

SEX DIFFERENCES IN RELATIVE FOOT LENGTH AND  
PERCEIVED ATTRACTIVENESS OF FEMALE FEET:  
RELATIONSHIPS AMONG ANTHROPOMETRY, PHYSIQUE,  
AND PREFERENCE RATINGS<sup>1</sup>

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*Summary.*—Foot size proportionate to stature is smaller in women than in men, and small feet apparently contribute to perceived physical attractiveness of females. This exploratory study investigated the sex difference in relative foot length and interrelations among foot length, physique, and foot preference ratings in samples from Austria and Canada, each comprised of 75 men and 75 women. The findings included the following lines of evidence: the sex difference in relative foot length replicated in both data sets; the magnitude of this sex effect was large. Relative foot length was smaller in young, nulliparous, and slim women. Pointed-toe and high-heel shoes were more likely worn by smaller, lighter, and slimmer women. Men reported liking women's feet in general more than vice versa. A vast majority of both men and women favored small feet in women, but large feet in men. One's own foot size appeared to correspond to evaluations of attractiveness; particularly, women with small feet preferred small feet in women in general. The preference for small feet in women was convergent across different methods of evaluating attractiveness. Directions for investigations in this emerging field of research on physical attractiveness are discussed.

Women tend to have smaller feet relative to stature compared to men (Fessler, Haley, & Lal, 2005a). Self-evidently, unlike the sex difference in absolute foot length, this sex difference in relative foot length must be markedly less discernible for oneself and others. Furthermore, when viewed from a biomechanical perspective, the sex difference in relative foot length is surprising, as pregnancy poses a challenge to body equilibration (shorter foot length affects dorsoventral stability) and thus, for this reason, women might be expected to have proportionately larger feet than men. It has thus been suggested that the sexual dimorphism in relative foot length, which is in the opposite direction, may be partly due to forces of intersexual selection that favored a reduction in female foot length over human evolutionary time (for a detailed discussion of arguments and evidence, see Fessler, *et al.*, 2005a).

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This hypothesis is conceived as follows. Children have smaller feet than adults, body growth generally follows a cephalo-caudal sequence (i.e., from head to the lower extremities), foot size increases slightly with age during adulthood, and, in women, foot size also increases with parity (for references and discussion, see Fessler, *et al.*, 2005a). Hence, small foot size in adult women in and of itself may index or may give the appearance of youth and nulliparity, properties universally sought by men. As a consequence, small feet may therefore contribute to women's physical attractiveness to men, which, in turn, could constitute the basis for intersexual selection pressures that potentially influence this anatomical trait. Many cultural practices and phenomena are indeed suggestive of the notions that, in mating contexts, men do focus on women's feet, and men do prefer relatively small feet in women, e.g., historical foot binding in China, existing erotica and pornography focusing on feet, various forms of female foot ornamentation, the proverbial "shoe mania" of women, and their reported tendency to wear shoes that are too small. Observations such as these led Barber to note that, although "dainty feet would appear to be associated with feminine beauty [. . .], this possibility has received no attention in the scientific literature" (1995, p. 415). This is in stark contrast to the vast literatures concerned with facial attractiveness (Rhodes & Zebrowitz, 2002) and other aspects of female physical attractiveness (Voracek & Fisher, 2002, 2006; Fisher & Voracek, 2006).

Recently, a systematic method (the "Fessler task," hereafter) was devised to investigate the contribution of relative foot length to female physical attractiveness. The Fessler task employs identical line drawings of women that differ only in relative foot length. Across diverse cultures (with samples from Brazil, Cambodia, India, Iran, Lithuania, Papua New Guinea, Russia, Tanzania, and the USA) the prevailing pattern was that small foot size enhances female physical attractiveness (Fessler, Nettle, Afshar, de Andrade Pinheiro, Bolyanatz, Borgerhoff Mulder, Cravalho, Delgado, Gruzd, Correia, Khal-tourina, Korotayev, Marrow, de Souza, & Zbarauskaite, 2005).

