



## Review

## Do pigmentation and the melanocortin system modulate aggression and sexuality in humans as they do in other animals?

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## ABSTRACT

Pigmentation of the hair, skin, cuticle, feather and eye is one of the most salient and variable attributes of vertebrates. In many species, melanin-based coloration is found to be pleiotropically linked to behavior. We review animal studies that have found darker pigmented individuals average higher amounts of aggression and sexual activity than lighter pigmented individuals. We hypothesize that similar relationships between pigmentation, aggression, and sexuality occur in humans. We first review the literature on non-human animals and then review some of the correlates of melanin in people, including aggression and sexual activity. Both *within* human populations (e.g., siblings), and *between* populations (e.g., races, nations, states), studies find that darker pigmented people average higher levels of aggression and sexual activity (and also lower IQ). We conceptualize skin color as a multigenerational adaptation to differences in climate over the last 70,000 years as a result of “cold winters theory” and the “Out-of-Africa” model of human origins. We propose life history theory to explain the covariation found between human (and non-human) pigmentation and variables such as birth rate, infant mortality, longevity, rate of HIV/AIDS, and violent crime.

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## 1. Introduction

Across species, pigmentation of the hair, skin, cuticle, feather and eye is mainly determined by the melanocortin system (a group of peptide hormones secreted by the pineal gland) and is one of the phenotypes that varies most among vertebrates (Ducrest, Keller, & Roulin, 2008). Individuals with darker pigmentation are found to be pleiotropically linked to higher levels of aggression, sexuality, and social dominance than individuals with lighter pigmentation. (Pleiotropy is the phenomenon whereby a single gene has two or more phenotypically different effects. A classic example of pleiotropy in human diseases is phenylketonuria [PKU], which can cause mental retardation and reduced hair and skin pigmentation.) Even before the term was proposed there were examples of distinct traits that seemed to be inherited together. In his classic 1866 paper, Mendel (1822–1884) listed his trait number three in peas as having brown seed coat, violet flowers, and axial spots. In humans, darker skin also correlates with lower IQ (Rushton & Jensen, 2005).

## 2. Animal studies

Ducrest et al. (2008) reviewed data on over 40 wild vertebrate species showing that within each species, darker pigmented individuals averaged higher levels of aggression and sexual activity than lighter pigmented individuals, with a larger body mass, more resistance to stress, and greater physical activity when grooming. The relationship between coloring and behavioral dominance was robust across three species of mammal (African lion, soay sheep, and white-tailed deer), four species of fish (mosquito fish, guppy, green swordtail, and Arctic charr), four species of reptile (asp viper, adder, fence lizard, and spiny lizard), one amphibian species (spadefoot toad) and 36 species of bird.

In captive Hermann's tortoises (*Eurotestudo boettgeri*), another reptile species, Mafli, Wakamatsu, and Roulin (2011) found darker shell coloration predicted greater aggressiveness and boldness. Darker individuals were more aggressive in male–male confrontations and bolder towards humans, independent of body size and ambient temperature. (Melanin based color traits are a criterion in mate choice.)

Validation of the pigmentation system as causal to the naturalistic observations was demonstrated by experimentally manipulating pharmacological dosages and by studies of cross-fostering (Ducrest et al., 2008). Thus, melanocortin hormone levels predicted the amount of testosterone and other sexual steroids along with

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concomitant increases (or decreases) in aggression and sexual behavior. Placing darker versus lighter pigmented individuals with adoptive parents of the opposite pigmentation did not modify offspring behavior. Male lions with darker manes remained more aggressive and sexually active than those with lighter manes, and darker feathered barn owls continued to have a stronger immune response to stress than lighter feathered barn owls. It was the biological, not adopting parent who determined coloration in the offspring.

The biological and behavioral responses are a finely regulated balance between neurotransmitters and hormones at the level of the whole organism. The genes that control that balance occupy a high level in the hierarchical system of the genome. The system is defined anatomically as a collection of central nervous system circuits which include neurons that express peptides and proteins that originate in the arcuate nucleus and the brainstem. Downstream, targets of these melanocortin hormones bind to five melanocortin receptors, each one being associated with different physiological and behavioral functions. (For a review of the biochemistry of the melanocortin system, see [Fong \(2003\)](#); for a review of pharmacological effects, see [Roulin and Ducrest \(2011\)](#).)

