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Evidence of unconstrained directional selection for male tallness

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Abstract There are many reports on a positive relationship between tallness and socioeconomic success, and between tallness and health in the human male. Accordingly, tallness is an explanatory variable in many studies on health or behavior. Recently, a positive correlation of tallness with fitness has been reported. However, whether this fitness advantage is the effect of the socioeconomic success of tall men (making them good providers) or of body height itself (tallness being directly associated with some genes, i.e., not requiring the father's presence, that are favorable for offspring number or survival) remains unclear. The exact type of selection (against short men, favoring men around some above-average height, favoring only very tall men) also remains unclear. Here, for a cohort of military officers, we show that tallness had a indirect effect on male lifetime fitness, independent of socioeconomic success. The crucial factor was not that tall men had more fecund wives, but that tall men more often had a second family. Selection worked strongly in favor of very tall men, not just against short men. Since there were no hints of any evolutionary check on this selection, these findings suggest unconstrained directional selection for tallness in men.

Keywords *Homo sapiens* · Male · Tallness · Reproduction · Success · Directional selection

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In this paper, in accordance with standard practise in biology, we use the term “fertility” for an individual ability to have children, and the term “fecundity” for the materialization of this ability: number of children born. Note, that the meaning of these two words is exactly reversed in conventional anglophone (but not francophone!) demography.

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Introduction

There are many reports of a positive relationship between tallness and socioeconomic success (Bielicki and Szklarska 1999; Frieze et al. 1990; Gillis 1982; Hensley and Cooper 1987; Jackson 1992; Stogdill 1974; Teasdale et al. 1991) and good health (Kuh and Ben-Shlomo 1997; Kuh and Wadsworth 1993; Macintyre and West 1991; Silventoinen et al. 1999) in men. Accordingly, tallness is an important explanatory variable in many health- or behavior-related studies. At the same time, tallness makes males more desirable mates (reviews in Buss 1994, pp. 38–40; Ellis 1992; Hensley 1994; Jackson 1992; Symons 1979). A recent cross-sectional study relates tallness to fitness (Pawlowski et al. 2000) in the human male, suggesting directional selection against short stature. These findings give rise to two questions:

1. Is the fitness advantage of taller men direct – with women preferring men of higher status (i.e., higher resource potential) and better health – because tall men have a status advantage over shorter men in the labor market, making them better providers for rearing young? Or is the effect indirect – with women preferring tall men because they supply “good” genes (without the father's prolonged presence) favorable for more offspring and better offspring survival? Both direct and indirect effects may, furthermore, be superseded or modified by sexual selection effects: females preferring men with the conspicuous trait tallness which signals direct and indirect benefits to their female mates, in order to get sons with the same market value (“sexy sons”).
2. What kind of directional selection is working on male height: a “horse race” competition (biggest prizes go to the fastest horses: the taller, the better), or a “threshold” competition (don't be too short, anything else is OK)? Is there an upper constraint at all (being tall is OK, but being too tall may be harmful)?

A serious limitation of studies to date is that formal education is usually the only measure of status, leading to an inappropriate application of evolutionary reasoning to modern humans. Given that educational homogamy is the most important segregating mechanism in the marriage markets of modern societies (Qian 1998; Ultee and Luijkx 1990), variation in education is equivalent to variation *across* marriage markets rather than variation *within* a marriage market. Such a distinction is not trivial: the formal level of education in many Western societies is or was inversely correlated with number of children, while individual achievement within one marriage market in virtually all populations studied is directly correlated to number of children (Wrong 1956/1980). Therefore, status should be measured by individual achievement within the same formal education category, i.e., within the same marriage market.

Furthermore, only with life course data, but not with cross sectional data – as in in Pawlowski et al. (2000) – can the true selection dynamics be observed.

We have a cohort data set with measures of individual status achievement, well suited to investigate the two questions raised above.

Methods

Of all surviving 539 members from the Class of 1950 of the United States Military Academy at West Point, 437 (81%) participated in a mailed survey in 1991, giving professional and family information. Using public sources, these data were merged with vital data, available measures of academic, athletic, and social performance while at the Academy known to predict career success (Mueller and Mazur 1996), and data on military career after graduation of all men of the class. Thus, we know the date of birth and death (including whether killed in action), height/company, facial dominance score, athletic accomplishments and the General Order of Merit (GOM), which is a measure of academic, athletic and social accomplishments, war college attendance, and final rank for all members of the Class, not only of participants in the survey.