The purpose of the present study was to replicate and to extend previous findings of this emerging line of research, concerning the sex difference in relative foot length and its contribution to perceived attractiveness of women. In addition, pertaining to this topic and as a novel contribution to stimulate further research, a number of relations of anthropometry, physique, and preference ratings for them were assessed.

The plan and the hypotheses of this research are as follows. First, the literature review and re-analysis of Fessler, *et al.* (2005a) on the sex difference in relative foot length contained no data for Austria and only less than optimal evidence was retrievable for Canada (only one study, in which the sex difference in foot size was represented only graphically, and thus the

magnitude of this cannot be accurately quantified). Therefore, foot-length measurements of adult men and women were obtained from these two countries, to see whether the sex difference in proportionate foot length would replicate in these populations. Apart from this, the selection of samples from Austria and Canada was a matter of convenience, i.e., it corresponded to the present authors' geographic location. There is no strong reason to believe that data from precisely these two countries should be particularly important within the context of the present research. In other words, it is more likely than not that the main findings from the present investigation are generalizable to comparable countries.

Second, Fessler, *et al.* (2005a) did not make the repeatability of foot-length measurements a subject of discussion, so this was also assessed in the present research. The assumption was that this anatomical trait can be measured very accurately with standard anthropometric methods. Given the lack of reference values in this area and the light of several recent reports concerned with the repeatability of finger-length measurements (Manning, Fink, Neave, & Caswell, 2005; Voracek & Dressler, 2006; Voracek, Manning, & Dressler, 2007; Voracek & Offenmüller, *in press*), this is not a trivial question.

Third, it has been noted that, possibly owing to the effects of fetal androgens that generally appear to enhance the development of the right side of the body, in men the right foot tends to be larger than the left foot, whereas in women, on average, the reverse pattern is observable. However, the findings regarding this sex difference in foot-length asymmetry appear to be inconsistent (for references, see Baron-Cohen, 2003, p. 106). Since both feet were measured, this allowed addressing this question anew. In addition, also examined were relationships of foot-length asymmetry with foot preference for motor actions and with self-reported side susceptibility for aching feet, for which relationships the hypothesis was one of correspondence.

Fourth, the age and parity effects on women's foot size, as previously reported in the literature, were re-investigated (for references, see Fessler, *et al.*, 2005a). This was supplemented by also investigating possible effects of slimness (as gauged by Body Mass Index) on relative foot size and on shoe size. For biomechanical reasons, heavier individuals should have larger feet.

Fifth, the female obsession with shoes and exaggeration of small foot size, as indexed by the magnitude of the sex difference in the number of shoes owned, and by an indicator of the wearing of too small shoes was addressed. This was particularly done because there appear to be no up-to-date data in the scientific literature. A large sex difference in shoe ownership and a pattern of wearing too small shoes in women only was expected.

Sixth, the possible relationships between owning and wearing pointed-toe or high-heel shoes and aspects of women's physique (height, weight, and

Body Mass Index) and with foot size were investigated. This question does not seem to have been addressed in the literature. Pointed-toe shoes increase apparent foot length, both in absolute terms and relative to stature, and make the feet look slimmer. High-heel shoes reduce apparent foot length, both in absolute terms and relative to stature, and further increase apparent height, which is even more marked with platform-style shoes. In other words, with this shoe type, the legs look elongated and altered in shape, which is further coupled with changes in body posture and gait (Etkoff, 2000, p. 195). The assumption was that women wearing pointed-toe or high-heel shoes should tend to be shorter, lighter, or slimmer, or all of these.

