance in evolutionary biology? Sexual behavior and social behavior in general pose special problems for evolutionary theory. These problems result from the fact that in social evolution the fitness of a trait commonly depends on its frequency (Maynard Smith 1982). How well a particular shape of tail serves a given bird in flight will generally not depend on the frequency in the population of tails of various shapes— that is, its fitness is frequency-independent. By contrast, the attractiveness of that tail to members of the other sex will depend on the preferences of the other sex, which will often depend in turn on the frequencies of various shapes of tail—that is, its fitness is frequency-dependent.

Frequency-dependent selection presents a number of seeming paradoxes. Under frequency-dependent selection there is no guarantee that natural selection will favor genetic variants that maximize mean population fitness. Instead, populations may attain an evolutionary equilibrium in which no individual can gain by adopting a different strategy, even though all would be better off if all acted differently. Or they may enter an endless "arms race" in which each tries to get ahead of the others without anyone's enjoying any long-term gains. Frequency-dependent selection may favor traits that increase the reproductive success of individuals but reduce the viability of groups and lower the productivity of ecosystems. It may favor the evolution of waste and extravagance, rather than efficiency, in sexual and other signals. It may result in coevolutionary positive feedback cycles that amplify arbitrary traits. It was only beginning in the 1960s, with the development of sociobiology and evolutionary game theory, that the problems associated with frequency-dependent selection were addressed in a sustained fashion.

The modern synthesis of the 1930s and '40s inspired

the "new physical anthropology" of the 1940s and '50s, and the neglect of sexual selection in the early modern synthesis was inherited by biological anthropology. Until recently, relatively few serious quantitative studies in physical anthropology paid attention to the possible role of sexual selection in human evolution. Hulse's (1967) study of skin-color variation in modern Japan suggested that sexual selection might influence the evolution of this trait, and a number of studies of assortative mating for physical traits (Spuhler 1968) suggested how mating patterns might influence genotype frequencies. However, Hulse's work inspired little comment or follow-up, and the literature on assortative mating was largely silent about the *causes* of the patterns observed. Thus in spite of Darwin's argument that sexual selection played a central role in human evolution, serious quantitative studies of adaptation in physical anthropology have focused overwhelmingly on adaptation to the physical environment. Only recently, with the rise of human behavioral ecology, have anthropologists begun trying to bring the modern theory of sexual selection to the study of human evolution (Chagnon and Irons 1979, Betzig, Turke, and Borgerhoff Mulder 1988). But to date, most such studies have focused on sexual selection and mate choice more in relation to behavior than in relation to morphology.

In conclusion, the study of physical attractiveness in the context of the theory of sexual selection, which was given a central place by Darwin, Westermarck, and Ellis, has not been a major topic for anthropological inquiry in the last half-century. It is not that investigation has shown attractiveness to be ill-defined or inconsequential; both social psychological studies and the ethnographic literature suggest at least moderate agreement in judgments of attractiveness within cultures and at least a moderately important role for attractiveness in social and especially sexual interactions. Rather, particular theoretical presuppositions have kept both cultural and biological anthropologists from giving these topics their full attention. Cultural anthropologists have been reluctant to deal with the more "biological" side of human behavior—reluctant to consider human behavior as the product not just of strivings for individual gains such as material comfort and social status but of adaptations for genetic reproduction. Biological anthropologists have often held a view of adaptation that could not readily accommodate frequency-dependent selection, including the possibility that one individual's reproductive success might come at the expense of others.

The theory of sexual selection has advanced so far in recent years that it may be time for renewed attention to the relationship between sexual selection and standards of physical attractiveness in our species. The theory of sexual selection does not imply that people always maximize inclusive fitness in choosing a mate—adaptations are often imperfect, and in humans as in other animals esthetic standards may be partly the product of nonadaptive "sensory biases." Nor does it imply that standards of beauty are completely "hard-wired"; in humans as in other animals the development of stan-

dards of attractiveness is likely to involve a range of mechanisms, from innate templates to imprinting to imitation and other forms of social learning. It does imply, however, that human beings, like other animals, are likely to have genetic adaptations for assessing the "mate value" of potential mates and that studying attractiveness without considering these adaptations would be like trying to understand the eye without treating it as an organ of vision.

Sexual Selection and Physical Attractiveness: A Human Anomaly

Sexual selection occurs when some organisms gain an edge in mating and fertilization at the expense of others of their sex. Sexual selection may take the form of contests within one sex over chances to mate with and fertilize members of the other sex or courtship of one sex by the other.[2]

In many animal species, male reproductive success is more dependent on mating success than is female reproductive success, so sexual selection commonly acts with greater intensity on males than on females (Trivers 1971, Williams 1975, Clutton-Brock and Parker 1992, Andersson 1994). The result is that in many species, males more than females show a syndrome of traits associated with intense sexual selection. This "sexual selection syndrome" includes behavioral traits: males are more likely than females to resort to violence against sexual rivals and to force copulations on resisting partners; males commonly expend more time and energy and take greater risks than females in courtship; males will generally court and attempt copulation with a wider range of partners than will females. The sexual selection syndrome also includes life-history traits: males commonly take longer than females to attain sexual maturity because of the sexual competition that they face from mature males; males commonly have higher mortality rates than females as a result of intrasexual competition; males commonly senesce more rapidly than females because higher mortality rates reduce the selection pressure for longevity. Finally, the sexual selection syndrome includes morphological traits: males are more likely than females to display anatomical specializations for intra- and intersexual aggression, including horns, antlers, enlarged canine teeth, and body sizes in excess of the ecological optimum; males commonly show greater development of sexual advertisements, both tactile (complex genitalia) and visual (elaborate and brightly colored adornments).

Among humans, considerable anatomical and behavioral evidence suggests that males have been subject to stronger sexual selection than females, although the differences are less pronounced than among many other mammals (Daly and Wilson 1983:279–312). Human males are larger than females. Human males attain sexual maturity at a later age than human females and senesce more rapidly. In all societies with appreciable levels of violent conflict, male-male aggression is more common than female-female aggression. Violent competition is more common among human males than among females, and male sexual coercion of females is far more common than the reverse. Polygyny is much more common than polyandry. And in most respects, human females seem to be more selective than human males in their choice of sexual partners.

In one respect, however, human beings reverse the usual pattern of differences between more and less sexually selected sexes—men are more concerned than women with the physical attractiveness of a potential sexual partner. This sex difference has been found repeatedly in studies by social psychologists. A recent meta-analysis (Feingold 1990) of the social psychological literature on sex differences in effects of physical attractiveness on romantic attraction shows consistent and strong sex differences, including content analyses of "lonely-hearts advertisements," studies of attractiveness and reported dating success, reports of interpersonal attraction following dyadic interaction, and surveys of characteristics desired in a mate (see also Jackson 1992:65–67).

This sex difference is not limited to Western society. Buss (1989) reviews survey data from 37 population samples from 33 countries and finds that in every sample males are more concerned than females with the physical attractiveness of a potential mate. The average sex difference is more pronounced among the non-Western populations in his sample. While Buss's study includes no tribal populations, the same pattern apparently holds for these as well. Ford and Beach (1951:94), summarizing evidence from nearly 200 cultures, conclude that although there is a great deal of cross-cultural variation in standards of attractiveness, "in most societies the physical beauty of the female receives more explicit consideration than does the handsomeness of the male. The attractiveness of the man usually depends predominantly upon his skills and prowess rather than upon his physical appearance." Gregersen (1983) reports similar findings in a more recent review of nearly 300 societies, mostly non-Western and nonurbanized.

In other words, human beings seem to be an exception to the general rule among animals that male attractiveness matters more than female attractiveness. The importance attached to female (as opposed to male) physical attractiveness in our species stands in need of an explanation.

An Anomaly Explained? Fecundity, Age, and Neoteny

Many anthropologists believe that human behavior is so radically different in its ontogeny from that of other organisms that the theory of sexual selection is not ap-

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2. Smuts and Smuts (1993) argue that it is useful to distinguish a third form of sexual selection, sexual coercion of one sex by the other.

plicable to human physical attraction. Polhemus (1988:8) probably expresses the attitude of a whole school of anthropology of "the body" concerning the human irrelevance of the theory of sexual selection when he writes:

> A male baboon has a fixed idea of what a desirable female baboon should look like. . . . The same general principle is true of any animal that reproduces by sexual selection. But there is an important difference between baboons and ourselves. For other animals the physical ideal is 100% instinctively determined. Thus all baboons of a particular species pursue the same ideal. . . . For humans, on the other hand, ideals of beauty are *learned*. . . . In a worldwide and historical framework, there is no such thing as natural human beauty.

If this view of the difference between human and nonhuman psychology were correct, the anomaly of female attractiveness in our species might be merely one more consequence of our having freed ourselves from the instinctive constraints that hobble the lives of other animals. This view, however, is doubly wrong.

First, learning often plays a large role in the acquisition of standards of attractiveness among nonhuman animals. An immense literature demonstrates that early experience influences later mate choice via imprinting (Immelman 1972). Imitation, too, plays a role in mate choice among nonhuman animals, and social transmission of mating preferences can even result in "fads" in mate choice that change from one breeding season to the next (Pruett-Jones 1992).

Second, physical attraction in humans cannot be entirely a product of enculturation. This is shown most dramatically by the experiments of Langlois et al. (1987). In these experiments, infants between the ages of two and three months were exposed to pictures of women rated attractive and unattractive by adult raters; infants spent more time looking at faces rated attractive. This held even across racial/cultural boundaries: for European-American infants looking at faces of African-American women rated by African-American men and for African-American infants exposed to European-American faces rated by European-American men.

Thus students of physical attractiveness are asking for trouble if they start out assuming that nonhuman animals are creatures of instinct and humans constructions of culture. A better starting point regarding the role of learning in behavior is suggested by several decades of research in comparative psychology: as a general rule, organisms have relatively "hard-wired" or canalized responses to stimuli that have had relatively unvarying fitness consequences over evolutionary time and relatively flexible learned responses to stimuli that have been associated sometimes with positive fitness consequences and sometimes with negative. In other words, given that learning entails costs, in terms of trial and error, organisms are expected to adapt to selectively important invariants in their environments with corresponding behavioral, cognitive, or motivational invariances (Seligman 1970, Johnston 1982).

How can we apply this principle to the anomaly of female attractiveness in our species? Let us define the mate value of a potential sexual partner, A, as the expected reproductive success from mating with A divided by some baseline expected reproductive success. The baseline expected reproductive success might be the expected reproductive success from mating at random or from mating with an individual of maximum mate value. As a general rule we expect that human beings, and other animals, are likely to have *both* relatively canalized, "hard-wired" responses to visual stimuli that have been consistently associated with high mate value throughout the evolutionary history of the species *and* relatively flexible learned responses to stimuli that have been associated sometimes with high mate value and sometimes with low. In other words, standards of physical attractiveness are likely to have both species-typical and population-specific components, and variation in these components may be predictable given knowledge of human biology and local circumstances (Symons 1979). For example, since fat stores may be selectively advantageous in environments subject to episodic food shortage and disadvantageous in environments requiring considerable physical movement, one might expect that esthetic responses to fatness would vary between populations depending on social learning and on individual assessments of the consequences of being fat or thin, rather than developing in a uniform fashion within the human species.

By contrast, one might expect human beings to have a relatively invariant, species-typical emotional response to signs of aging, because age has a relatively invariant association with fecundity and thus with mate value. In a classic article Henry (1961) reviews data on age-specific fertility rates in a wide range of "natural-fertility" (noncontracepting) populations. The *levels* of fertility in these populations range from a lifetime average of 6 to 11 children per married female, but the *shapes* of the curves of fertility versus age are remarkably similar across all populations. For all populations, female fertility rates at age 30–34 are around 85% of rates at age 20–24, with further declines to around 35% for women aged 40–44 and 0% for women aged 50–54. More recent work suggests that the curve of natural fecundity (potential reproduction) differs somewhat from the curve of natural fertility (actual reproduction) because the latter is influenced by such variables as age of spouse and frequency of intercourse (James 1979, Menken, Trussell, and Larsen 1986). Studies that control for the latter variables suggest that the decline in female fecundity between 20 and 35 is less pronounced than the decline in female natural fertility—but the overall shapes of the two curves are fairly similar.

The shape of the curve of fecundity versus age is very different for males. Goldman and Montgomery (1989), reviewing data from several traditional societies, report fertility declines to about 90% for men between 45 and 50, relative to younger men, and to about 80% for men over 55, after controlling for age of wife and duration of marriage.