In 1950, the Academy still followed the practice of assigning cadets to companies according to their height so that they would present a uniform appearance on the parade grounds; there were 12 company grades, from shortest to tallest (range 52–60 men). A man's height did not predict which particular service (Air Force or Army) or branch within a service (e.g., Armor, Artillery, Infantry) a man would enter after graduation. Mortality rates in the various branches and services vary both during war and in peacetime. Men were born between 1923 and 1929, with birth year unrelated to height ($r=0.040$, $P=0.420$). Height/company at the Academy among the survivors up to 1991 did not predict survey participation ($r=0.020$, $P=0.636$). For this study, we selected the 333 respondents (80% of surviving careerists) who had followed military careers for 20 years or more (by which time they could retire with benefits) in order to control for variations in the socioeconomic environment and to apply identical standards of professional success (if not stated otherwise, our findings refer to this sample). These men remained fairly equally distributed over the 12 height groups (range 22–33 men). Height admission requirements at West Point used to be 62–78 inches (157–198 cm), today being 60–80 inches. Exact height, while certainly in the personnel files, is not included in the public sources, and is therefore not accessible. This should not be a problem. Our use of company membership is equivalent to a conversion of the original metric data into "percentile" values, a conversion frequently undertaken in a variety of regression models. In general, betas in such regression

models tend to be equal or slightly lower, with P -values equal and slightly higher for categorized variables compared with the original metric ones. Thus, using data transformed by our methodology is more likely to risk underestimate than overestimate the true effect size in such models.

We have no data on the body weight of cadets. Therefore, we cannot test for eventual effects of the body mass index, which may reflect physical appearance features other than mere height, like "physicality" (muscularity, robustness, vigor) which Gangestad and Simpson's (2000) review (see also Mueller 2000) found as predicting an earlier age of first sexual experience and more sexual partners. The athletic minimum performance requirements for admission (today eight correct pull-ups and 54 push-ups in 2 min, among others – see <http://www.usma.edu>) and the continuing physical training during active service were demanding. Thus, it is difficult to imagine a West Point graduate in active military service from admission to the Academy up to the age 45–50, by which time his professional and reproductive career in most cases was completed, having a BMI outside the "desirable" range as given by the 1959 "Metropolitan Desirable Weight Table", which is still referred to in the "desired weight" column (ranging from a BMI of 27.0 for the shortest and 25.1 for the tallest men) in the currently valid United States Army Maximum Allowable Weight (MAW) Table with MAWs ranging from a BMI of 29.9 for the shortest and 27.9 for the tallest men (Institute of Medicine 1992). Thus, in our study group, the BMI probably would not be useful for differentiating the body appearances of subjects independently of height.

The facial dominance score of these men was measured from their fairly uniform portraits in the class graduation yearbook (method in Mueller and Mazur 1996). Facial dominance – dominant facial looks – is an honest signal of dominance (Mueller and Mazur 1997), is known to predict an earlier age of first sexual experience (Mazur et al. 1994), is helpful in obtaining high rank in the military (Mueller and Mazur 1996, 1997), and in this study population had a weak positive effect on number of children independent of its relation with rank, but was unrelated to height (Mueller and Mazur 1997).

We do not know if there is a difference in mean height between our study group and the general male US population of their age, but we assume that variance in the general male population was greater, so the size of a tallness effect on fitness may be greater in the general population than in our West Point group.

We equated professional success with military rank attained at the time of retirement plus whether or not the respondent graduated from a war college, which is a prerequisite to promotion to the highest ranks. Until 1976, upon graduation, every cadet was given an ordinal number, reflecting his GOM. The GOM is also known to be a powerful career predictor. A four-level category of athletic accomplishments during the Academy (four being the top category; details in Mueller and Mazur 1997) together with facial dominance score were also used as additional career predictors.

Of all graduates, 13% attained the rank of general, making this class one of the most successful in West Point history. Status distribution from major to "full" general (four stars) in our sample matched expectations as derived from the Register of Former Graduates of the West Point Alumni Association.

The West Point Class of 1950 is a sample of the middle-class US population of almost exclusively European origin (two men indicating a non-European ancestry were in the sample). Respondents' fathers had all graduated from high school, and 60% had had at least some college attendance; respondents' mothers had all graduated from high school, and 50% had had at least some college attendance; respondents' first wives had all graduated from high school, and 85% had at least some college; respondents' second wives had all graduated from high school, and 78% had at least some college attendance. Cadets came from a rural background and had a professional soldier as father apparently more often than the average adolescent of their cohorts (with height related to neither of these two variables), but were otherwise without conspicuous selectivities. Since tallness and career chances may also be influenced by the ethnicity of the family of origin, each respondent's