Seventh, sex differences in the liking of other-sex feet and shoes, and preferences for foot size in the other sex were investigated. It was predicted that men would be more attracted by the feet and shoes of women than women by the feet and shoes of men. Further, it was predicted that smaller feet in women would be preferred by both sexes over larger ones, whereas neither smaller nor larger feet in men would be preferred by both sexes. The rationale for this asymmetrical prediction is derived from the view that the preference for small female feet is a cause, and not a consequence, of the sex difference in relative foot size (Fessler, *et al.*, 2005b).

Eighth, the relationship of women's own foot size with their preference for female foot size in general was investigated. It may well be that implicit theories of physical attractiveness, i.e., about how one's own body influences one's preferences with regard to other bodies, also extend to foot size. The prediction was that women with smaller feet in absolute terms, because this is an easily perceptible trait, would also present a preference for smaller feet in women in general, whereas women with smaller feet relative to their stature because this is an inconspicuous trait, would show a less marked preference or none for smaller feet in women in general.

Ninth, the relationship between one's own foot length with the choices made for the most and least attractive foot size on the Fessler task, of which a modified version was also administered in the present study, were investigated. For the same reason as outlined above, it was expected that there would be positive associations with same-sex choices, but a lack of associations with other-sex choices, and further, for the reasons given above, generally smaller associations for relative foot length than for absolute foot length.

Tenth, the relationship between self-reported preferences with regard to female foot size and performance on the Fessler task were investigated. The prediction was one of correspondence between these two measures, since they were concerned with the same topic. By comparing participants' stated preferences with their selections among the nearly identical images of the modified Fessler task, the validity of the latter was examined.

## METHOD

*Participants*

The Austrian sample was comprised of 75 men and 75 women, ranging in age from 19 to 88 years ( $M=33.7$ ,  $Mdn=27$ , and  $SD=13.5$  yr.), and the Canadian sample of 75 men and 75 women, ranging in age from 17 to 64 years ( $M=26.0$ ,  $Mdn=22$ , and  $SD=9.9$  yr.). These convenience samples were not matched on demographic variables. For details of the recruitment of participants, see Procedure below. Owing to sporadic missing values for some variables, sample size was slightly reduced for some analyses.

*Measures*

Participants completed a modified version of the Fessler task (for detailed description, see Fessler, *et al.*, 2005b; this earlier study relied on line drawings, and order of presentation was held constant, so that all subjects viewed the female images first). The version administered here consisted of two sets of realistic, computer-generated color images (5 male and female pictures each) that varied only with regard to relative foot size. The picture stimuli were numbered (not visible for the participants) from 1 to 5, with Number 3 representing the baseline, i.e., a medium foot length of 15.3% of stature for the male stimuli and of 14.9% for the female stimuli, Number 1 depicting the smallest, and Number 5 displaying the largest relative foot length. Over the range of stimuli, the variation in relative foot length was subtle, increasing or decreasing in increments of 6% from the baseline, making the pictures look nearly identical (further information regarding the production of these color images is available from the authors). From each of the sets of male and female pictures, participants were requested to choose the most and the least attractive picture. The data for this part of the investigation were gathered to contribute to an ongoing cross-cultural follow-up study of Fessler, *et al.* (2005b), the findings of which will be published elsewhere. Here, the focus was on the relationships between specific choices on the modified Fessler task with other groups of variables.

The survey contained personal information, a measure of footedness, and items related to feet and shoes. Two investigators (M.V. and B.R.) developed English translations of the original German-language survey, using the parallel blind technique (Behling & Law, 2000, p. 23). Discrepancies between individual draft translations were resolved consensually to arrive at the final version. The investigators at the Canadian study site (M.L.F. and D.L.), then received the annotated English survey version which, to ensure methodological consistency across the study sites, was further discussed with the Austrian investigators (M.V. and B.R.) prior to the data-collection phase.