Fecundity versus age curves thus have two important

characteristics that may help to explain the anomaly of female attractiveness: the curves (1) are relatively invariant in shape across populations and (2) show an earlier and more pronounced decline in fertility among females than among males. Given the general rule that organisms commonly have invariant responses to stimuli that have had relatively invariant fitness consequences over evolutionary time, the first characteristic suggests that human beings are likely to have relatively invariant esthetic responses to signs of aging. The second characteristic suggests that these responses are likely to be stronger in males' evaluations of females than in females' evaluations of males.

This does not add up to a complete theory of physical attractiveness, of course, or even a complete theory of age-related changes in physical attractiveness. Fecundity is only one component of mate value. Other components include the ability and willingness to provision offspring and heritable viability or attractiveness ("good genes"), and these components of mate value may also vary with age, while sensory bias will ensure that attractiveness does not track mate value perfectly. Nevertheless, age-related changes in fecundity are likely to be a particularly important component of age-related changes in physical attractiveness, especially in females, both because these changes have been relatively invariant over the history of the species and because other components of mate value such as provisioning ability and inclination may be more readily assessable on the basis of behavior than on the basis of physical appearance.

There is one alternative explanation for male attraction to youthful features in females that requires a more extended treatment. Gowaty (1992:231–40) writes:

> There should be strong selection on males to control females' reproduction through direct coercive control of females. . . . Evolutionary thinkers, whether informed by feminist ideas or not, are not surprised by one of the overwhelming facts of patriarchal cultures, namely that men . . . seek to constrain and control the reproductive capacities of women. . . . Juvenilization decreases the threat some men may feel when confronted with women; many men are comfortable around women whom they can clearly dominate and are profoundly uncomfortable around women whom they cannot so clearly dominate. The hypothesis that femininity signals ability to be dominated through juvenilization is an alternative to, but not necessarily mutually exclusive of, other evolutionary hypotheses that posit that femininity signals, sometimes deceptively, reproductive value and fertility.

Several findings seem to be at odds with this hypothesis. Berry and McArthur (1986) presented subjects with a series of outline profile drawings representing individuals ranging from juvenile to adult and collected ratings of perceived social characteristics of each drawing. The drawing rated weakest and least threatening was the most juvenile-looking. (Subjects judged this drawing to represent a 4-year-old.) The drawing rated sexiest was intermediate in juvenility. (It was judged to be 23 years old.) In other words, the level of juvenility that maximizes perceived vulnerability does not maximize perceived sexiness. Kenrick and co-workers (Kenrick 1994) show that for teenage males the ideal sexual partner is older than they are—again, more consistent with the hypothesis that males are concerned with cues to female fecundity than with the hypothesis that males prefer younger, more easily dominated females. Thus current evidence suggests that female attractiveness cannot simply be equated with powerlessness and that something more than changes in perceived vulnerability is involved in age-related changes in physical attractiveness. However, nothing in evolutionary theory rules out the possibility that markers of female submissiveness may be attractive to men, and the topic certainly deserves more research.

There may be room for argument about *why* attractiveness changes with age, but, in spite of a considerable literature devoted to the claim that human sexuality and standards of physical attractiveness are culturally constructed, there does not seem to be *any* evidence from *any* society that seriously challenges the proposition that physical attractiveness *is* perceived to decline from young adulthood to old age, especially for females. "The correlation of female age and sexual attractiveness is so intuitively obvious that ethnographers apparently take it for granted—as they do the bipedalism of the people they study—and the significance of female age tends to be mentioned only in passing, in discussions of something else" (Symons 1979:188). Symons cites passing references to the effects of aging on female attractiveness in ethnographies of the Kgatla, pre-revolutionary China, the Yanomamö, and the Tiwi. Additional references can be found in ethnographies of Trobriand Islanders (Malinowski 1987 [1929], Weiner 1976) and Gawa (Munn 1986) of Melanesia, Mende (Boone 1986) of Sierra Leone, and Mehinaku of Amazonia (Gregor 1985), to name just a few. A number of social psychological studies (reviewed in Jackson 1992) have documented such age-related declines in physical attractiveness and demonstrated the expected sex differences as well.

Let us summarize the argument up to this point. Human beings are anomalous among sexually selected species in the importance attached to female (relative to male) appearance in mate choice. Human beings are anomalous in another respect as well: female fertility commonly declines to zero long before the end of the life span. As a result of menopause there is considerably more age-related variance in fecundity among adult females than among adult males in our species. The second anomaly may explain the first: the importance attached to female attractiveness in our species may reflect the operation of adaptations for assessing age-related changes in fecundity, a component of female mate value. Whether for this reason or another, social psychological and ethnographic evidence provides overwhelming support for the proposition that human beings have relatively invariant esthetic responses to signs of aging and that these responses operate more strongly in males' evaluations of females than vice versa.

Thus far we have been exclusively concerned with changes in attractiveness with age rather than differences in attractiveness between individuals of the same age. However, if age-detecting mechanisms do not operate with perfect accuracy, then adaptations for choosing a mate of a particular age may lead incidentally to nonadaptive biases in the choice of mates from among individuals who fall *within* a particular age-class. In other words, given that attractiveness varies with age, individuals may be more or less attractive than others of the same age in part because they have facial proportions associated with younger or older ages. Because the retention of traits from early stages of the life cycle into later stages, relative to ancestors or to other members of the population, is known as neoteny ("holding on to youth"), the proposition above may be rephrased: given that attractiveness varies with age, neoteny may be a component of facial attractiveness. This proposition may hold with particular force for female facial attractiveness: a by-product of the human male's attraction to markers of youthful fecundity may be an attraction to adult females presenting markers of youth to an exaggerated or "supernormal" degree.

Beginning with the anomaly of female attractiveness in our species, we are led to the hypothesis that neoteny may be a component of female facial attractiveness. The remainder of this paper will be given over to testing and elaborating this hypothesis.

Cephalofacial Age Markers

To consider how age-related changes in physical attractiveness might result from differing esthetic responses to differing facial proportions, it is necessary to review how the sizes and shapes of facial features change with age. It is convenient to divide these changes into changes in hard tissue (bone) and changes in soft tissue (cartilage and connective tissue).

Hard tissue. In human beings as in other mammals, the neurocranium—the portion of the skull housing the brain but also including the contiguous orbital region—grows rapidly early in development, while the facial skeleton proper—including the nasal and masticatory complexes—attains its maximum rate of growth only later (Enlow 1990). As a result, juvenile mammals present a characteristic "cute" appearance, with relatively large eyes, high foreheads, and reduced snouts.

Changes in the shape of the craniofacial skeleton associated with aging are closely approximated by a simple mathematical transformation called cardioidal strain (Mark, Shaw, and Pittenger 1988). Cardioidal strain of degree k maps each point $\{x, y\}$ onto $\{x', y'\} = \{x \cdot (1 - k \cdot y/r), y \cdot (1 - k \cdot y/r)\}$ where $r^2 = x^2 + y^2$. A shape subject to positive cardioidal strain ($k > 0$) shows a downward and outward expansion in features located toward the bottom and a downward and inward contraction in features located toward the top. Negative cardioidal strain presents the opposite changes. Pictures of the faces of children or young adults subjected to a posi-
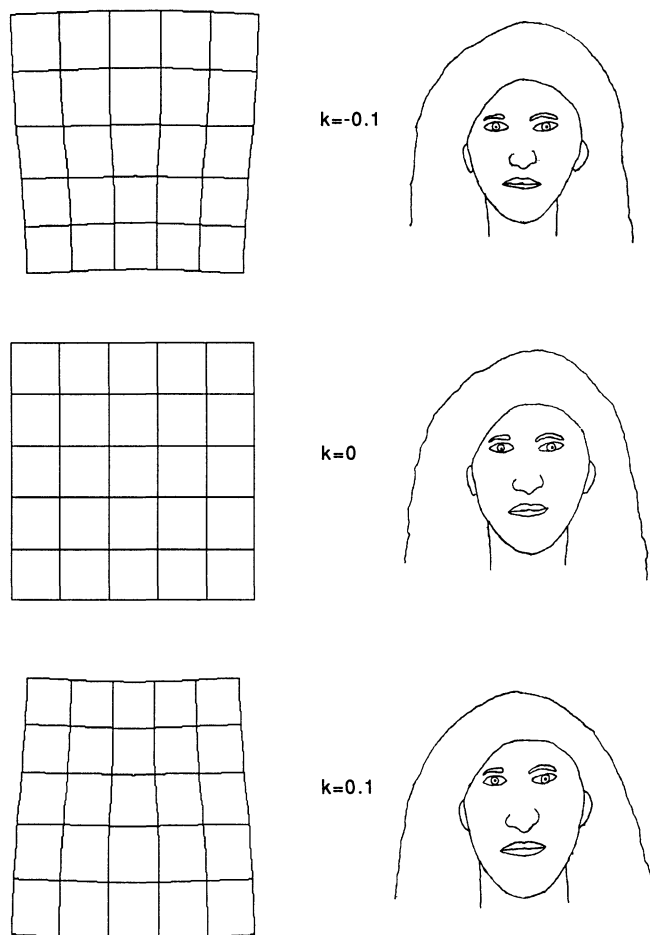
FIG. 1. *The effects of negative* (top row) *and positive* (bottom row) *cardioidal transformations on a 5 × 5 grid and on a female face.*

tive cardioidal transformation are perceived as older and less cute; pictures subjected to a negative transformation are perceived as younger and cuter. Full facial and profile drawings of the heads of birds, monkeys, and dogs and even front and side drawings of Volkswagen Beetles can be made to appear more or less "mature" or "cute" by subjecting them to positive or negative cardioidal strain. Figure 1 illustrates the effects of positive and negative cardioidal strain on a square grid and on a face. The transformed grids were produced with the Mathematica 2.2 software package, while the transformed faces were redrawn from the original face with the assistance of polar coordinate graph paper.

Attraction to "cute" proportions may be unlearned: even at 4 months of age infants orient preferentially toward pictures of infant rather than adult faces—although it is not known whether infantile facial proportions per se are the relevant cue (McCall and Kennedy 1980). I have cited research (Langlois et al. 1987) showing that infants as young as 2 months of age orient preferentially toward attractive rather than unattractive female faces. If, as I will argue, female attractiveness is

partly a matter of cephalofacial neoteny, then infant preferences for attractive female faces may be part of a more general attraction to faces or facelike stimuli manifesting low cardioidal strain.[3]

Soft tissue. Skeletal growth slows down (but does not stop [Behrents 1985]) with the attainment of adulthood. However, other changes in facial proportions result from the growth of cartilage and the atrophy of connective tissue. These affect the relative sizes of eyes, noses, ears, and lips. "Beginning at age 25, the eyebrows steadily descend from a position well above the supraorbital rim to a point far below it; sagging of the lateral aspect of the eyebrows make the eyes seem smaller" (Larrabee and Makielski 1993:14). Cartilaginous tissues grow steadily throughout adulthood: ears get bigger, and noses get longer, wider, and more protrusive with increasing age. With the loss of connective tissue, the vermilion or red zone of the lips gets thinner (Enlow 1990, Larrabee and Makielski 1993, Susanne 1977).

As a result of changes in hard and soft tissue with age, it is possible to estimate ages of adults using information about the relative sizes of eyes, noses, and lips.

Neoteny and Attractiveness

A youthful or neotenous face is one that combines a high ratio of neurocranial to lower-facial features with a small nose and ears and full lips. The appendix gives a summary of a number of studies of neoteny and facial attractiveness. Virtually all of them find that neotenous facial proportions, as defined above, contribute to female attractiveness. Results for males are equivocal. One limitation of these studies is that they are confined to Western societies or societies strongly influenced by Western ideals of physical attractiveness. For example, Wagatsuma (1968) shows that contact with Europeans and U.S. Americans has had a significant influence on Japanese standards of attractiveness over the past hundred years. Because the line of argument presented above suggests that attraction to female cephalofacial neoteny is a good candidate for a human universal, it is important to establish whether such attraction is characteristic of non-Westernized societies as well.

