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Assessment of physical strength from gait: data from the Maasai of Tanzania

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In industrialized societies, male gait provides information about physical strength. Male physical strength may be used by men and women to assess the fighting ability of rivals and the quality of potential mates, respectively. Women more than men discriminate between strong and weak walkers when assessing gait attractiveness. We presented videos of British men's gait—pre-categorized into strong and weak walkers—to male and female members ($n = 100$) of the traditional Maasai in northern Tanzania in Africa. Maasai men and women judged the gaits of physically strong men less attractive than those of weak men and judged strong walkers to be weaker than weak walkers. These findings counter results from industrialized societies where participants accurately assessed strength from gait, thus arguing against a universal perception of physical strength from gait information.

1. Introduction

Physical strength is a sexually dimorphic (men > women; [1]), heritable trait [2] that correlates positively with measures of male health [3] and sexual behaviour [4] and negatively with male mortality [5]. Thus, physical strength may be a Darwinian fitness indicator in men [6]. Male physical strength can be accurately assessed from facial and body morphology [7–9], vocal cues [10,11] and body movements, such as gait [12,13] and dance [14–16]. Most of these studies have assessed men in industrialized societies, although the significance of male physical strength has also been documented for Hadza hunter–gatherers in Tanzania [17].

Recent studies of the perception of male physical strength (as indexed by handgrip strength, HGS) from gait showed videos of gender-neutral, featureless virtual characters, animated with the motion-captured gait of strong and weak (British) men to (German) male and female panelists. Both sexes judged strong walkers higher on dominance and strength than weak walkers [12]. Women (but not men) judged strong walkers more attractive than weak walkers, and these effects were independent of observers' physical strength. Thus, body movement alone, independent of facial and body morphology, provided information about male physical strength, which selectively affected men's and women's attractiveness assessments of male gait. These findings were recently replicated in samples from Chile, Germany and Russia [13].

It is not known whether these findings (including attractiveness assessments) extend to members of non-WEIRD (Western, Educated, Industrialized, Rich and Democratic [18]) societies. Culture-specific strength

relationships, in contrast to findings from investigations of WEIRD samples, have been reported in traditional societies. For example, a positive relationship of HGS with the number of living children was documented for women (but not men) of the Himba of Namibia [19]. Butovskaya *et al*. [20] reported that the patterns of relationships between physical strength and facial shape in the Maasai of northern Tanzania are similar to those reported from investigations in WEIRD samples, although the strength of this relationship varies with age-related mating effort. Here, we present data on Maasai assessments of male physical strength from gait by employing the same stimuli used in investigations of gait perception in industrialized societies [12,13].

2. Material and methods

(a) Gait and strength recordings

Walk movements of 80 British men, 18–42 years, were recorded with an optical motion-capture system (Vicon, Oxford, UK) running Vicon Nexus software as part of a large-scale study on body movement in relation to anthropometry and personality. Participants were recruited primarily from the student population at Northumbria University (UK). No participants reported any injuries that might affect natural movements. They did not wear shoes at recording. Gait recordings were applied to size- and shape-standardized, sex-neutral humanoid characters rendered as 773 × 632 pixel video clips using MotionBuilder (Autodesk, San Rafael, CA). A 3 s (4–5 strides) sequence was digitally isolated from the middle of each walk sequence for presentation in rating studies (figure 1).

Participants' HGS (kgf; 1 kgf = 9.81 N)) was measured with a hand dynamometer, twice for each hand, and the means of the two left and two right measurements were used for assignment to either the 'strong' or 'weak' walker group [12,13]. The videos of the 10 strongest (mean HGS (M_{HGS}) = 48.6, s.d. = 3.2) and 10 weakest heterosexual participants (M_{HGS} = 23.8, s.d. = 4.0) were selected for the rating study. Strong and weak walkers differed in HGS but not in the number of strides displayed in the videos. Three repetitions of each participant's walk sequence were used to construct a new video showing walk movements in a loop.