Participants stated their sex, age, height, weight, number of biological children, and shoe size. The latter variable was verified by the respective in-

vestigator by examining the shoes worn. Footedness was assessed with a four-item measure taken from the Coren Lateral Preference Inventory (Coren, 1993, pp. 37-43). These four items ask for foot preference (right or either or left) for the following actions: to kick a ball to hit a target; to pick up a pebble with the toes; to step on a bug; and to step up onto a chair. Self-reported foot preference is known to be almost perfectly concordant with direct behavioral performance testing on the same motor actions (Coren, 1998). In the present samples, internal consistencies based on Cronbach coefficient alpha for the footedness measure were .69 (Austria) and .75 (Canada), which figures tallied with a previously published reference value [Voracek, Reimer, Ertl, and Dressler (2006) reported .70 for a sample of tournament fencers]. The footedness measure is unidimensional. In the present samples, factor analysis extracted a single factor with an eigenvalue beyond unity ( $\lambda=2.09$ , Austria, and  $\lambda=2.35$ , Canada, accounting for 52.2% and 58.7% of the total variance, respectively).

Participants further responded to nine survey items: (1) and (2) "Do you own and wear pointed-toe [high-heel] shoes?" (asked of female participants only; response format: "yes" vs "no"; high heels defined as 7 cm or over); (3) "How many pairs of outdoor shoes do you currently own?" (except for various sports shoes; respondents were given adequate time for consideration; for interval estimates, midpoints were taken); (4) and (5) "Generally speaking, to what extent do you deem other-sex feet [shoes] as pleasing and attractive?" [both items rated on an 11-point scale, with 0 ("not at all") and 10 ("maximally")]; (6) and (7) "Based on your personal opinion and preference: are men [women] with larger feet or smaller feet more pleasing and attractive to you?" (for both items, dichotomous response format: "larger feet" vs "smaller feet"); (8) "Do you now buy your shoes precisely the same size as you did when you were 18 to 20 years old?" ("yes" vs "no"; for participants age 25 years or over only; "no" answers were further detailed by stating the shift of adult shoe size over time, including past and present shoe size, and increase vs no increase in shoe size was recorded); and (9) "When you 'wear in' new shoes, which one of your feet is more likely to be squeezed or feeling uncomfortable?" ("right foot" vs "left foot" vs "can't say, either").

### *Procedure*

Two investigators (Vienna, Austria: B.R.; Halifax, Canada: D.L.) collected the data in a variety of public and semipublic urban locations, such as community centers, club houses, pedestrian areas, offices, parks, and workplaces. Participants were unaware of the background and the central hypotheses of the research. Upon agreement to volunteer, participants were first administered the modified Fessler task. After that, they completed the survey,

whereafter length measurements of the right and left foot were taken. Participants were then debriefed and thanked.

Length of bare feet of sitting participants was measured twice by the respective investigator, using a sliding anthropometer, measuring to the nearest 1 mm (Lafayette Instrument Co., Lafayette, IN; Model 01291). Measurement landmarks were the extreme point of the heel and the tip of the first toe, regardless of whether the subject's first toe or second toe was the longer one.

#### *Data Analysis*

Repeatability of foot-length measurement was evaluated with the appropriate type of intraclass correlation coefficient (*ICC*; two-way mixed-effects model with absolute-agreement definition; see Case 3 *ICC* in McGraw & Wong, 1996; see also Voracek, *et al.*, 2007). The dual measurements for individual traits (length of right and left foot) were averaged for analysis. Asymmetry in foot length was calculated by subtracting length of left foot from length of right foot. Absolute foot length (right, left, or the average) as well as relative foot length (expressed as a percentage of height) were used in the analyses.

From participants' self-reported height and weight, which are generally known to be reported quite accurately in normal populations (Nakamura, Hoshinko, Kodama, & Yamamoto, 1999; but see Jacobson & DeBock, 2001), Body Mass Index, (i.e., weight scaled for height ( $\text{kg}/\text{m}^2$ ), was calculated. European shoe sizes (Austrian sample) and U.S. shoe sizes (Canadian sample) were converted to shoe length (in mm), using international shoe-size conversion charts.<sup>2</sup> Average foot length subtracted from shoe length served as indicator for the wearing of too small shoes.