This paper reports results from an ongoing cross-cultural study of criteria and consequences of physical attractiveness one of whose aims is to investigate possible universals of attractiveness by collecting data from as wide a range of populations as practical. Populations studied to date include two relatively isolated indigenous South American groups, the Ache (or Guayaki) of

eastern Paraguay and the Hiwi (or Cuiva) of southern Venezuela, as well as three Westernized societies—Brazil, the United States, and Russia. Each of the Westernized populations is the subject of a large body of ethnographic literature; below I provide a very brief summary of some facts relevant to physical attractiveness in the two indigenous South American populations. The Ache and the Hiwi were first peacefully contacted by outsiders in the 1960s and 1970s; up to that time they had lived as hunter-gatherers. Members of the two populations know what outsiders look like, but most have little contact with outsiders on a day-to-day basis. Both groups maintain a strongly ethnocentric standard of physical attractiveness. For the Ache, Kim Hill (personal communication) writes, "The Ache have frequently commented on how ugly Europeans are particularly because of their long noses (they called us *pyta puku*—long nose—behind our backs) and because they are so hairy." These responses are similar to those reported by Wagatsuma (1968) for the first generation of Japanese exposed to contacts with Westerners. Although the Ache and the Hiwi have had little or no contact with Asians or Asian-Americans, they are curious about photographs of East Asian faces, generally attracted to them, and aware of the similarity between these faces and their own. A previous study (Jones and Hill 1993) showed much stronger agreement in ratings of attractiveness among the three Western societies in the sample (mean correlations in ratings of attractiveness $r = .64$) than between Westerners and Ache and Hiwi. The latter correlations were still significantly positive ($r = .18$), however, suggesting a universal as well as a culture-specific component to standards of attractiveness.

Below I present three studies addressing the topic of neoteny and female facial attractiveness. Data for males are included for purposes of comparison. Since previous studies of neoteny and facial attractiveness show a positive relationship for females and an equivocal relationship for males, I use one-tailed statistical tests for females and two-tailed tests for males. The first study includes data from all five populations. The other two studies are more preliminary, but further fieldwork is planned to test the artificial stimuli of the third study in a wider range of populations.

STUDY I: AGE PREDICTORS AS ATTRACTIVENESS PREDICTORS ACROSS CULTURES

Between 1989 and 1992 I collected data on standards of physical attractiveness in four populations: U.S. Americans, Brazilians, Russians, and Ache Indians. Kim Hill, currently at the University of New Mexico, assisted with data collection among the Ache and collected additional data among the Hiwi. The research material reported on in this paper includes facial photographs of individuals in three populations and interview data and ratings of attractiveness of facial photographs from five populations. Facial photographs derive from undergraduates at the University of Michigan in Ann Arbor, students at the Federal University of Bahia in Salvador,

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3. Neotenous facial proportions in children may be a releaser for parental behavior (Lorenz 1943). McCabe (1988) reviews studies showing that subjects report a greater willingness to nurture and protect children with a high ratio of neurocranial to lower-facial features. She also cites research conducted at several localities showing that abused children under court protection (ages 3–6) have lower ratios of neurocranial to lower-facial dimensions—that is, are less cute—than age-matched nursery school control groups.

Brazil, and natives of two Ache villages. Ratings of photographs and questionnaire/interview data were collected from a second sample of University of Michigan undergraduates, from middle- and lower-class residents of Salvador, Brazil, from natives of another Ache village, from students at the Russian State University of the Humanities in Moscow, and from a Hiwi settlement.

U.S. American photographic subjects and raters were recruited in introductory anthropology and psychology courses and by flyers posted on campus. For Brazilian and Ache photographic subjects, photographic equipment was set up in public places, and interested individuals were invited to participate. Brazilian, Russian, Ache, and Hiwi raters were recruited by going from door to door and by approaching potential raters in public places.

U.S. photographic subjects and raters were largely of European ancestry; attractiveness ratings of and from Asian-Americans and African-Americans are omitted in this analysis because a restricted sample provides a better test of hypotheses. Brazilian subjects and raters largely identified themselves as being of mixed ancestry, mostly African and European with some Indian ancestry. (The issues raised for the study of physical attractiveness by Brazil's combination of race mixture and racial stratification cannot be treated at any length here but are discussed in Jones [n.d.].) Russian raters were largely of Russian nationality with some other nationalities of the former Soviet Union present as well. Mean ages of photographic subjects were 23, 20, and 29 for Brazilian, U.S. American, and Ache females and 24, 21, and 32 for Brazilian, U.S. American, and Ache males; age ranges were 17–34, 18–25, 14–51, 19–32, 18–30, and 16–60.

Facial photographs were taken indoors in the United States and outdoors in Brazil and Paraguay at a fixed distance in a standard position. Ratings of photographs were collected by having raters rank subsamples of a photographic sample population. For Brazilian and U.S. American photographic samples, new subsamples were drawn at random for each rater. Because Ache photographic subjects spanned a wider range of ages, individuals from the Ache photographic sample were assigned to fixed subsamples with others of similar age. Each rater rated photographs of members of the opposite sex drawn from a single photographic sample population; ratings of all three photographic sample populations were collected in each of five populations of raters (except for Hiwi rating U.S. Americans). The attractiveness rating of a given photograph relative to a given population of raters is the mean attractiveness rating of that photograph across raters from that population, with age of photographic subject partialled out. For Ache, reported correlations between attractiveness ratings and relevant variables are means of correlations within subsamples (more exactly, means calculated using Fisher's z-transformation and its inverse [Sokal and Rolf 1969: 520–23]). An Apple Scanner connected with a Macintosh II was used to measure {x, y} coordinates of a number of facial photographic landmarks. Jones and Hill

(1993) and Jones (n.d.) provide further discussion of procedures involved in taking, rating, and measuring photographs.

For each photograph in each population sample I calculated the following measures of facial proportions: eye width (EW = mean of D[left endocanthion, left exocanthion] and D[right endocanthion, right exocanthion]), nose height (NH = D[glabella, subnasale]), and lip height (LH = D[labiale superius, labiale inferius]), where $D(a,b)$ is the Euclidean distance between photographic landmarks a and b, and landmark names follow definitions in Farkas (1981). For the analysis below I have divided each measure by face height (FH = D[glabella, gonion]) to correct for differences in sizes of faces, producing three indices of facial proportions: relative eye width (EW/FH), relative nose height (NH/FH), and relative lip height (LH/FH). These indices were selected to measure the relative sizes of the three major facial features—eyes, nose, and lips. I demonstrate below that they do vary as expected with age—eye width and lip height decrease, and nose height increases. Two other features that might have been included, ear height and cheek width, are omitted from this analysis: ear height was difficult to measure from photographs, and cheek width did not show a consistent relation with age.

Table 1 presents summary statistics for these three indices of facial proportions and correlations between these indices (each subject to log transformation) and ratings of physical attractiveness for different combinations of photographic subjects and raters. The table provides some support for the hypothesized relationship between neotenous facial proportions and attractiveness, especially for relative eye width. However, simply piling up a list of measures of facial proportions and reporting their correlations with attractiveness ratings provides only a weak test of the neoteny hypothesis. A better test, combining information from different age cues, is presented below. This analysis proceeds in two stages, the first resulting in several equations that can be used to calculate the predicted age of each photographic subject on the basis of relative sizes of facial features and the second using these predicted ages to produce an index of neoteny.

Age-predictor equations. I begin by using stepwise multivariate regression to produce equations that predict age as a function of relative sizes of facial features. For this stage I use only photographs of Ache, since Ache span a much wider range of ages than either of the other two photographic sample populations. Using the stepwise multiple linear regression routine from Systat 5.0 with both *p to enter* and *p to discard* set at .15 produces the following equation:

$$\text{Predicted Age I} = -141 \cdot \log[\text{EW/FH}]$$
$$- 62 \cdot \log[\text{LH/FH}] - 128. \quad (\text{I; females})$$

The variance accounted for (R^2) is .23.

Equation I predicts ages of Ache females as a function of relative eye width and relative lip height; relative nose height drops out of the regression. However, an

TABLE I
Correlations between Measures of Facial Proportions and Ratings of Attractiveness

Photographs of	Rated by	Males Rating Females			Females Rating Males		
		EW/FH	NH/FH	LH/FH	EW/FH	NH/FH	LH/FH
Brazilians	Brazilians (19, 11)	.39**	.01	.24[+]	−.09	−.19	.17
N = 49, 20	U.S. Americans (12, 20)	.19	−.14	−.07	−.35	−.41[+]	.42[+]
	Russians (11, 14)	.32*	.13	.12	−.10	−.43[+]	.27
	Ache (11, 13)	.43**	−.29*	.23	−.07	−.15	.10
	Hiwi (4, 4)	.28*	−.19	.21	.03	−.47*	.53*
	Mean	.210	.589	.125	.185	.585	.135
	S.D.	.014	.030	.020	.018	.033	.027
U.S. Americans	Brazilians (20, 23)	.23	−.26[+]	.17	.00	.18	.04
N = 51, 35	U.S. Americans (11, 18)	.30*	.04	−.04	−.03	.02	−.15
	Russians (12, 14)	.21	−.20	.03	.07	.09	.05
	Ache (20, 21)	.25[+]	.10	.13	−.11	−.04	−.01
	Hiwi (0, 0)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
	Mean	.225	.581	.121	.202	.574	.118
	S.D.	.018	.024	.022	.013	.025	.022
Ache	Brazilians (17, 16)	−.12	.00	.10	.12	−.26	.19
N = 41, 36	U.S. Americans (12, 15)	−.09	.19	.08	.22	−.29[+]	.18
	Russians (12, 12)	−.22	.31	−.03	.13	−.43**	.14
	Ache (15, 15)	.15	−.02	.00	.21	−.17	.14
	Hiwi (7, 4)	.19	−.32*	.49**	.31[+]	−.11	.01
	Mean	.189	.599	.128	.177	.607	.118
	S.D.	.013	.035	.023	.013	.032	.029

NOTE: EW/FH, eye width/face height; NH/FH, nose height/face height; LH/FH, lip height/face height. Numbers in parentheses are numbers of raters for female and male subjects.
[+]$p < .1$
*$p < .05$
**$p < .01$

equation can be produced with nearly the same predictive power as Equation 1 by leaving relative lip height out of the regression. The resulting equation is:

$$\text{Predicted Age 2} = -108 \cdot \log[\text{EW/FH}] + 139 \cdot \log[\text{NH/FH}] - 17. \quad (2; \text{females})$$

The variance accounted for (R^2) is .17.

In other words, ages of Ache females can be predicted as a function of relative eye width in combination with either relative lip height or relative nose height.

For Ache males, stepwise multiple regression of age on relative eye width, relative nose height, and relative lip height produces another equation:

$$\text{Predicted Age 3} = -146 \cdot \log[\text{EW/FH}] - 61 \cdot \log[\text{LH/FH}] - 136. \quad (3; \text{males})$$

The variance accounted for (R^2) is .55.

However, when relative lip height is excluded from the regression, the remaining two variables do not yield another significant predictor equation. Thus we are left with two alternative age-predictor equations for females and one for males.

Indices of neoteny and facial attractiveness. A neotenous face is one that retains youthful traits or presents markers of youth in an exaggerated form relative to others of the same age. Equations 1 to 3 can be used to produce indices of neoteny: I define facial neoteny as the difference between the actual age of a face and the age predicted by one of the equations above. In other words,

$$\text{Neoteny 1} = \text{Age} - \text{Predicted Age 1} \quad (4; \text{females})$$

$$\text{Neoteny 2} = \text{Age} - \text{Predicted Age 2} \quad (5; \text{females})$$

$$\text{Neoteny 3} = \text{Age} - \text{Predicted Age 3} \quad (6; \text{males})$$

Thus a face with unusually large eyes, small nose, and full lips in relation to face height will have a low predicted age according to Equations 1 to 3 and a high index of neoteny according to Equations 4 to 6.