Further, [Roulin and Ducrest \(2011\)](#) describe the role of the melanocortin system in activating the MC1 receptor induced by the production of brown to black eumelanin pigments. Activation of four other melanocortin receptors affected stress response, energy homeostasis, female sexual receptivity and male sexual performance. These were mediated by the production of sexual steroids including testosterone. Although numerous genes interact to stabilize an organism's development, the lead role belonged to the genes controlling the functioning of the neural and endocrine systems. However, [Ducrest et al. \(2008\)](#) cautioned, because of genetic mutations, melanin-based coloration may not exhibit these traits consistently across human populations.

Pigmentation change in wild silver foxes (*Vulpes vulpes*) was one outcome of breeding for tameness. It was the Russian geneticist [Belyaev \(1917–1986\)](#) who found that selecting easy-to-handle foxes pulled along with it many features that distinguish domestic animals from their wild forebears including white patches in the fur, droopy ears, a smaller skull, and a faster reproductive cycle ([Trut, 2003](#); [Trut, Iliushina, Prasolova, & Kim, 1997](#)). Domesticated foxes reached sexual maturity a month earlier (at 7 months) than non-domesticated foxes, and gave birth to litters averaging one pup larger (about six). After 40 years and the breeding of 45,000 foxes, [Belyaev's](#) successor, [Trut \(2003\)](#) had animals as tame and eager to please as a dog. The pattern of coat color that had evolved as camouflage in the wild, depigmented to piebald, one of the most striking mutations among domestic animals and seen frequently in dogs, cats, sheep, donkeys, horses, pigs, goats, mice, and cattle. About 35% of the co-variation in the domesticated traits was genetic in origin as assessed by cross fostering newborns and transplanting embryos between wild and tame foxes. Because behavior is rooted in biology, selection for tameness selected for physiological characteristics with broad effects.

Similar effects of de-pigmentation have been found in laboratory rats, which are typically albinos with white coats and pink eyes. Black rats are more aggressive (and so also make poorer pets). However, black rats with white spots (from the “white spotting gene”) are calmer and more easily handled. A 15-year study of selection for tameness over 30 generations in wild Norway rats (*Rattus norvegicus*) found the percentage of piebald rats increased rapidly until over 70% had white bellies and about 50% had white feet and ankles or “socks” as they are called ([Trut et al., 1997](#)). In this experiment in rats, selection for tameness correlated with their depigmentation.

Dogs too, show a relationship between coloring and behavior ([Coren, 2011](#)). Black dogs are more difficult to get adopted from

shelters and are rated as less desirable as pets. Using computer images of black, brown, and yellow Labrador Retrievers to control for size, pose, and background, [Coren](#) found people had more negative attitudes to the black than to the brown or yellow retrievers. Observers rated the black dogs as less friendly, less likely to make a good pet, and to be more aggressive. Assuming that people's attitudes and beliefs about dogs have some validity, this study provides further support for the pigmentation hypothesis.

### 3. Human studies

A first examination of whether melanin based pigmentation plays a role in human aggression and sexuality (as seen in non-human animals), is to compare people of African descent with those of European descent and observe whether darker skinned individuals average higher levels of aggression and sexuality (with violent crime the main indicator of aggression). Internationally, we found Blacks are over-represented in crime statistics relative to Whites and Asians. In Canada, a government commission found that Blacks were five times more likely to be in jail than Whites and 10 times more likely than Asians ([Ontario, 1996](#)). In Britain, the [Home Office \(1999\)](#) found that Blacks, who were 2% of the general population, made up 15% of the prison population. In the US, [Taylor and Whitney \(1999\)](#) analyzed the FBI Uniform Crime Statistics and National Crime Victimization Surveys from the US Department of Justice and found that since record keeping began at the turn of the century and throughout the 1960s, 1970s, 1980s, and 1990s, African Americans engaged in proportionately more acts of violence than other groups. Since victims' surveys tell a similar story, the differences in arrest statistics cannot just be attributed to police prejudice.

[Lynn \(2002\)](#) reviewed the literature on psychopathy in childhood and adolescence and found that Blacks averaged the highest rates including diagnosis with childhood conduct disorder, Attention Deficit Hyperactivity Disorder (ADHD), being suspended or excluded from school, scoring low on tests of moral understanding, failing to live up to financial obligations such as paying back student loans, poor work commitment, recklessness (e.g., having traffic accidents), maintaining monogamous relationships, being responsible parents, engaging in domestic violence, and needing hospitalization for injuries sustained through altercations.