Individual item responses on the footedness measure were scored as -1 (left), 0 (either), and +1 (right), and summed up to yield the total score which, by its sign and absolute value, indicated more or less strong preference for the right or left side, or ambifootedness. Following Fessler, *et al.* (2005b), extremity scores were calculated for participants' choices on the modified Fessler task by subtracting the number of the least attractive from the number of the most attractive male or female color drawing. Both the hypothesis and previous findings led to the expectation that, on average, a negative extremity score would characterize selections among the female stimuli, resulting from choices of smaller female feet as most attractive and larger female feet as least attractive.

Two-tailed statistical significance tests were used throughout. The significance level was set at  $p < .05$ . For brevity, the details of statistically non-

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<sup>2</sup>[www.i18nguy.com/110n/shoes.html](http://www.i18nguy.com/110n/shoes.html).

significant results are omitted. The application of Bonferroni-correct  $p$  levels seemed inappropriate. In recent years, strong scepticism with respect to the general usefulness of this procedure has arisen (for arguments and discussion, see Rothman, 1990; Perneger, 1998; Nakagawa, 2004). Most importantly, Bonferroni correction would assume that a single i.e., the universal, null hypothesis is tested, when there were separate and differentiated hypotheses for the variables under study. Further objections to this procedure include that the interpretation of findings would depend on the number of statistical tests performed, would increase the rate of statistical Type II errors, and would assume complete independence of tests and variables, which is invariably not the case.

The Austrian and Canadian data sets were analyzed separately. The focus was not on possible sample differences across variables but rather on the consistency of findings, i.e., it was desired to examine whether findings from one sample would replicate in the other. Occasionally, when results in both samples were in the expected direction but did not achieve nominal significance, to increase statistical power, a combined analysis was applied. Most of the tested hypotheses were sex-specific and for these the *a priori* power estimates (Elashoff, 2000), based on the present subsample sizes, were as follows: two-group mean comparisons with  $n=75$  per group, i.e., single-sample analyses, have more than 99%, 86%, and 22% power to detect an effect size  $d$  that is large (0.80), medium (0.50), and small (0.20), respectively. With  $n=150$  in each group, i.e., when the two samples are combined, power, in above order, is more than 99%, more than 99%, and 40%. For correlational analyses, based on Pearson  $r$ , a sample size of  $n=75$  has 94%, 58%, and 13% power to detect an effect size  $r$  that is large (.40), medium (.25), and small (.10), respectively. With  $n=150$ , power, in the above order, is more than 99%, 87%, and 22%. Hence the present study design had excellent power to detect large effects and sufficient power to detect medium-sized effects, particularly with combined-sample analysis.

## RESULTS

### *Sex Differences in Relative Foot Length*

There was a strong sex difference in the relative length of the right foot in the Austrian sample (men:  $M=14.70\%$ ,  $SD=0.52\%$ ; women:  $M=14.25\%$ ,  $SD=0.55\%$ ;  $t_{148}=5.12$ ,  $d=0.84$ ) which replicated in the Canadian sample (men:  $M=14.91\%$ ,  $SD=0.66\%$ ; women:  $M=14.36\%$ ,  $SD=0.55\%$ ;  $t_{147}=5.52$ ,  $d=0.91$ ). A similar sex difference was seen in the relative length of the left foot (Austria, men:  $M=14.73\%$ ,  $SD=0.53\%$ ; women:  $M=14.26\%$ ,  $SD=0.49\%$ ;  $t_{148}=5.65$ ,  $d=0.92$ ; Canada, men:  $M=14.87\%$ ,  $SD=0.67\%$ ; women:  $M=14.38\%$ ,  $SD=0.57\%$ ;  $t_{147}=4.81$ ,  $d=0.79$ ). All  $p$  values associated with the

independent-group  $t$  tests were smaller than .001 and, by conventional standards, the magnitude ( $d$ ) of the sex effect in the present data sets was large.