Table 2 shows correlations between indices of neoteny and ratings of attractiveness for different combinations of photographic subjects and raters. When correlation coefficients for two different samples are sufficiently similar, the samples can be treated as a single sample and the correlation coefficients pooled (Sokal

TABLE 2
Correlations between Indices of Neoteny and Ratings of Attractiveness

Photographs of	Rated by	Males Rating Females		Females Rating Males
		Neoteny 1	Neoteny 2	Neoteny 3
Brazilians	Brazilians (19, 11)	.37**	.24*	−.23
N = 49, 20	U.S. Americans (12, 20)	.06	.04	−.17
	Russians (11, 14)	.23+	.11	−.05
	Ache (11, 13)	.38**	.45**	−.02
	Hiwi (4, 4)	.25*	.25*	.35
	Mean	−1.0 yrs.	−1.6 yrs.	−1.3 yrs.
	S.D.	7.5 yrs.	5.5 yrs.	7.1 yrs.
U.S. Americans	Brazilians (20, 23)	.34*	.36**	.03
N = 51, 35	U.S. Americans (11, 18)	.20+	.28*	−.13
	Russians (12, 14)	.23+	.26*	.08
	Ache (20, 21)	.25+	.18	−.07
	Hiwi (0, 0)	n.a.	n.a.	n.a.
	Mean	−.2 yrs.	−.1 yrs.	−1.6 yrs.
	S.D.	7.8 yrs.	4.5 yrs.	7.7 yrs.
Pooled samples	Brazilians (39, 44)	.36**	.30**	−.10
(Brazil + U.S.)	U.S. Americans (23, 38)	.13+	.16+	−.15
N = 100, 55	Russians (23, 28)	.23+	.18*	.02
	Ache (31, 34)	.32**	.32**	−.05
	Hiwi	n.a.	n.a.	n.a.
Ache	Brazilians (17, 16)	−.10	−.13	.00
N = 41, 36	U.S. Americans (12, 15)	−.05	−.16	.14
	Russians (12, 12)	−.19	−.29	.01
	Ache (15, 15)	.07	.12	.21
	Hiwi (7, 4)	.38**	.24+	.07
	Mean	.2 yrs.	−.2 yrs.	−.4 yrs.
	S.D.	9.2 yrs.	9.6 yrs.	9.3 yrs.
Pooled samples	Brazilians (56, 50)	n.a.	n.a.	−.07
(All)	U.S. Americans (35, 53)	n.a.	n.a.	−.07
N = 141, 91	Russians (35, 40)	n.a.	n.a.	.02
	Ache (46, 49)	.25**	.26**	.03
	Hiwi (7, 5)	.31**	.24**	.23*

NOTE: Numbers in parentheses are numbers of raters for female and male subjects.
+*p* < .1
**p* < .05
***p* < .01

and Rolf 1969:520–23); table 2 shows pooled data where appropriate. The rows reporting pooled correlations for female subjects—for Brazilians, U.S. Americans, Russians, and Ache rating Brazilian and U.S. photographs and for Ache and Hiwi rating all three sets of photographs—provide consistent support for the proposition that neoteny is a component of female facial attractiveness.[4] Across five populations of raters, and across

4. The range of correlation coefficients is such that, for Western raters (Brazilians, U.S. Americans, and Russians), it is not legitimate to pool coefficients for all three female photographic subject samples. While Western raters are attracted to neotenous facial proportions when rating U.S. American and Brazilian women, they seem to show a mild aversion to neotenous facial proportions when rating Ache women. This slight reversal of the neoteny/attrac-

two indices of neoteny, *females are perceived as more attractive to the extent that their predicted ages, as calculated from their facial proportions, are less than their actual ages.*

tiveness connection for Westerners rating Ache females is probably largely an artifact of responses to eye shape. Ache have epicanthic folds, and Ache with a high relative eye width (log [EW/FH]) also have relatively narrow eyes. Western raters all show an aversion to narrow eyes—correlations between log (EW/EH) and ratings of female facial attractiveness = −.31, −.33, and −.44 for Brazilian, U.S. American, and Russian raters. The apparent Western aversion to Ache females with wide eyes disappears when eye shape is controlled for. In addition, for all populations of raters, the much wider range of ages among Ache photographic subjects makes it more difficult to uncover possible correlates of attractiveness other than age.

STUDY 2: STUDENTS AND MODELS

A second test of the neoteny hypothesis incorporated measurements of two new samples of facial photographs, of U.S. female and male models, on the theory that the distinguishing features of attractive faces might stand out especially clearly in comparisons between these samples and University of Michigan undergraduates. The two model samples consist of (1) photographs of ten female models displayed on the covers of *Cosmopolitan* and *Glamour* magazines between 1989 and 1993 (five from each magazine) and (2) photographs of ten male models displayed in advertisements in *Esquire* and *GQ*. Both samples were selected from magazines on file at the Ann Arbor Public Library. For the female model samples, I began with the most recent issue of each magazine and worked through successively earlier issues until I found five suitable faces from each magazine cover. Models not facing directly toward the camera, models with their mouths open, celebrities, and non-Caucasians were excluded. Since *Esquire* and *GQ* normally feature celebrities rather than models on their covers, male models were selected from consecutive advertisements in these magazines, subject to the same restrictions as females. I used calipers to measure face height, right and left eye width, nose height, and lip height and calculated relative eye width (EW/FH), relative nose height (NH/FH), and relative lip height (LH/FH). The mean and standard deviation of these measurements and the comparable figures for my sample of University of Michigan undergraduate females are presented in table 3. For females, all differences between models and undergraduates are in the expected, neotenous direction—models have large relative eye width, small relative nose height, and large relative lip height. *T*-tests (conducted on log-transformed variables) show that all mean differences between female models and students are significant.

TABLE 3
Facial Proportions and Predicted Ages of Students and Models of Both Sexes

	Students		Models	
	Mean	S.D.	Mean	S.D.
Females				
EW/FH	.23	.019	.24	.012*
NH/FH	.58	.024	.49	.034**
LH/FH	.12	.022	.17	.015**
Predicted Age 1 (yrs.)	20.2	8.0	7.4	3.1**
Predicted Age 2 (yrs.)	20.2	4.5	6.8	3.8**
Males				
EW/FH	.20	.013	.20	.014
NH/FH	.57	.025	.47	.025**
LH/FH	.12	.022	.12	.018
Predicted Age 3 (yrs.)	22.8	8.3	23.1	5.8

*p < .05
**p < .01

Table 3 also includes data on ages predicted from Equations 1 to 3 above. Female models have extremely neotenous faces: predicted ages based on facial proportions are 6.8 years and 7.4 years. This does *not* mean that the facial proportions of models match those of real 7-year-olds, since the ages predicted by these equations are based on naive linear extrapolations of age-related changes in adult facial proportions. It does argue strongly, however, that *female models' faces represent a "supernormal stimulus,"* presenting in exaggerated form the features that distinguish young women from old ones.

STUDY 3: CARDIOIDAL STRAIN AND FACIAL ATTRACTIVENESS

A third test of the neoteny hypothesis employed drawings of faces made more and less neotenous by differing degrees of cardioidal strain. From the University of Michigan photographic sample I selected nine photographs: three of females given high ratings of attractiveness by University of Michigan undergraduates, three of females given average ratings, and three of females given low ratings (high-, medium-, and low-attractiveness subgroups). I made a line drawing of each face and produced two new drawings for each of the original nine by subjecting each original drawing to negative and positive cardioidal strain. For each trial, a rater was presented with one original and two transformed drawings of a single face ($k = -0.1, 0, 0.1$) and asked to rank the three versions in order of attractiveness. Raters were drawn from students in an intermediate-level anthropology class; each set of drawings was rated at least four times. The entire procedure was repeated using photographs of nine males, divided as before into high-, medium-, and low-attractiveness subgroups.

For both males and females, faces subjected to positive cardioidal strain ($k = 0.1$) were rated consistently less attractive than the original faces (fig. 2). The results are highly significant ($p < .01$, binomial test) for both sexes. Results for negative cardioidal strain ($k = -0.1$) are more complicated. For females, average attractiveness ratings were higher for neotenous faces than for original faces. For males, attractiveness ratings were lower for neotenous faces than for original faces. Results were marginally significant and nonsignificant, respectively ($p = .06$, $p = .11$, binomial test). Since male and female trends are in the opposite direction, the difference between the trends for the two sexes is strongly significant.[5]

For both sexes there seemed to be an interaction be-

5. The null hypothesis in this case is that d_f (the probability that a neotenous female face, $k = 0.1$, will be rated more attractive than the original face, $k = 0$) is equal to d_m (the probability that a neotenous male face will be rated more attractive than the original face). But for all possible values of $d_f = d_m$, the probability of getting the observed results both for females and for males—that is, the product of the probability for males and the probability for females—is less than .01.
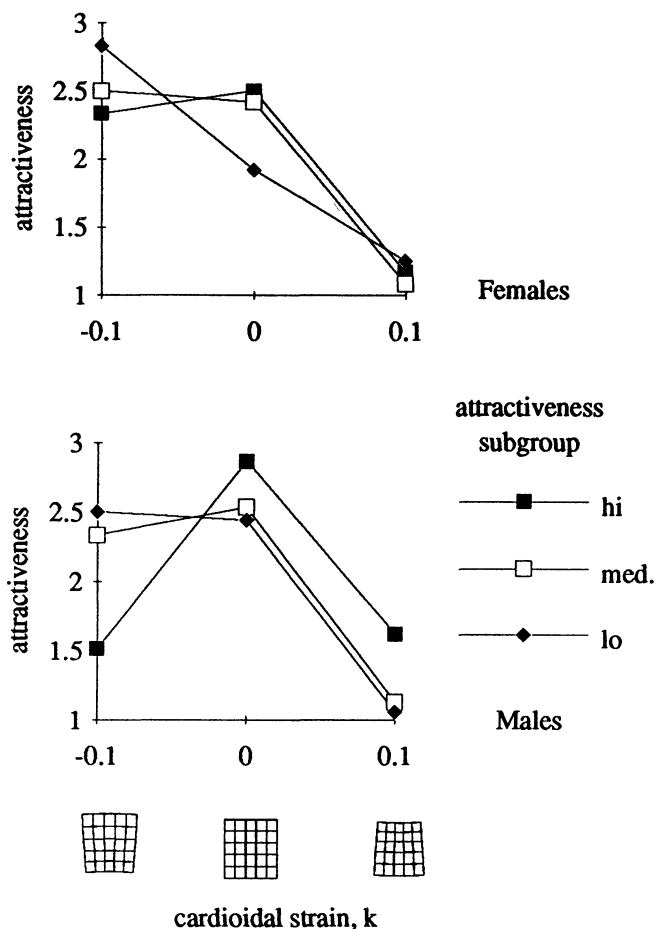
FIG. 2. *The effects of negative and positive cardioidal transformations on the perceived attractiveness of faces of both sexes (including faces previously rated attractive, medium, and unattractive).*

tween attractiveness subgroup and the effect of negative cardioidal strain. For the three unattractive females, 11 out of 12 raters found neotenous faces more attractive than original faces, while for medium and attractive faces just 13 out of 24 raters found neotenous faces more attractive. For the three attractive males, 11 out of 12 raters found neotenous faces less attractive than non-neotenous faces, while for medium and unattractive faces just 16 out of 31 raters found neotenous faces less attractive. In other words, negative cardioidal strain resulted in a marked increase in the attractiveness of unattractive female faces and a marked decrease in the attractiveness of attractive male faces but little change in the attractiveness of other faces.

In summary, results from drawings of faces subjected to cardioidal transformations support the hypothesis that *neoteny is a component of facial attractiveness, at least for females,* but they also suggest that *the relationship between neoteny and attractiveness is nonlinear.* For all attractiveness subgroups and both sexes, making faces less neotenous via positive cardioidal strain makes them less attractive. But highly and moderately attrac-

tive females are apparently neotenous enough that making their faces more neotenous via negative cardioidal strain does not make them more attractive (although it does not make them less attractive either), while unattractive females *are* rated more attractive when their faces are made more neotenous. Attractive males are apparently neotenous enough already that making their faces more neotenous via negative cardioidal strain actually lowers their attractiveness, while moderately attractive and unattractive males are apparently not so neotenous that making their faces more neotenous makes them less attractive (but it does not make them more attractive either). Thus there is a limit to how far increasing neoteny results in increasing attractiveness, and that limit is reached sooner for males than for females.

Summary and Implications

In humans, mate value declines with age beginning in early adulthood. It declines more quickly for females than for males. Consequently, we expect human beings, especially males, to have adaptations for assessing age-related changes in mate value. Regardless of whether age-related changes in physical attractiveness (especially for females) result from such adaptations or from other causes, it is possible that particularly attractive faces are those that present age-related cues in an exaggerated or supernormal form. Large eyes in relation to face height, small noses, and full lips are markers of youth. The results presented in this paper suggest that neotenous features are indeed criteria of female attractiveness even when age is controlled for. Specifically,

1. Women whose facial proportions make them look younger than their actual age (as measured by regression equations predicting age as a function of facial proportions) are perceived as more attractive by male raters from five populations (but see n. 4).

2. A sample of U.S. female models has significantly more neotenous facial proportions than a sample of U.S. female undergraduates and a strikingly low predicted age, about 7 years, according to regression equations predicting age as a function of facial proportions.

3. Cardioidal strain, a mathematical transformation shown by earlier research to provide a good model for changes in facial proportions during the course of maturation and to affect the perceived ages of faces, also has an effect on female facial attractiveness according to U.S. raters. The effect is nonlinear, suggesting that neoteny is a component of attractiveness only up to a certain point.

