ELSEVIER

Evolution and Human Behavior 25 (2004) 38–50

Evolution and Human Behavior

Second to fourth digit ratio, sexual selection, and skin colour

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Received 9 July 2003; received in revised form 14 October 2003

Abstract

Skin pigment may be related to mate choice, marriage systems, resistance to microorganisms, and photoprotection. Here we use second to fourth digit ratio (2D:4D) to disentangle the relationships among these variables. There is evidence that 2D:4D is negatively associated with prenatal testosterone and positively with prenatal oestrogen. We show (i) a negative association between skin colour and 2D:4D in Caucasian women, but not in men, suggesting that skin colour in women is partly dependent on prenatal oestrogen; and (ii) Caucasian subjects with low 2D:4D reported higher susceptibility to sun-burn, athlete's foot and eczema than subjects with high 2D:4D, suggesting that prenatal testosterone increases susceptibility to sunburn and skin diseases. Frost [*Hum. Evol.* 9 (1994) 141] has reported that with latitude controlled, highly polygynous peoples have relatively dark and monogamous peoples relatively light skin. We suggest that polygynous populations incur selection for high prenatal testosterone and low prenatal oestrogen because of competition among men for wives. Such groups have low 2D:4D, and high susceptibility to sunburn and skin infections which may result from the immunosuppressive effects of prenatal testosterone. Where polygynous groups are found at low latitudes, they have evolved dark skin for protection against UV and microorganisms. More monogamous peoples experience selection for low prenatal testosterone and high prenatal oestrogen as a result of mate choice for light-skinned oestrogenised women. Such groups have high 2D:4D, resistance to sunburn and skin infections, and light skin. The association between very dark skin and low latitude exists only when polygynous societies are found at low latitudes, as is common in sub-Saharan Africa, but not in the New World.

Keywords: 2D:4D; Sexual selection; Skin colour

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doi:10.1016/S1090-5138(03)00082-5

1. Introduction

Skin colour has been used in the social construction of race. Therefore, the selective pressures involved in the evolution and maintenance of skin pigmentation have been obscured by ideological and political polemic. This work is an attempt to clarify the behavioural and physiological factors influencing the frequency of the genes that determine the pigmentation of the skin. We suggest that it is sexual selection (through male–male competition, which favours testosteronized men in polygynous societies and mate choice for light-skinned oestrogenized women in monogamous societies) which is the primary selection pressure that determines the skin's sensitivity to ultraviolet (UV) light and hence skin colour itself. Polygyny favours the evolution of high prenatal testosterone and this leads to a susceptibility to sunburn and skin infections. Monogamy favours high prenatal oestrogen that is protective against sunburn and skin infections. Very black skin evolves in populations with high UV and polygyny. Very light skin is associated with low intensities of UV and monogamy. Here we use the second to fourth digit ratio (2D:4D), a likely correlate of prenatal sex steroids, to disentangle the associations between sexual selection, skin colour and photo-protection.

Skin colour varies considerably within and between human groups. Much of this variation is dependent on the light-absorbing polymer melanin. Two types of melanin are common, the black-brown eumelanins and the yellow to reddish pheomelanins. The production of melanin occurs within melanocytes, which are found on the basal layer of the skin, between the epidermis and the dermis (Nordlund, Boissy, Hearing, King, & Ortonne, 1998). The melanocytes have many fine processes that extend to, and intertwine with, the surrounding cells called keratinocytes. Melanin is synthesised in the melanocytes, packaged into vesicles or melanosomes and exported to the surrounding cells. The majority of melanin within the skin is therefore to be found within the keratinocytes. Skin colour is dependent on the size and number of the melanosomes, in addition to the nature of their melanin content (Ortonne, 2002).

Much is now known about the biochemical pathways that lead to the production of melanin, and the genes which control these pathways (Sturm, Teasdale, & Box, 2001). However, the nature of the selection pressures which influence the frequencies of pigmentation genes remain obscure. There is evidence for at least four important selective pressures on human pigmentation. They include a widespread male preference for light-skinned women, an association between dark skin and polygyny which may arise from selection for high testosterone, the possibility that melanocytes, melanosomes, and melanin form a physical barrier to skin penetration by microorganisms, and a role for melanin as protection against UV. Each of these selective pressures have their advocates, and at present it is not at all clear which are the most important.

The evidence for a mate choice effect on skin colour has been summarised by Aoki (2002). In all human groups, males tend to be darker skinned than females (Wagner, Parra, Norton, Jovel, & Shriver, 2002). This sexual dimorphism is likely to arise from the differences in prenatal and adult oestrogen found in females and males. Women's skin lightens at puberty whereas men's skin becomes darker, and there is evidence from twin