#### *Repeatabilities of Foot-length Measurements*

The measurement repeatabilities within investigators were as follows (all  $ps < .001$ ,  $df_1 = df_2 = 149$  for the  $F$  ratios):  $ICC = .997$  (Austrian sample) and  $.999$  (Canadian sample) for length of the right foot ( $F_s = 688.0$  and  $1550.0$ , respectively),  $.996$  and  $.999$  for length of the left foot ( $F_s = 567.2$  and  $1668.9$ ), and  $.998$  and  $.999$  for the average foot length ( $F_s = 1289.9$  and  $2313.6$ ). Inter-individual differences in measurements were, by orders of magnitude, larger than measurement error, so investigators' measurements were highly precise.

#### *Sex Differences in Foot-length Asymmetry, Relationships to Footedness, and Side Susceptibility for Aching Feet*

In the Austrian sample, men on average did not have longer right feet than left feet (right-minus-left difference in absolute foot length, men:  $M = -0.53$  mm,  $SD = 3.53$  mm; women:  $M = -0.10$  mm,  $SD = 4.04$  mm;  $t_{148} = -0.70$ , ns,  $d = -0.11$ ). In contrast, the evidence from the Canadian sample was in the expected direction, but was not statistically significant (men:  $M = 0.53$  mm,  $SD = 4.16$  mm; women:  $M = -0.38$  mm,  $SD = 3.91$  mm;  $t_{148} = 1.38$ ,  $p = .17$ ,  $d = 0.23$ ). Relative length of right and left foot were comparably strongly correlated in both samples ( $r_s = .93$  for Austria and  $.94$  for Canada,  $ps < .001$ ). Foot-length asymmetry was unrelated to footedness scores (Austria: Pearson  $r = -.10$ ; Canada:  $r = -.03$ ; both ns). There was no sex difference in side susceptibility for aching feet in either sample (data not shown). Foot-length asymmetry corresponded to responses on the survey item concerned with side susceptibility for aching feet, i.e., the group mean on the asymmetry measure was lowest and negative, indicating a longer left foot than the right, for "left shoe" responses, higher for "can't say, either" responses, and highest for "right shoe" responses. However, these group means were statistically not significant even when the two samples were combined (one-way analysis of variance; data not shown).

#### *Age, Parity, and Body Mass Index Correlated with Women's Relative Foot Length and Shoe Size*

For women, average relative foot length was positively correlated with parity, i.e., having at least one biological child vs none ( $r_s = .28$ , Austria and  $.15$  Canada), and to age ( $r_s = .29$  and  $.23$ , respectively; all  $ps < .05$ , except for the second correlation coefficient, ns). Controlling these associations between relative foot length and parity for age reduced them to nonsignificance (partial  $r = .13$ , Austria, and  $-.04$ , Canada). Similar associations, albeit weaker than those reported above, were observed when using women's current shoe size instead of relative foot length, whereas parity status was not associated

with a reported increase in adult shoe size in women ages above 25 years (data not shown). Body Mass Index was positively correlated with relative foot length and shoe length (Austria:  $r_s = .27$  and  $.29$ , respectively,  $p_s < .05$ ; Canada:  $r = .39$  with relative foot length,  $p < .01$ ;  $r = .21$  with shoe length,  $p = .08$ ). These relations were attenuated when controlled for age, but still significant in pooled-sample analysis (partial  $r = .32$  with relative foot length,  $p < .001$ ; partial  $r = .26$  with shoe length,  $p < .01$ ).