[Rushton and Whitney \(2002\)](#) analyzed the 1993–1996 INTERPOL Yearbooks and found that across 100 countries, the rate of murder, rape, and serious assault is four times higher in African and Caribbean countries than elsewhere in the world. In violent crimes per 100,000 people, the rate for African countries was 149; for European, 42; and for Asian, 35. These results are similar to those carried out on other data sets from INTERPOL and the United Nations. They show the Black overrepresentation in violent crime to be a worldwide phenomenon.

In regard to sexual behavior, differences between Blacks and Whites also support the pigmentation hypothesis. In an early international survey, [Ford and Beach \(1951\)](#) asked married couples how often they had sex each week. Pacific Islanders and Native Americans said from 1 to 4 times, US Whites answered 2–4 times, while Africans said 3 to over 10 times. Later surveys confirmed and extended these findings. [Rushton and Bogaert \(1987\)](#), [Rushton and Bogaert \(1988\)](#) examined 41 items from the Kinsey data and found that Blacks not only had a higher rate of intercourse at an earlier age and with more partners, but also had more orgasms per act of coitus, spent more time thinking about sex, and had lower levels of sex guilt. Black females became pregnant more quickly indicated by speed of pregnancy after demobilization. Race predicted sexual behavior better than did socioeconomic status. Kinsey's Black sample was college educated (from 1938 to 1963) and came from a middle class background (parentally intact, with high educational

level) while one of the White samples was non-college educated and were lower on the same parental indices. Mixed-race (Black–White) adolescents reported an intermediate number of sexual partners compared to the two parental populations, even after controlling for socio-economic status (Rowe, 2002).

The World Health Organization found the average intercourse per week for married couples in their twenties was, for American Blacks, 5; for American Whites, 4; and for the Japanese and Chinese in Asia, 2.5 (see Rushton, 2000, for a review of these studies). National surveys from Britain and the United States produce similar findings. A Los Angeles study found that the age of first sexual activity in high school students was 14.4 years for Blacks, 16.4 years for East Asians, with Whites in the middle. The percentage of students who were sexually active was 32% for East Asians and 81% for Blacks, with Whites again between the other two. In another study, White Americans reported more sex guilt than Black Americans and that sex had a weakening effect. Blacks said they had casual intercourse more and felt less concern about it than Whites.

African descended people are over-represented in rates of sexually transmitted diseases [STDs] such as syphilis, gonorrhea, herpes, chlamydia, and HIV/AIDS (US Centers for Disease Control, 2009). Of the more than one million people living in the US with HIV/AIDS in 2007, almost half (46%) were Black. The Black–White difference in HIV/AIDS is found worldwide with high levels in sub-Saharan Africa, for example, Botswana (24.8%), South Africa (17.8%), Zambia (14.6%) and Zimbabwe (14.3%) (CIA World Factbook, 2010). The Black Caribbean is also disproportionately represented, despite limited recent contact between Africa and the Caribbean Islands. In the Caribbean, the rates approximate as high as they were in sub-Saharan Africa 20 years ago, for example, the Bahamas (3.1%), Haiti (1.9%), and Jamaica (1.7%).

To slow the spread of HIV/AIDS, public health agencies give out free condoms. Condom size can affect comfort level and so whether one is used. Thus these agencies take note of penis size. The World Health Organization Guidelines specify a 49-mm-width condom for Asia, a 52-mm-width for North America and Europe, and a 53-mm-width for Africa. China is now making its own condoms – 49 mm.

#### 4. Evolutionary life history

Life history theory (LHT) provides a framework for understanding the allocation of bodily resources for survival, growth and reproduction. Life history traits form a continuum from “fast” ( $r$ ) strategies at one end to “slow” ( $K$ ) strategies at the other end. The traits include age of gestation, litter size, total number of offspring, time between births, speed of physical growth, timing of puberty, age at first birth, infant mortality, degree of parental care, brain size, longevity, mate seeking, parenting, investing in kin and even social organization and altruism (MacArthur & Wilson, 1967; Pianka, 1970; Wilson, 1975). Unlike other approaches to explain behavior, life history theory predicts the co-variation of diverse clusters of biological and behavioral traits. Traits need to be harmonized rather than work independently. They work more effectively when organized in a coordinated system, fitting together like the pieces of a puzzle. Thus, we hypothesize that the relationships reviewed between darker pigmentation, higher levels of aggression and increased sexuality, go along with multifarious other characteristics.