4. Results for male attractiveness in the above studies are weak and/or inconsistent.

What are some possible future directions for research on neoteny and physical attractiveness and in the anthropology of physical attractiveness more generally? Research to date provides strong support for the hypothesis that neoteny is a component of female facial attractiveness in Western societies. By contrast, the results

for the two non-Westernized societies presented in this paper are only a beginning; much more research will have to be carried out in a wide range of such societies with a variety of research instruments before we can state with any confidence whether the neoteny/attractiveness connection is a human universal. Assuming that this connection continues to be supported by further research, many additional topics will remain to be addressed. These include the evolutionary bases of male attraction to female cephalofacial neoteny and the possible consequences of such attraction for human morphological evolution.

1. *Evolutionary causes of attraction to neoteny—further puzzles.* While the connection between neoteny and female facial attractiveness proposed here may partly explain the anomaly of female attractiveness, it raises other puzzles. An attraction to markers of youth may be adaptive for men insofar as it leads them to find younger women more sexually attractive than older women, but it will not be adaptive if it leads men to find juveniles more attractive than young women. Why, then, do males apparently find markers of youth attractive even among females at the age of maximum fertility? Part of the answer may be that mate choice in the real world involves attention to more than just facial cues. If real-world mate choice involves both attention to markers of cephalofacial neoteny to discriminate young adults from old adults and attention to secondary sexual characteristics from the rest of the body to discriminate adults from juveniles, then attraction to supernormally neotenous facial features is less puzzling. This line of argument suggests that the neotenous female faces generated in Study 3 will be perceived as more attractive, relative to nonneotenous faces, if attached to drawings of unequivocally adult bodies. Another part of the answer could be that female mate value may be highest somewhat before the age of maximum fertility. Symons (1979:189–90) argues that males are most physically attracted to females of maximum reproductive value, rather than maximum fecundity. Reproductive value is a measure of expected lifetime reproduction, and an individual choosing a partner with a long-term relationship in mind should be adapted to take into account a mate's future reproductive potential as well as her current fecundity.[6] A testable implication of this line of argument is that the attractiveness of neotenous features (in comparison with markers of sexual maturity) will vary depending on whether individuals are considering long-term or short-term relationships. Finally, neotenous facial proportions in females might provide information about levels of ovarian function above and beyond the information they provide about age (Johnston and Franklin 1993). By analogy, Singh

(1993*a,b*) notes that the waist-to-hip ratio, another candidate for a universal component of female physical attractiveness, varies not only with age but, even among women of the same age, with endocrine profiles associated with fecundity. The theoretical case that neotenous cephalofacial features provide such information is not very strong, because such features, unlike secondary sexual characteristics such as enlarged breasts, buttocks, hips, and thighs, do not appear suddenly at puberty under the control of female sex hormones. However, the topic clearly warrants investigation by reproductive ecologists and medical anthropologists.

2. *Evolutionary consequences of attraction to neoteny.* Darwin united his discussions of human evolution and sexual selection in a single volume because he thought that the latter had played a major role in the former. The results of this paper suggest that it is time for renewed attention to the possible connection between sexual selection and morphological evolution in our species. The evolution of modern *Homo sapiens* over the past 100,000 years has been marked by a trend toward increasing craniofacial neoteny, including reduced prognathism, increased brachycephaly, and general gracilization in a number of populations (Weidenreich 1945, Newman 1962, Brace and Mahler 1971, Frayer 1981). Biological anthropologists have generally invoked natural selection for ecological adaptation or nonadaptive forces such as pleiotropy or biased mutation to explain these trends. The analysis in this paper suggests that sexual selection may also be involved. Sexual selection for neotenous features in females is likely to have become a particularly powerful force in human evolution once increases in life expectancy had resulted in a larger fraction of the adult female population living past the age of menopause, thus increasing the age-related variance in adult fecundity. Parallel trends toward neoteny in males could be a by-product of such selection in females or a direct product of sexual selection on males. Whether ongoing sexual selection for neotenous features (or other physical traits) can be measured in living populations is a topic for future investigation.

The conventional wisdom in the social sciences has been that evolutionary theory, including the theory of sexual selection, is more or less irrelevant in explaining human social behavior. The successes of such new fields as evolutionary psychology and human behavioral ecology, as well as improved understanding of the physical underpinnings of human behavior, are likely to force a reassessment of this conventional wisdom. The study of physical attractiveness is a particularly promising test case for investigating the relationship between biology and culture. While this paper has emphasized the "biological" side of physical attractiveness, with the modern theory of sexual selection as a starting point, this theory will undoubtedly have to be expanded and revised to allow for the unique importance of social learning in our species (Laland 1994). Whatever the fate of the hypothesis that neoteny is a universal of female facial attractiveness, this paper will achieve one of its aims if it

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6. Strictly speaking, reproductive value is not a perfect measure of long-term mate value because a person committed to a long-term relationship may die or become infertile before the end of a mate's reproductive career. When this possibility is taken into account, mate value becomes a function both of mate's age and of ego's age. This topic is treated in more detail in Jones (n.d.).

encourages both biological and cultural anthropologists to explore a topic that has lain for too long in the no-man's-land between the two subdisciplines.

Appendix: Research on Neoteny and Female Facial Attractiveness

McArthur and Apatow (1983–84)
    Population. U.S. Americans.
    Research methods. Researchers used a police Identi-kit to produce "average" male and female faces and faces with different combinations of "baby-faced" and mature features: large and small eyes, low and high vertical placement of features, small and large noses and ears, all three baby-faced features together, and all three mature features together.
    Results. For both sexes, faces with large eyes were rated more attractive than average faces, which were rated more attractive than faces with small eyes. The effect was stronger for females than for males. For other traits, (1) for females only, average faces were rated more attractive than faces with baby-faced features, which were rated more attractive than faces with mature features; (2) for males only, average faces were rated more attractive than faces with mature features, which were rated more attractive than faces with baby-faced features.

Fauss (1986)
    Population. Germans.
    Research methods. Researcher asked subjects of both sexes to construct the face of an ideal member of the opposite sex using a police Identi-kit.
    Results. Ideal males and females had wide mouths with full lips and a gracile lower jaw and chin. Ideal females also had gracile noses and high-arched eyebrows.

Cunningham (1986)
    Populations. U.S. Americans (raters), U.S. American and international (photographs).
    Research methods. Researcher collected measurements of relative size of facial features in a sample of photographs of 50 females. The sample included 23 photographs of U.S. American college students and 27 photographs of Miss Universe contestants. Photographs were rated by a sample of U.S. American undergraduates.
    Results. Higher attractiveness ratings were associated with larger and more widely separated eyes, wider cheekbones, narrower cheeks, and smaller noses.

Riedl (1990)
    Population. Austrians.
    Research methods. Subjects were instructed to produce the most attractive facial image using a computer program which allowed them to manipulate sizes, shapes, and positions of facial features.
    Results. Males' ideal female faces had larger eyes and

smaller chins and jaws than typical female faces. Females' ideal male faces were similar to typical male faces.

Johnston and Franklin (1993)
    Population. U.S. Americans.
    Research methods. Researchers used a "genetic algorithm" to allow subjects to generate attractive female faces by a process analogous to artificial selection. A computer program generated a small population of female faces from a set of random binary strings ("genotypes") which specified shapes and positions of facial features. Subjects assigned attractiveness ratings to faces. A new generation of faces was produced by "selecting" genotypes in proportion to their attractiveness and adding small random "mutations" to the binary strings. The trial-and-error process continued until each subject had "evolved" the most attractive face.
    Results. Attractive faces had significantly smaller eye-chin lengths, smaller lower-facial proportions, fuller lips, and narrower mouths than average undergraduates.

Perrett, May, and Yoshikawa (1994)
    Populations. English, Japanese.
    Research methods. Researchers constructed three facial images using graphics software: (1) a composite (blend) of digitized photographs of 60 Caucasian English females, (2) a composite of the most attractive 15 females (as rated by English raters), and (3) an attractiveness "caricature" that exaggerated the features distinguishing the second composite from the first. They used the same techniques to generate three images based on photographs of Japanese females as rated by Japanese males.
    Results. Images were rated 3, 2, 1 (most to least attractive) by Japanese and Caucasian raters rating both own group and across groups. Attractive faces had higher cheekbones, a thinner jaw, larger eyes relative to the size of the face, and shorter vertical distances between jaw and mouth and between mouth and nose.

Comments

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It is all very well to show that males may rate females on various scales of "attractiveness" and that neotenousness may be one of them, but in order for this to have any cumulative effect on the appearance of future generations it also has to be demonstrated that this is somehow related to differential reproduction (Ryan 1995). Stephen Jay Gould has argued that aspects of human neoteny emerged because people find it "cute" (1977:350), and Jones has expended considerable effort

in demonstrating that males evaluate female appearance to that effect. However, not only does this ignore the role of female choice in reproductive behavior that was such an important part of Darwin's argument in the first place (Mayr 1972:90–91)—a perspective which has seen a recent resurgence of interest (e.g., Strier 1992, Cronin 1993)—but it does not take into account the fact that, in the available human examples, it is the males who "are characterized by an appreciably higher variance in their reproductive behavior" while "women are uniformly exposed to the risk of pregnancy and rarely fail to reproduce" (Dobzhansky 1972:77). And, in the past, this was true whether males thought they were "cute" or not.

Evidently, if all females have the same opportunity to reproduce, male choice is not going to have any effect on the characteristics of future female form. Jones is quite right that human craniofacial form has undergone increasing gracilization over the past 100,000 years (Brace, Smith, and Hunt 1991), but he has not made a case that human choice had anything to do with it. Furthermore, there are some very important aspects of that gracilization which cannot be detected by ready visual discrimination by either males or females. The decrease in bone density and the thinning of the bones of the cranial vault cannot be visually discerned, and it would be a most extraordinary person who would go to the extent of assessing the relative degree of incisor shoveling and lingual-tubercle development or third-molar agenesis and the relative reduction of the hypoconulid when considering the attractiveness of a potential sexual partner. That leaves "the neoteny hypothesis" right where it was some years ago, when it was judged to be "largely, if not totally, a bankrupt concept" whose persistence was due mainly to "anthropocentrism" (Shea 1989:97)—in this case one could call it male chauvinist anthropocentrism.

The emergence of "modern" human form over the past 100,000 years and more is a consequence of reductions from Middle Pleistocene levels of robustness which I have treated in considerable detail elsewhere (Brace, Smith, and Hunt 1991; Brace 1995, n.d.). I suggested that those reductions were the effects of mutations that were not weeded out when selection for the maintenance of the formerly necessary levels of robustness was relaxed. The mutations that produce the trend observed are not "biased" but just the most likely minimal kind of change that can occur. This is the mechanism that I labeled the probable mutation effect (Brace 1995). What it produces, in effect, is evolution by entropy. When selection is reduced or suspended, everything that had formerly been maintained simply tends to run down. In actual mechanistic terms, what we see is not really "neoteny," or the selective retention of youthful form, but the increasing failure of the developmental process to produce the formerly necessary adult configuration. This is the most likely result of the most likely mutations occurring in the relaxation or absence of selection—which is the minimum working definition of the probable mutation effect.

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Jones has provided a concise, lucid, and ultimately aesthetically pleasing response to one of human evolution's most intriguing questions: Why is the human male so interested in a potential partner's relative physical attractiveness? It should come as no surprise to anyone who has been partially conscious since the onset of puberty that men around the globe have long been intensely preoccupied with the relative attractiveness of youthful-looking women. Although the existence of the sex-linked pattern of gazing is seldom contested, the reasons for its persistence account for some of the liveliest and, at times, most emotionally charged debates in the history of social science.

Cultural anthropologists are more comfortable explaining the origins of men's keen interest in the nuances of female beauty as stemming from an unresolved Oedipus complex, the persistence of a patriarchal tradition, or the demands of a postcapitalist world order promoting a consumption ethic that, in turn, encourages the sexual objectification of the female, but not the male, body. By failing to study the phenomenon from a comparative perspective, cultural explanations are prone to confuse the phenomenon's origins with the social factors that shape its cultural expression or stylistic embellishment. From the perspective of Foucault and his admirers, for example, every social interaction is, first and foremost, about power, and therefore men's preference for youthfulness is less about aesthetics than about domination and control. It is not clear, however, if men's preference for female youthfulness arises from a will to dominate as much as from a general ability to objectify a potential partner's relative fecundity, with an unintended consequence being the transformation of the female into an object of aesthetic contemplation.