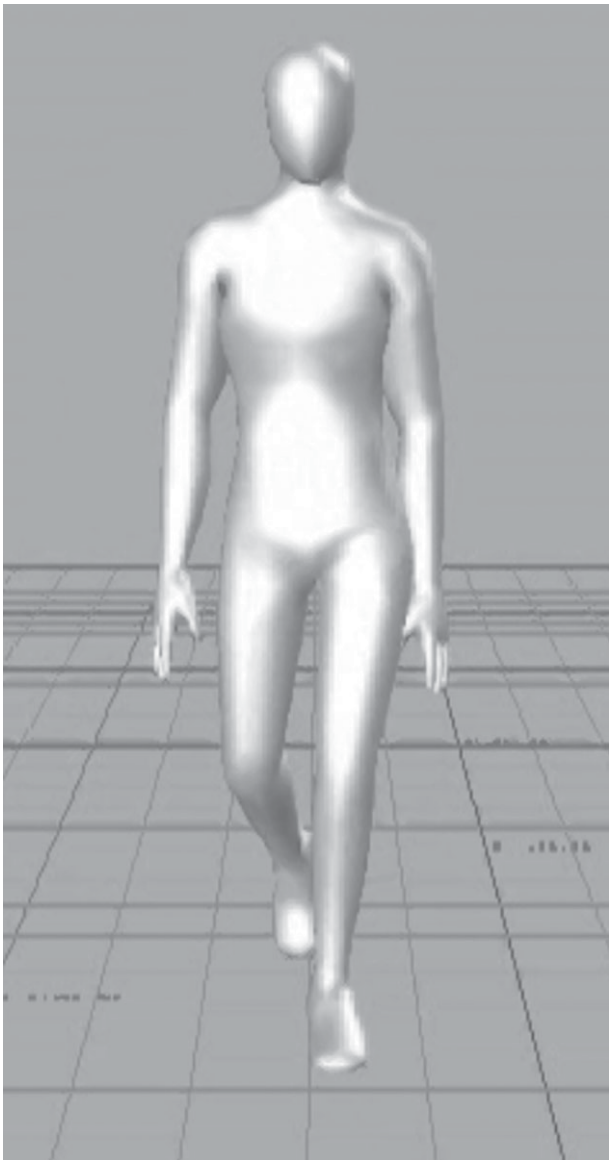

Figure 1. Snapshot of a size- and shape-standardized, sex-neutral humanoid character clip from a walking sequence as shown in the rating study.

(b) Gait ratings

The gait videos were shown to randomly selected members of the Maasai population settled around Endulen village in the Ngorongoro Conservation Area in Tanzania [20,21]. Our sample was 51 men and 49 women, 18–39 years (M = 25.6, s.d. = 5.5). Each participant viewed all videos (n = 20) on a 15 inch laptop computer and judged them one after the other for attractiveness and strength, on a three-point Likert-type scale (1 = unattractive/weak, 2 = neither attractive or unattractive/weak or strong, 3 = attractive/strong). The order of clips was randomized for both attractiveness and strength judgements. The assignment whether to begin with either attractiveness or strength judgements was also randomized across participants. A still image of the virtual character was presented for illustration of stimuli before the collection of judgements. Participants received instructions in the native Maa language from a local assistant who also collected their verbal judgements. For the analysis, the means of attractiveness and strength assessment (per rater) of strong and weak walkers, respectively, were calculated.

3. Results

Table 1 presents descriptive statistics of attractiveness and strength ratings of strong and weak male walkers. Lilliefors tests revealed deviations from normality for these variables ($z > 0.98$, $p < 0.02$). We therefore used non-parametric statistics (Wilcoxon signed-rank test, two-sided) to test for differences between assessments of strong and weak men's gaits. A difference was detected, such that the gait of strong men was judged lower on attractiveness ($z = -3.49$, $p < 0.001$) and strength ($z = -5.50$, $p < 0.001$) compared with that of weak men. Performing these tests separately for male and female judges revealed the same pattern of results (men, attractiveness: $z = -2.10$, $p < 0.05$; strength: $z = -3.45$, $p < 0.001$; women, attractiveness: $z = -2.97$, $p < 0.01$; strength: $z = -4.32$, $p < 0.001$). A similar pattern was found when considering differences between younger judges (18–29 years, n = 65) and older judges (30–42 years, n = 35), although for older judges, differences in attractiveness assessments did not reach significance (younger, attractiveness: $z = -3.02$, $p < 0.01$; strength: $z = -4.95$, $p < 0.001$; older, attractiveness: $z = -1.80$, $p = 0.08$; strength: $z = -2.52$, $p < 0.05$). We present the results in the more familiar Wilcoxon format here, but we also conducted a more advanced analysis (i.e. ordinal logistic regression) on the raw scores of individual assessments as dependent variables