The “fast–slow” or “ $r$ – $K$ ” scale originates in population biology, with  $r$  and  $K$  as symbols denoting rates of reproduction and death. Together they measure population density and change. A high reproductive rate ( $r$ ) typically requires little or no parental care (with a tiny percentage of offspring surviving), while a low reproductive rate ( $K$ ) requiring intensive parental care (with a large percentage of offspring surviving). Oysters, producing 500 million

eggs a year exemplify the  $r$ -strategy or “fast” life history. The great apes, producing one infant every 5 or 6 years (and providing extensive parental care), exemplify the  $K$  strategy or “slow” life history. All animals (and plants) are only relatively  $r$  and  $K$ . Thus rabbits are  $r$ -strategists compared to tigers, but  $K$ -strategists compared to frogs.

Across species, studies show the predicted co-variation among the traits. For example, Smith (1989) found that among 24 primate species, age of eruption of first permanent molar correlated with length of gestation (0.89), body weight (0.89), age of weaning (0.93), birth interval (0.82), sexual maturity (0.86), and life span (0.85). The highest correlation was with brain size (0.98). Rushton (2004) found that across 234 mammalian species, a principal components analysis revealed a single  $r$ – $K$  life history factor with loadings of brain weight (0.85); longevity (0.91); gestation time (0.86); birth weight (0.62); body length (0.63), litter size (0.54); age at first mating (0.73), and duration of lactation (0.67). The correlations remained high when controlling for differences in body size.

Rushton (1985) applied  $r$ – $K$  life history theory to human differences. He suggested that ‘one basic dimension –  $K$  – underlies much of the field of personality’ (p. 445). Diverse personality traits such as altruism, aggression, crime, intelligence, attachment, growth, health, longevity, sexuality, fertility, dizygotic twinning, infant mortality, and hormone levels were predicted to vary together culminating in a single, heritable, super-factor. Many predictions have been confirmed. For example, Rushton (1987) compared the mothers of one-egg twins (monozygotic or MZ) with those of two-egg twins (dizygotic or DZ). The mothers of DZ twins averaged higher on  $r$ -strategy traits including earlier pregnancies, shorter gestation periods, shorter menstrual cycles, less spacing between births, more siblings and half-siblings, more divorces, and shorter lifespans.

Ellis (1987) drew a distinction between intentional victimizing acts in which someone is obviously harmed and non-victimizing acts such as prostitution and drug-taking. He conceptualized victimizing behavior as the opposite of altruism and therefore  $r$ -selected. Victimizers tended to have the following  $r$ -strategy demographics: many siblings and half-siblings, less stable pair bonds, parents with less stable pair bonds, shorter gestation periods, more premature births, earlier age at first sexual intercourse, more sexual promiscuity (or at least a stated preference for such), a lower investment in offspring (higher rates of child abandonment, neglect, and abuse), and a shorter life expectancy.

Behavior genetic studies show that all these traits are about 50% heritable and that many are genetically linked (Figueredo and Rushton, 2009; Rushton, 1995). For example, not only are sexuality and delinquency heritable but genetically they go together. Among adolescents, 36–49% of the sexual intimacy engaged in by one sibling was predicted by the amount of delinquency engaged in by the other sibling (Rowe, Rodgers, Meseck-Bushey, & St. John, 1989). A subsequent study found that individuals with high scores on measures of sexuality and delinquency correlated positively with measures of impulsivity, deceitfulness, and rebelliousness, and negatively with those of parental affection and encouragement of achievement (Rowe & Flannery, 1994).

Race differences are found on the  $r$ – $K$  continuum. Africans average toward the  $r$  end, devoting resources to mating effort and producing more children but providing less parental care. East Asians average toward the  $K$  end, producing fewer offspring but investing more resources in them. Europeans average intermediately. Another three-way race difference is two-egg twinning, which is more numerous in Africans than in Europeans or East Asians (i.e., 16, 8, and 4 per 1000 twin births, respectively). Another is that Blacks have the most testosterone (Ellis & Nyborg, 1992), which helps to explain their higher levels of athletic ability (Entine, 2000). Testosterone acts as a “master switch.” It goes everywhere in the body and affects many bio-behavioral systems. It affects

self-concept, aggression, altruism, crime, and sexuality, not just in men, but in women too. Testosterone controls muscle mass and the deepening of the voice in the teenage years. It also explains why Black women have the most premenstrual syndrome (PMS) and East Asians the least.