It is important to remember that youthfulness is an important resource of female power, which often results in the heightening of men's apprehension and sexual anxiety. While doing research in the People's Republic of China I was repeatedly struck by the paradox of men's yearning for while simultaneously fearing becoming involved with a beautiful woman. Although it was understood that beautiful women (which in the Chinese context meant women in their early twenties) were harder to control, manage, or mold, when I broached the topic of the ideal mate men invariably acknowledged, at least in the realm of fantasy, that they preferred beauty to submissiveness. Chinese men are not alone in being apprehensive of female beauty. Cautionary tales from around the globe repeatedly warn men of the hidden dangers and potentially dire consequences of becoming involved with a pretty woman who is a stranger. The femme-fatale archetype and, to a lesser extent, the fatale status is a panhuman theme, suggesting that cultures everywhere warn men and women to avoid becoming overly fixed on what is most desired in the opposite sex. For men it is physical beauty, whereas for women it is

accessing a man's relative social standing. The cross-cultural pervasiveness of femme-fatale tales reveals that beauty, which is always associated with youthfulness, is seen as conferring greater power on its possessor. In this context, youthfulness is seldom taken as evidence of submissivness and thus powerlessness.

I find Jones's experimental design an ingenious way to bracket, for purposes of analysis, the possible effects of social learning while focusing on the impact of sex-linked differences in the perception of relative physical attractiveness. It would be interesting to know what effect sex orientation and thus potential erotic interest would have on his research findings. If sex orientation were controlled for, lesbians and straight women might be expected to differ in their appreciation of relative youthfulness in females. I further suspect that lesbians more than straight women will find relative maturity aesthetically pleasing. Because straight women often come to value what men desire in the opposite sex, they will also find youthful women more attractive. Conversely, I predict that compared with straight men gays will find relatively youthful men aesthetically more attractive. If my speculations—and that is all they are—turn out to be accurate, then erotic preference may operate as the trigger for heightened or dampened interest in the cultural objectification of a potential sex partner.

By grounding his analysis in an evolutionary framework, Jones provides a convincing explanation for the human male's proclivity to focus on youthfulness as an important aspect of female attractiveness. His request that cultural anthropologists study the psychological processes of sexual attraction harks back to the discipline's historical mission to study the particular and universal aspects of human experience. It remains to be seen how many anthropologists will follow his lead and enter the troubled waters of documenting the parameters of our sex-linked human nature.

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Jones illustrates the value of an evolutionary perspective. I agree that the relationship between human mating preferences and sexual selection demands further attention, and cross-cultural comparisons are particularly insightful. I appreciate the rigor of Jones's analysis, especially since human sociobiology and evolutionary psychology have often strayed toward methodological laxity. I am a little suspicious of his use of one-tailed statistics for females (cf. two-tailed for males), particularly since the findings are used to justify a hypothesis concerning a sex difference, but his conclusions are probably fairly robust. His study touches on important points regarding the nature and complexities of human sexual selection, which I address below. First, I raise some concerns about the evolutionary psychological approach.

Jones writes that "standards of physical attractiveness

are likely to have . . . species-typical . . . components, and variation in these components may be predictable given knowledge of human biology and local circumstances." I wonder just how powerful this prediction is likely to be. We can only speculate about such local circumstances, we don't know whether the mating preferences have been consistent over time, and we can be less certain than with other species that preferences will translate into greater reproductive success for the trait carrier. At best, we are able to make non-specific predictions such as "one might expect human beings to have a . . . species-typical emotional response to signs of aging." While I do not wish to denigrate the evolutionary approach, which I consider both important and insightful, I believe it is essential that we be conscious of the dangers inherent in this strategy.

We would do well to ask ourselves a number of questions: First, have we simply focused on the traits which support our hypothesis, ignoring those that do not? Clearly, there are many age-indicative traits. Would we have got the same answers if we had focused on, say, head shape, skin quality, and hair color? Secondly, have we considered alternative explanations for the findings? Here I find myself in disagreement with Cosmides and Tooby (1987), who write that "learning is not an alternative hypothesis" to an evolutionary explanation. In a trivial sense this statement must be true, since learning must itself have evolved and its operation must be constrained and informed by processes operating at other levels and on other time scales. However, this does not negate the fact that a mating preference could be learned or unlearned, and if learned it could be independent of or influenced by the social environment. Nor, since there is empirical and theoretical evidence that social learning may allow maladaptive traits to spread (Cavalli-Sforza and Feldman 1981, Boyd and Richerson 1985, Durham 1991), should we assume that there is an adaptive explanation for all human behaviour. I believe that cross-cultural studies such as Jones's are invaluable, precisely because it is plausible that attraction to facial neoteny or any other trait is a society-specific fad. Thirdly, are we just telling stories? Human evolutionary history began not in the Pleistocene but with the beginning of life. This means that there is no shortage of hominid, ape, primate, or social carnivore models which we could use as the basis for an adaptive story. Evolutionary arguments are so easy to construct that empirical support should demand more than a cursory review of circumstantial evidence or a quick questionnaire handed out to undergraduates. Jones's study is to be welcomed both for the modesty of its claims and for the rigor of its analysis.

Finally, we should be aware that human sexual selection may operate by means, and at rates, atypical of animal populations. Classically, researchers interested in human sexual selection have treated cultural influences on mating preferences as a confounding factor which obscures understanding of how sexual selection has operated. In contrast, a recent theoretical analysis[1] of mine has demonstrated that mating preferences do not have

to be innate to generate sexual selection (Laland 1994). Rather than obscuring sexual selection, learned and socially transmitted preferences (for instance, for body shape, hair color, or foot size) may themselves generate sexual selection, increasing the frequency of the preferred trait. Since, in comparison with genetic transmission, social transmission typically results in a more rapid diffusion of a preference through a population, culturally generated sexual selection may be unusually fast, and the alleles underlying favored traits may be selected to high frequency in just a handful of generations.

This analysis suggests that (1) there should be local, society-specific correlations between favored traits and mating preferences; (2) sexual selection may account for cross-cultural variation in traits underlying attractiveness; and (3) recent selection may have modified any predilections favored throughout the Pleistocene. These theoretical findings renforce the importance of empirical studies such as Jones's which explore mating preference patterns across societies. But in focusing on those aspects of human mating preferences which are universal, we should not neglect the fact that other aspects show considerable cross-cultural variability (Ford and Beach 1951, Rosenblatt 1974). Males in all societies may yearn for an attractive mate, but in some societies "attractive" means small feet, protruding buttocks, or pendulous breasts. How can we account for such local preferences? And could they explain cross-cultural variation in anatomical or personality traits?

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Jones's paper is an interesting treatise on the importance of physical attractiveness for sexual selection, but several points raised in it are in need of further consideration.

1. The nature of attractiveness. Jones claims that attractiveness is "undertheorized in psychology." In fact, there are two current theoretical perspectives on the nature of facial attractiveness that he does not consider.

One perspective, consistent with Jones's approach, centers on the importance of facial features for defining attractiveness. Cunningham and his colleagues (Cunningham 1986, Cunningham, Barbee, and Pike 1990) suggest that attractive faces are those that possess a constellation of mature, neotenous, and expressive facial features. Their approach involves measuring the sizes of particular individual facial features and correlating these measurements with overall facial attractiveness ratings.

We have offered a different theoretical approach in which we define attractive faces as those whose facial configurations are closest to the average population configuration (Langlois and Roggman 1990, Langlois, Roggman, and Musselman 1994). This approach differs from that of Cunningham and Jones in that it is not concerned with particular facial features; instead, it fo-

cuses on the facial gestalt as the basis for perceptions of attractiveness. This view is consistent with the literature demonstrating that faces are perceived as wholes (e.g., Hosie, Ellis, and Haig 1988, Morton and Johnson 1991, Purcell and Stewart 1988, Rhodes 1986, Sergent 1984, Young, Hellawell, and Hay 1987). Furthermore, this approach is more parsimonious than feature-based approaches; both Jones and Cunningham find different patterns of results for male and female faces, while we posit, and find, the same pattern of results for both male and female faces.

According to Jones's theory, faces with extreme features representing neoteny will be perceived as more attractive than other faces because of selection pressures. As he points out, directional selection favors traits that are extreme in their dimensions (large antlers, big tails, etc.). However, another form of selection—stabilizing selection—is more prevalent than directional selection and favors traits that are the average of values in the population (Barash 1982, Dobzhansky 1970). Thus, one could just as easily predict that selection would favor faces with average configurations rather than extreme features.

2. The relationship of neoteny to attractiveness. Jones claims, as does Cunningham, that neoteny is an essential component of facial attractiveness in females because it signals fecundity. However, we have shown that, although neoteny may be a component of attractiveness, it is not essential to it. Empirically, if neoteny is fundamental to attractiveness, judgments of neoteny and attractiveness must be significantly and highly correlated. However, we (Langlois, Roggman, and Musselman 1994) and others (Berry 1991) have demonstrated that judgments of attractiveness and age are unrelated in samples of college-age female faces, indicating that a neotenous appearance is not required for attractiveness. Furthermore, while of course Jones is correct in pointing out that old faces are perceived as less attractive than young faces, it is also certainly possible to think of young-looking faces that are far from attractive. Even infants, who are certainly all neotenous, show the full range of facial attractiveness.

3. Measuring faces. Jones measures relative eye width, relative nose height, and relative lip height from photographs and uses these measurements to produce equations that predict age on the basis of the size of these various features. These measurements are problematic for several reasons. First, thousands of facial measurements are possible (Farkas 1981), and Jones's selection of particular features to measure seems to be guided only loosely by a priori theoretical considerations related to neoteny. His theoretical discussion of changes in facial structure as a function of age does not mention cheek width, yet he measures it and then later omits it when he finds that it is not related to age. Furthermore, choice of cheek width as a neotenous feature is not consistent with the features chosen by Cunningham (Cunningham 1986, Cunningham, Barbee, and Pike 1990). According to Cunningham, "neotenous features" include eye height, eye width, nose length, nose tip width, nostril

width, forehead height, eye placement, and eye separation. Cheek width is a "mature" feature according to Cunningham's criteria. If Jones considers "neotenous" and "mature" features to be opposite ends of a continuum of age appearance, then he should also have measured chin area, chin length, chin width, eyebrow thickness, and cheekbone prominence, the other "mature" features measured by Cunningham et al. We wonder what results would be obtained if these other potential measures were used and whether a neotenous-feature approach can provide more than post-hoc explanations and predictions. For neoteny to be useful as a theory of attractiveness, researchers who employ it should (1) be consistent in their use of the same theoretically driven measures of neotenous features and (2) not conveniently omit features that they find to be unrelated to age.

Second, measurements obtained from photographs may not be accurate or reliable (Farkas et al. 1980). Evidence indicates that when measurements are taken from faces as opposed to photographs, attractive faces are more likely than less attractive faces to have facial features within ± 1 standard deviation of the mean (Farkas, Munro, and Kolar 1987). Farkas et al. suggest that "the face with most measurements in the range of ± 1 SD may be close to the 'ideal face'" (p. 128). Additionally, Jones's estimation that his stimuli would have the facial proportions of first- and second-graders suggests that the equations he has developed on the basis of measurements do not accurately estimate neoteny.

4. Coda. Jones claims that across five populations more neotenous faces are perceived as more attractive. However, of the 42 correlations measured (not including the data from pooled samples), only 11 (approximately 26%) were significant at the .05 level or greater. How are we to account for the 74% of the correlations that indicated no significant relationship between attractiveness and neoteny?[1] Although Jones has provided us with interesting cross-cultural data, thus far these data raise more questions than they answer.

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Jones is to be commended for a particularly clear, well-designed, and interesting study. As he points out, sexual selection theory has been neglected in relation to human morphology. This paper presents some of the first empirical tests of explicit evolutionary hypotheses concerning female facial attractiveness and provides reasonable evidence in support of the author's claim that neoteny acts as a kind of "superstimulus" signaling female fecundity. Finding Jones's study generally sound and his results plausible, I will limit myself to raising two issues that

may or may not serve as food for thought in this area of inquiry.

1. Does attractiveness necessarily equate with *sexual* attractiveness? For sexual selection (or any kind of Darwinian selection) to operate, the ultimate outcome has to be differential fitness. In the case of female neoteny, Jones argues that this process is actualized through males' being more attracted to youthful-looking females because, on average, these females make for *reproductively* more valuable mates. Hence, attractiveness is clearly equated here with sexual attractiveness. We are told, however, that neoteny also makes us perceive infants, animals, and even cars as "cute"—a quality closely analogous to attractiveness but without a sexual component. The article does not specify how attractiveness was defined for the raters. If Jones's subjects had been given a series of pictures of children (or dogs) to rate according simply to their "attractiveness," my guess is that we would find an age gradient running from younger to older, with babies (or puppies) being rated more attractive.