Table 1. Descriptive statistics of attractiveness and strength ratings of strong and weak male walkers.

	strong walkers		weak walkers	
	median (range)	mean (std dev.)	median (range)	mean (std dev.)
attractiveness	2.00 (1.10–2.80)	1.95 (0.34)	2.10 (1.10–3.00)	2.11 (0.38)
strength	1.90 (1.20–2.80)	1.93 (0.31)	2.20 (1.40–3.00)	2.20 (0.38)

and sex and age as factors, which revealed substantively similar results (effect of walker group: attractiveness $\chi^2_{(1)} = 10.55$, $p < 0.001$; strength $\chi^2_{(1)} = 25.65$, $p < 0.001$; all other effects were non-significant). Finally, there were positive relationships (Spearman's r_s) of attractiveness and strength judgements for strong and weak walkers, respectively (strong: $r_s = 0.48$, $p < 0.001$; weak, $r_s = 20$, $p < 0.05$).

4. Discussion

Across several industrialized countries, men and women can accurately assess male strength from gait, suggesting that this is not culture-specific [13]. The findings of this study challenge this assertion. Massai men and women judged the gaits of strong (British) men less attractive than those of weak men. Strong walkers were judged to be weaker than weak walkers. This finding is in contrast to reports from samples in Chile, Germany and Russia, in which participants accurately assessed strength from gait [13]. In these samples, women more than men discriminated between strong and weak walkers when assessing the attractiveness of gait. We did not find evidence for sex or age effects on assessments in the Maasai. Considering the present findings together with previous reports, we conclude that the assessment of male physical strength from gait shows culture-specific variation.

The Maasai are semi-nomadic pastoralists who walk distances of up to 60 km daily without suffering foot ailments [22]. Walking activity is significant through the mid-50s and accounts for high energy expenditure and cardiorespiratory fitness [23]. The optimization of bipedal locomotion over human evolution has reduced the energetic costs of travel [24]. Different gaits have different energetic requirements, however [25]. Physical strength may be important in hunter–gatherer societies such as the Hadza [17], where hunting-related physical traits play a larger role than in the Maasai. The Maasai do not hunt for food but may kill predators occasionally to protect their cattle or themselves, as well as for use in ritual events. Owing to their lifestyle, the Maasai may be less concerned with physical strength; thus, display of strength may not be as important as in other societies. In fact, display of physical strength from male body movement may be interpreted to be a signal of aggression, rather than a quality cue, and this may explain the negative assessments of strong (British) walkers. The finding that strong walkers are perceived as 'weak' (and vice versa) may also suggest that in the Maasai, 'strength' is associated with agility rather than muscularity, as has been reported from investigations of WEIRD samples. Thus, energy-saving body movements might be judged higher on attractiveness than those correlated with high HGS.

Maasai men are known for their frequent participation in jumping dances (*adumu*)—a competitive ritual in which men demonstrate physical skills to attract a bride. The more gracefully and high a man can jump, the more appealing he is to the women watching. Jump heights of greater than 50 cm are possible, which is comparable to the performance of Western elite athletes [26]. Jump performances are part of the Maasai lifestyle, and males practise them from an early age. The continuous practice of athletic ability and skills to display effortless jumps—in addition to the high energy expenditure and low body weight—likely affects gait biomechanics. This remains to be investigated in future studies.

Ethics. Ethical approval of the study was obtained from the ethical committee at Moscow State University (protocol no. 55, 2015) and the Tanzania Commission for Science and Technology (protocols no. 2015-117-ER-2009-151 and no. 2017-185-NA-2009-151). Informed consent was obtained from all participants, either written or verbal.

Data accessibility. Data are available from figshare (https://doi.org/10.6084/m9.figshare.7334447).

Authors' contributions. B.F. and M.L.B. conceptualized the study. B.F. collected strength and gait recordings. M.L.B. collected the rating data. B.F., M.L.B. and T.K.S. analysed the data. All authors contributed to the interpretation and manuscript preparation. All authors revised the article critically for important intellectual content, gave final approval of the version to be published and agree to be accountable for all aspects of the work.

Competing interests. The authors declare that they have no competing interests.

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