A path-breaking study by Templer and Arikawa (2006) analyzed data from 129 countries and found a remarkably high correlation of 0.92 between skin color and national IQ. Skin color was measured using data from Biasutti (1967) estimated for the world's indigenous people at the time of Columbus's first voyage in 1492 and average national intelligence scores from Lynn and Vanhanen (2002). (Templer and Arikawa's rationale for using the year 1492 to define skin color in indigenous populations came from the authoritative tome by Cavalli-Sforza, Menzoni, and Piazza (1994) which mapped human genetic diversity.) The relationship between skin color and national IQs replicated separately within the three continents showing the generality of the phenomena:  $-0.86$  for Africa;  $-0.55$  for Asia; and  $-0.63$  for Europe. Templer and Arikawa conceptualized skin color as a multigenerational adaptation to the cold winters encountered as people migrated north "out of Africa" over the last 70,000 years.

Templer (2008) added life history variables to the 2006 national IQs compiled by Lynn and Vanhanen (updated from 2002). Templer found that skin color correlated across the 129 nations with IQ ( $-0.91$ ), birth rate (0.85), infant mortality (0.71), longevity ( $-0.84$ ), rate of HIV/AIDS (0.53), and GDP (0.60). A super-factor accounted for 75% of the variance. Subsequently, Rushton and Templer (2009) found skin color correlated with crime in 113 countries (homicide, 0.34; rape, 0.24; and serious assault, 0.25) as well as with IQ ( $-0.91$ ), GDP ( $-0.57$ ), HIV/AIDS (0.56), birth rate (0.87), longevity ( $-0.85$ ), and infant mortality (0.76). Rates of murder, rape, and serious assault correlated with those of HIV/AIDS (0.48, 0.57, and 0.42, respectively). Templer and Rushton (2011) replicated their international findings with data from the 50 US states. Skin color, measured by the percentage of Blacks in the state, correlated with infant mortality (0.41), longevity ( $-0.66$ ), HIV/AIDS (0.74), birth rate (0.12), murder (0.84), robbery (0.77), assault (0.54), and also IQ ( $-0.48$ ), and income ( $-0.28$ ).

Templer and Arikawa's (2006) "ecological correlations" (widely used in epidemiology) have been criticized on both theoretical and methodological grounds but have also been defended (Jensen, 2006; Templer, 2010) and corroborated and extended. For example, Meisenberg (2004) calculated a correlation across 121 countries of 0.89 between IQ and skin reflectance measures (from Jablonski & Chaplin, 2000).

## 5. Conclusion

We have found, in both human and non-human animals, that darker pigmentation is associated with higher levels of aggression and sexuality (and in humans with lower IQ). Lighter pigmentation is associated with the slow reproductive strategy (*K*) including lower birth rates, less infant mortality, less violent crime, less HIV/AIDS, plus higher IQ, higher income, and greater longevity.

The correlations between human pigmentation, aggression, and sexuality (and IQ), is further supported by the anthropological and sociological research on "pigmentocracies" (Lynn & Vanhanen, 2006). A pigmentocracy is a society in which status hierarchies are based largely on skin color, with lighter skin denoting higher status and darker skin lower status. Although these are typically explained by the legacy of slavery and imperialism, and although cultural and environmental factors undoubtedly play a substantial role (Rushton & Jensen, 2005), we have focused on genetic pleiotropy to explain the much less known relationship between skin color and behavior.

Life history theory (LHT) may explain why darker individuals are more aggressive and sexually active and why these traits covary with longevity, birth rate, infant mortality, speed of maturation, and many other characteristics (Templer, 2008; Templer & Rushton, 2011). The melanocortin system is a physiological coordinator of pigmentation and life history traits. Skin color provides an important marker placing hormonal mediators such as testosterone in broader perspective.

We recognize that this paper provides only a first approximation to what may become a workable explanation of melanin and its correlates. There are complex issues that need to be resolved. For example, skin coloration in humans is labile, showing much unexplained variation such as the African Khoi-san in the Kalahari Desert who display light pigmentation. Nonetheless, we believe our data reviews point in a direction that could greatly advance knowledge. Although the traits do not always go in lockstep, our data and analyses raise new research directions that should be seriously explored.

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