The implication is that the female-attractiveness–neoteny association reported here may reflect, at least in part, something other than an attractiveness-fecundity relationship. I am willing to take Jones's word that the female models' predicted age of about 7 years does not mean that their faces are identical to those of 7-year-old girls, but still, the models' "age" is considerably lower than that of an average sample of 20-year-old women whose very high fecundity men should have been selected to find extremely attractive. Again, might neoteny elicit something other than just sexual attraction? The answer may lie in Jones's n.3, where he mentions that neotenous features probably act as a release for parental behavior. Among other things, such behavior entails providing for and giving protection to individuals who are relatively dependent upon oneself. It could thus be argued that in the past neotenous adult females benefited disproportionately from male provisioning—in which case neoteny would not be the result of *sexual* selection.

2. Is female physical attractiveness really a human *anomaly?* Jones develops his argument for a human anomaly by pointing out that (*a*) in most sexually selected species males show greater development of sexual advertising than females and (*b*) this pattern is reversed in the case of humans, where men are more concerned than women with physical attractiveness. This seeming exception is explained by (*c*) the human female age-related variance in fecundity. Hence, female physical features linked to high fecundity and youth would have evolved to be attractive to males—that is, would have become criteria for mate choice by males. If we really want to find some originality in our species, I think we ought to look at *a* rather than *b*: as a sexually selected species, human males are exceptional in the degree to which male-male competition is played out not in sexual advertising but in control over resources (e.g., Pérusse 1993, 1994). Concerning *b* and *c*, however, the human situation fits strikingly well what seems a quasi-

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1. If we restrict our comparison to female measures, of the 28 correlations measured only 11, roughly 40%, are significant at the .05 level or better.

universal pattern: females generally do advertise their current fecundity through a host of visual, olfactory, postural, behavioral, and other cues. In nonhuman primates, for example, female physical signaling of fecundity has been observed in at least 55 species out of 79 (reviewed in Blaffer Hrdy and Whitten 1987). Such sexual advertising includes vulval or labial swelling and reddening/pinkening/whitening, clitoral reddening, perineal swelling and reddening, face reddening, chest blistering, and others. I fail to see the fundamental difference between the human case and that of other species. The anomaly is only apparent, stemming from the fact that human females go into estrus with much greater frequency and asynchrony than their animal counterparts—to the extent that men are likely to have been selected to find physical features of repeatedly fecund women *permanently* attractive. Ultimately, however, in all these species males are attracted by those female physical traits that strongly covary with fecundity.

A phenomenon that might come closer to a human anomaly would be the differential attraction of men to women who possessed attractive physical features in different degrees *notwithstanding the fact that they were of equal fecundity* (i.e., same-age but differentially neotenous and therefore differentially attractive). Blaffer Hrdy and Whitten (1987), however, point out that at least four primate species show *variance* in female sexual advertising. In three of those species, the variance is age-related. It may be of interest that the first two are crab-eating and Japanese macaques and the third is *Homo sapiens.*

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7 III 95

The pattern of the ideal partner has various components, some innate, some imprinted, and some actively learned from the environment. It is not easy to keep them apart and to focus on a single one. In every population there are tendencies toward maintaining traditions and tendencies toward trying new strategies. Females are known to be more tradition-bound than males in the mate-selection process. Some female birds are said to have an innate partner model whereas the males of their species are imprinted after birth (Daly and Wilson 1983). And in humans it seems that females are more content with the average male face than males are with the average female face. Thelen (1983) speaks of minority-type human mate preference on the part of men where physical appearance is concerned. Jones's data leave no doubt that human males are more attracted by neotenous proportions in female faces than by the average female face, but I do not think it is sufficient to explain this in terms of its indication of fecundity.

The response to a childlike appearance (*Kindchenschema*) is innate. Eibl-Eibesfeldt (1984) points out that its signal character is based on the difference between its characteristic features and those of the average adult face. Even children, male or female, are more interested in children's faces than in adult ones. The typical reaction to the *Kindchenschema* is a wish to protect and pamper the object, whether it is Donald Duck, a kitten, or a baby. Since "nurturing behaviour" is a component of courting in animals and humans (e.g., birds feed each other during courtship), this could have entailed a preference for childlike craniofacial features. Konrad Lorenz once said that in his opinion the Neanderthals were not exterminated but simply found *sapiens sapiens* cuter and preferred them as mates. The preference for neotenous-faced mates might therefore be found in males and females, although it might not be so marked in the tradition-bound females. Another approach to the explanation of the preference for the *Kindchenschema* in the male mate-selection process is the trained eye of the hunter. Our perception of beauty and symmetry is based on the necessity for the hunter to assess his prey. Why do we prefer to bite into a crunchy, juicy apple than into a shriveled one that may have lost none of its flavor?

From the day we are born we are told that new things are better than old ones and that we should exchange old for new immediately. Fromm (1992) points out that we regard our partners as consumer goods and try to get the best we can afford on the partner market in relation to our own market values. Since Sigall and Landy's (1973) work we have known that men are judged by the appearance of their spouses. This is why women in particular become status symbols; it goes without saying that a man can express his high status only with a young and good-looking partner. In nonhuman primates, as Goodall (1991) points out, males prefer experienced females to young ones. The preference for childlike features seems to be a human characteristic. Perhaps this mating strategy has reproductive value only in monogamous species. It would be interesting to know whether monogamous animals have developed a strategy for judging the ages of potential partners.

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Jones makes a lucid, succinct, and persuasive case for an adaptationist perspective on human physical attractiveness. Although my comments are informed by the same perspective, I will propose some alternative interpretations (see Symons 1995 for a more thorough presentation and for references).[1]

Jones's research is a significant contribution to the "adaptationist program," the goal of which is to partition organisms into functional components—that is, into special-purpose problem-solving devices. Nevertheless, his main hypothesis—that the human male's preference for "neotenous" female facial features is a by-product of selection for preferring youth—is in a sense less adaptationist than "constraintist." It does not imply

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1. I thank Nancy Etcoff and Yonie Harris for their metacomments.

that in ancestral human populations neotenous facial features per se indexed relatively high female mate value.

If the human male's preference for neotenous facial features is merely a by-product, it presumably would have entailed at least some costs in ancestral populations. For example, assuming that Jones's hypothesis is correct, an ancestral male given the opportunity to choose between two potential mates of the same age, one of whom (A) had a more neotenous face than the other (B), would have been willing to pay a higher bride-price for A because of her more attractive face, although B, at a lower bride-price, would have represented better value; or he might have failed to acquire B's superior weaving skills, which would have contributed something to his fitness, and instead acquired A's more gracile jaw, larger eyes, smaller nose, and fuller lips, which, according to the by-product hypothesis, would have contributed nothing; or he might have chosen an older female with neotenous features over a younger female (of higher mate value) with average features.

While many factors can constrain selection from achieving design perfection, it is nonetheless worth asking, when considering any given constraintist hypothesis, why selection didn't do better. If neotenous facial features *in themselves* did not index relatively high female mate value, why didn't selection favor males whose preferences were a function of veridical age cues? And why are only certain facial features, rather than all, most attractive when neotenous? In short, although Jones's hypothesis may well prove to be correct, more relentlessly adaptationist possibilities are worth exploring.

Perhaps the facial proportions that Jones interprets in terms of age cues also indexed some other aspect(s) of female mate value. One possibility is hormonal status, which Jones considers unlikely. Yet high androgen levels in women are positively correlated with reproductive system dysfunctions, and observable indices of high androgen levels—such as acne, hirsutism, and a high waist-to-hip ratio—seem to be systematically perceived as unattractive. To my eye, the faces in Jones's figure 1 appear to differ more in "masculinity" than in age.

Also, there is a clear adaptationist rationale for expecting female mate value in ancestral populations to have been a negative function of parity, and certain facial proportions may index parity. Maternal bone formation rates are elevated during pregnancy, which may permanently lengthen the mother's face, and a growth hormone (hGH-V) is expressed in the placenta and secreted in large amounts into the maternal circulation, which may permanently "coarsen" her facial features.

Jones proposes that neotenous female facial features are supernormal stimuli, and he may be right. But there is a more general (and more adaptationist) reason that a "preference mechanism"—in any species and in any domain—might be shaped by selection to identify as ideal a stimulus other than the theoretical optimum. Suppose that, in a particular case, the theoretical optimum stimulus value is X. Further suppose that an allele

exists in the population's gene pool that causes its bearers to prefer X *on average*. Now, the myriad vagaries of ontogenetic development essentially guarantee that individuals bearing this allele will, in fact, exhibit a *range* of preferences distributed around X. Selection will favor the allele *if* deviations from X in either direction depress fitness to the same extent. But this is not always the case.

An "asymmetrical fitness distribution" exists whenever a unit of deviation from the optimum in one direction depresses fitness more than does a unit of deviation in the other. Extreme examples have been referred to as the "cliff-edge effect": The most nutritious grass (the theoretical optimum) may grow right at the edge of a steep cliff, but the cow that always tries to graze there is unlikely to have the highest fitness in the herd. When an asymmetric fitness distribution exists, selection can be expected to favor a preference that diverges from the theoretical optimum (away from the cliff edge). For example, perhaps in ancestral human populations females with relatively gracile jaws (and, hence, relatively short lower faces and large eyes) typically had slightly *less* mate value than females with average jaws, but selection nonetheless favored males who preferred gracile rather than average jaws because the fitness penalty for choosing females with robust jaws was comparatively large.

As Jones's theoretical presentation makes clear, the *general* hypothesis that human males evolved species-typical preference mechanisms designed to assess female mate value does *not* imply that males universally will develop the same absolute standards of female attractiveness. The ideal stimulus values of some female phenotypic features can be specified in an absolute sense (e.g., unwrinkled and unblemished skin), and these are likely to be perceived as attractive universally. The ideal stimulus values of other phenotypic features, however, cannot be specified in an absolute sense because they vary among human populations (e.g., skin color), hence the attractiveness of these features is likely to be assessed relative to local phenotypes rather than absolutely. For example, a psychological mechanism that instantiated an obligate preference for a specific skin color could not possibly have been universally adaptive among humans. What could have been universally adaptive, however, is a mechanism that calibrated preferences facultatively, using as input information about local skin colors (which in ancestral populations represented adaptations to local conditions).

A species-typical male psychological mechanism that instantiates the rule "Prefer female skin that is a bit lighter than the adult female average" (in ancestral populations relative lightness probably signified nubility, nulliparity, and high estrogen levels) would result in very different *absolute* skin color ideals in Nigeria and Norway. Nigerian men would perceive Norwegian women as much too light, and Norwegian men would perceive Nigerian women as much too dark. This line of reasoning also implies, however, that men may sometimes perceive women of another population as *more*

attractive, in certain respects, than women of their own population. A classic example is reported by Wagatsuma (in the paper Jones cites). On first contact, Japanese men perceived white Western women as less physically attractive than Japanese women in most features, including skin texture, facial hair, and eye color. But the men perceived Western women's typical skin color as *more* attractive, because it was a bit lighter than the adult Japanese female average and, hence, close to their ideal.

If there is significant interpopulation variation in facial proportions, the perception of neoteny may be analogous to the perception of skin color. That is, human males may have been selected to prefer female facial features that are *relatively* neotenous, by local standards, rather than to prefer certain absolute facial proportions. If so, males will *not* necessarily prefer female features that are neotenous by the standards of *every* human population. Surely it is possible for a woman's eyes to be *too* large, her lower face *too* short, her nose *too* small, and her lips *too* full (imagine Betty Boop as a real woman). In fact, Jones's data imply a ceiling effect for the attractiveness of facial neoteny even within populations.

In sum, I propose that accurate predictions about a given male's perceptions of female facial attractiveness can be derived only from (*a*) knowledge of the designs of species-typical preference mechanisms in the human male brain and (*b*) knowledge of the female faces that the male has been exposed to (because information contained in these faces will have calibrated some of his preference mechanisms). Intrapopulation agreement and interpopulation disagreement in attractiveness ratings are *not* evidence that people "learn" standards of attractiveness from one another—any more than intrapopulation homogeneity and interpopulation heterogeneity in skin color is evidence that people "learn" their skin colors from one another.

Reply

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Is there a link between neoteny and attractiveness? Virtually all commentators agree that the evidence presented in this paper supports the proposition that female facial neoteny is linked to male perceptions of attractiveness. The main dissent comes from Musselman, Langlois, and Roggman, who point to evidence for an averageness or "prototype" effect: faces with proportions close to those of the average face are perceived as more attractive. In testing this hypothesis it makes sense to incorporate information from as many facial measurements as possible. Thus Jones and Hill (1993) and Jones (n.d.) construct indices of the "averageness" of facial proportions which combine several hundred measurements of distances between photographic ana-

tomical landmarks and demonstrate moderate correlations between these indices and ratings of attractiveness. Although the averageness effect is important and deserves theoretical treatment in its own right (Koeslag 1990, Langlois and Roggman 1990), there is also abundant evidence, at least for females, that faces close to the population average are not the most attractive possible faces (Alley and Cunningham 1990 and references in appendix).

A different strategy is necessary to test the neoteny hypothesis. In this case it is appropriate, *contra* Musselman et al., to "omit features . . . not correlated with age." It also helps if information from different features can be combined to provide an overall index of neoteny. In studies 1 and 2 I focus on just three measures of facial proportions (relative eye width, relative nose height, and relative lip height) because there are strong grounds in the standard literature on facial aging for expecting the relative dimensions of the three major facial features (eyes, nose, and lips) to change with increasing age and consistent evidence in my samples that the measures do change with age in the expected fashion. Alternative measures of the relative dimensions of the three major facial features are less satisfactory. Eye height and width of mouth do not decrease significantly with increasing age. Eye height gives some signs of being positively correlated with ratings of female attractiveness across samples but may be as much an expressive feature as a neotenous one. Nose width is correlated with age; including it in age regressions for females produces an age predictor equation similar to Equation 2.[1] The corresponding index of neoteny predicts attractiveness about as well as Equation 5 (Jones 1994).

Pooling of correlation coefficients, as in table 2, is a standard technique for testing hypotheses across multiple samples. What matters is not the number of samples for which there are significant results but the consistency with which males in five populations of raters prefer neotenous features in the pooled samples.

Why neoteny? Age, fecundity, and sensory bias. I have proposed not only that there is a connection between facial neoteny and female attractiveness but that this connection is a by-product of the universal male perception that younger women are more physically attractive than older women and that esthetic responses to signs of aging are largely genetic adaptations to age-related changes in fecundity. Several commentators point out potential extensions or limitations of this line of argument.

I argue that human beings are anomalous in that males are more concerned with female attractiveness than vice versa, but Pérusse points out that males in many primate species are attentive to cyclical and seasonal indicators of female fecundity. His point is well taken. A more complete treatment of the evolutionary basis of attraction to markers of youth and fecundity would consider not only menopause but the loss of estrus.

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1. The equation is Age $= -168 \cdot \log[\text{EW/FH}] + 87 \cdot \log[\text{NH/FH}] + 195 \cdot \log[\text{NW/FH}]$.

Laland offers some important caveats about applying evolutionary theory to human psychology. Understanding how the human body and brain have been shaped by natural selection often requires inferences about selective pressures very different from those which most of us face today. At worst, researchers may select post hoc from among alternative models of Pleistocene human or other ape, primate, or social carnivore behavior whichever model best fits some preferred adaptive story. However, we are on particularly safe ground in making inferences about the selective pressures on mate choice with respect to age-related changes in fecundity, because demographic evidence suggests that humans have faced much the same relationship between age of mate and relative probability of conception not just through the Pleistocene but right up to the demographic transition of the past few centuries.

Symons notes that according to my hypothesis attraction to neotenous facial features is not adaptive per se but a by-product of attraction to younger women. It is a result, in other words, of "sensory bias." This is not an argument against the hypothesis if we accept that natural selection will rarely build 100% accurate perceptual systems and therefore sensory bias will be ubiquitous. Sensory systems commonly respond to stimuli other than those to which they are adapted and often respond especially strongly to "supernormal" stimuli that present the distinguishing features of a target stimulus in exaggerated form (Ryan 1990, Enquist and Arak 1993). The argument from asymmetrical fitness functions is not an alternative to the sensory-bias argument but a variation on it. It assumes evolutionary constraints such that natural selection cannot build sensory systems that always respond to stimulus X but never to nonadaptive or less adaptive stimuli similar to X.

Why neoteny? Alternative explanations. Several commentators consider alternative explanations for the attraction to neoteny. One popular explanation for men's attraction to youthful features is that such features are signs of powerlessness and submissiveness. I review some reasons for being skeptical of this possibility, and Jankowiak offers cogent ethnographic grounds for supporting that the relationship between beauty and power is the opposite of that proposed by the hypothesis. My own observations in Brazil corroborate his account of sexuality in China. Far from supposing that old men involved in relationships with young women will typically dominate their partners by virtue of their age and experience, Brazilians often suggest that men in such relationships are especially vulnerable to cuckoldry and economic exploitation.

Pérusse and Schweder propose that attraction to neotenous features may be a by-product of the parental feelings aroused by infantile features, but this hypothesis does not seem to explain why men are more consistently attracted to neotenous facial features than women. Nor does it seem to explain why, although men are attracted to female faces that present in exaggerated form the features that distinguish young women from old women, they are also commonly attracted to secondary sexual characters in the female figure that appear at the time of puberty.

Finally, Symons proposes that the traits I have labeled neotenous may actually carry information about female fecundity over and above the information they carry about age. In my paper I express mild skepticism about this possibility, partly because there is no evidence in my samples that indices of facial neoteny are correlated with potential non-age-related indicators of fecundity such as age at menarche and waist-to-hip ratio. But Symons's (1995) recent work on this subject has persuaded me that we need direct tests of the possibility that estrogen/androgen ratios and parity have effects on facial attractiveness over and above the effects of aging.[2]

Attractiveness and morphological evolution. Brace suggests several reasons for doubting that attraction to neotenous features could have had any effect on human morphology via sexual selection. He claims that (1) in the evolutionary past all women had the opportunity to reproduce, so there was no scope for sexual selection on females; (2) some changes in skull morphology are not readily visible and could not have been targets of sexual selection; (3) Shea has demonstrated that neoteny is "a bankrupt concept" in the context of human evolution; and (4) the "probable mutation effect" provides a sufficient explanation for declining robustness since the Middle Pleistocene.

Brace's claim that all females have the same opportunity to reproduce is refuted by an immense body of research in demography and reproductive ecology (Bongaarts 1983, Ellison 1990). Female fecundity shows considerable variation both within and between societies; levels of ovarian function and probabilities of conception depend on a number of environmental variables, including frequency of intercourse, nutrition, work effort, and pathogen levels. Additional variance in female fitness results from variance in mortality and offspring survivorship. In turn, frequencies of intercourse, nutritional levels, and infant mortality risks commonly depend in part on women's success in finding and keeping desirable mates. Research in modern industrial societies demonstrates an effect of attractiveness on a woman's probability of marriage and on the social status and attractiveness of her husband (reviewed in Jackson 1992). Whether quantitative research in traditional societies will show similar correlations between attractiveness and mating success is an open question; considerable qualitative evidence points in this direction.

Studies of assortative mating commonly show assortment even for the traits not easily assessable by potential mates, such as lung volume and blood pressure (Spuhler 1968). Presumably assortment results not be-

2. None of the Brazilian or U.S. American female photographic subjects had had any children or reported being pregnant when photographed. Thus parity per se could not have contributed to differences in facial attractiveness in these samples, although sensory bias against facial porportions suggestive of parity could have.

cause people choose mates on the basis of lung volume per se but because they choose on the basis of correlated traits. Choice of partners on the basis of perceptible traits is likely to have consequences for correlated imperceptible traits.

Shea (1988) criticizes the hypothesis that human beings show an across-the-board increase in neoteny as a result of a general slowdown in rates of morphological change associated with delayed maturation. He also argues that allegedly neotenous traits in adult humans are not generally homologous with similar traits in juvenile nonhuman apes. This has no bearing on whether specific anatomical regions have a neotenous appearance as a result of sexual selection (or other social selection).

Trends toward craniofacial neoteny in the past 100,000 years may result from ecological selection for increased mechanical efficiency and reduced metabolic cost, from sexual or other social selection, or from directional mutation—Brace's probable mutation effect. Of these three possibilities, the last is probably the least plausible: a strong prediction of the last hypothesis is increasing trait variance over time, but Frayer (1977) finds the opposite trend, toward reduced variance.

Whether sexual selection has contributed to the evolution of human craniofacial neoteny is an open question. Brace provides no good reason to doubt it. Instead, his reply demonstrates a failure to take sexual selection seriously. Admittedly, this failure puts Brace in good company. When Darwin attributed the showy plumage of some male birds to female choice, Wallace proposed that such plumage resulted instead from the overflow of surplus energy. Julian Huxley argued that the elaborate courtship dances of some birds were not a product of sexual selection but a by-product of emotional excitement. Mayr suggested that the extraordinary complexity and diversity of male genitalia in a number of groups resulted not from female choice but from pleiotropy— that genes selected for their effects in other parts of the body produced increased genitalic complexity as a side effect. More recent research has made it clear that Wallace, Huxley, Mayr, and many other major figures in evolutionary theory had a blind spot about sexual selection (Eberhard 1985, Cronin 1991, Bartley 1995). A similar blind spot seems to have kept many biological anthropologists from seriously investigating the sexual selection of human morphology.

Attractiveness, learning, and culture. Symons and Laland consider the topic of variation in standards of attractiveness. Symons notes that if people calibrate their standards of attractiveness to the local population average—for example, if the most attractive face is a neotenous version of the average face—then standards of attractiveness will vary with population differences in facial proportions. Such variation will involve learning but not culture. Consistent with this possibility, Ache and Hiwi show stronger agreement with each other than with Brazilians, U.S. Americans, or Russians in standards of facial attractiveness. This agreement is more likely to reflect the operation of a "face-averaging mech-

anism" than shared culture, because the two populations have similar facial proportions but little in common culturally (Jones and Hill 1993).

While habituation to local physical features may account for a great deal of variation across populations, Laland rightly notes that many local preferences for exaggerated characters cannot be explained in this fashion. He has pioneered models of the coevolution of genes and culturally transmitted standards of attractiveness which are likely to illuminate cross-cultural divergence in standards of beauty. I would add only that the theoretical bare bones of these models will need to be fleshed out with more empirical work on psychological mechanisms and cultural contexts.

Future research will further clarify the relationship between neoteny and facial attractiveness. More generally, I suggest that the study of sexual esthetics may develop in the same fashion as the study of language. Both language acquisition and the development of standards of sexual attractiveness are probably regulated by specialized "mental organs" shaped by natural selection. But both are presumably influenced as well by nonadaptive sensory and cognitive biases and by social factors, including perceptions of what is popular and what is associated with status in its various dimensions.

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Calendar

1996

January 1–8. International Development Ethics Association, 4th International Conference, Tamil Nadu, India. Theme: Globalization, Self-Determination, and Justice in Development. Write: Peter Penz, Faculty of Environmental Studies, York University, 4700 Keele St., North York, Ont., Canada M3J 1P3.

April 18–20. Delta Blues Symposium: The Blues II, interdisciplinary conference, State University, Ark., U.S.A. Deadline for abstracts January 15, 1996. Write: Delta Symposium Committee, Department of English and Philosophy, P.O. Box 1890, Arkansas State University, State University, Ark. 72467-1890, U.S.A. (e-mail: wclement@toltec.astate.edu or rburns@quapaw.astate.edu).

May 29–June 2. 3d European Ethnopharmacological Colloquium and 1st International Conference of the Anthropology and History of Health and Disease, Genoa, Italy. Write: Comitato Organizzazione Etnofarmacologia Antropologia, Istituto di Antropologia Fisica, Università di Genova, Via Balbi, 4, 16126 Genova, Italy (fax: [39] 10 2095987).

June 13–16. 9th International Oral History Conference, Göteborg, Sweden. Theme: Communicating Experience. Deadline for abstracts December 1. Write: Sven B. Ek or Birgitta Skarin Frykman, Department of Ethnology, University of Göteborg, Västra Hamngatan 3, S-411 17 Göteborg, Sweden.

September 8–14. Lithic Technology: From Raw Material Procurement to Tool Production, workshop in connection with the 13th International Congress of the Union of Prehistoric and Protohistoric Sciences, Forlì, Italy. Write: Sarah Milliken, c/o Segreteria XIII Congresso U.I.S.P.P., Via Marchesi, 1, 47100 Forlì, Italy (fax: [39] 543 35805).

October 19–20. Interface '95: 20th Annual Humanities and Technology Conference, Atlanta, Ga., U.S.A. Write: Julie Newell, Social and International Studies, Southern College of Technology, 1100 S. Marietta Parkway, Marietta, Ga. 30060-2986, U.S.A.

Errata

In Manzi and Passarello's report on the Neandertals from Grotta Breuil in the April issue (CA 36:355–66), two corrections to table 1 (p. 361) were overlooked; the size and shape values for the left third molar of Breuil 3 should have been 119.9 and 113.9 respectively.