#### *Sex Differences in Number of Shoes Owned and Wearing of Too Small Shoes*

In both data sets, there was a strong sex difference in the number of currently owned outdoor shoes (Austria, men:  $M = 6.5$ ,  $SD = 4.0$ ; women:  $M = 15.2$ ,  $SD = 9.4$ ;  $t_{148} = -7.44$ ,  $d = -1.20$ ; Canada, men:  $M = 4.6$ ,  $SD = 6.2$ ; women:  $M = 9.0$ ,  $SD = 7.7$ ;  $t_{148} = -3.79$ ,  $d = -0.63$ ; both  $p_s < .001$ ) which was not reduced when participants' age was covaried out or when a nonparametric method (Mann-Whitney  $U$  test) was employed to account for skewed distributions (further data not shown). Regarding the indicator for the wearing of too small shoes (shoe length minus average foot length), there was a significant sex difference in the opposite direction of the hypothesis in the Austrian data (men:  $M = 4.03$  mm,  $SD = 6.49$  mm; women:  $M = 7.81$  mm,  $SD = 7.24$  mm;  $t_{148} = -3.37$ ,  $p = .001$ ,  $d = -0.55$ ). This trend was also evident from the Canadian data but was statistically nonsignificant (men:  $M = 6.27$  mm,  $SD = 10.10$  mm; women:  $M = 9.00$  mm,  $SD = 6.34$  mm;  $t_{145} = -1.96$ ,  $p = .052$ ,  $d = -0.32$ ).

#### *Relationships of Wearing Pointed-toe or High-heel Shoes with Women's Physique*

Owning and wearing of pointed-toe shoes (reported by 85.4% and 83.8% of Austrian and Canadian women, respectively) or high-heel shoes (in above order, 42.7% and 68.0%) was weakly related to smaller stature, lower weight, lower Body Mass Index, and younger age in women, but these correlations were statistically not significant, even when the samples were combined for analysis, except for the relation with age ( $r = -.20$ ,  $p < .05$ ; further data not shown). The relationships of these two shoe-type variables with average relative foot length or with the indicator for the wearing of too small shoes were neither consistent across samples nor statistically significant.

#### *Sex Differences in Liking of Other-sex Feet and Shoes and Preference for Other-sex Foot Size*

There was a significant sex difference in the liking of other-sex feet in the Austrian sample (men:  $M = 6.03$ ,  $SD = 2.55$ ; women:  $M = 4.25$ ,  $SD = 2.58$ ;  $t_{148} = 4.23$ ,  $p < .001$ ,  $d = 0.69$ ). A trend in the same direction was also evident in the data from Canada but was statistically not significant (men:  $M = 4.49$ ,  $SD = 2.40$ ; women:  $M = 3.89$ ,  $SD = 2.83$ ;  $t_{140} = 1.40$ ,  $p = .16$ ,  $d = 0.23$ ). No such

trend was observed regarding the liking of other-sex shoes (Austria, men:  $M=6.05$ ,  $SD=2.79$ ; women:  $M=6.07$ ,  $SD=2.69$ ;  $t_{148}=-0.03$ , ns,  $d=-0.01$ ; Canada, men:  $M=5.29$ ,  $SD=2.39$ ; women:  $M=5.91$ ,  $SD=2.62$ ;  $t_{148}=-1.50$ ,  $p=.14$ ,  $d=-0.25$ ). Respondents overwhelmingly favored small over large feet in women (Austrian men and women: 87.8% and 88.0%; Canadian men and women: 94.5% and 85.5%) as they favored large over small feet in men (Austrian men and women: 78.4% and 80.0%; Canadian men and women: 74.2% and 76.7%). All the within-sample sex differences were statistically not significant.

*Relationships of Women's Absolute and Relative Foot Length with Preference for Female Foot Size*

Preference responses for foot size in women (coded as 0 "smaller feet" and 1 "larger feet") were associated with women's own foot length in absolute terms but not with foot length relative to stature. That is to say, women with smaller feet (a trait expression easily visible for self and others), but not those with proportionately smaller feet (a trait expression less perceptible for self and others), also preferred smaller foot size in women in general. In the Austrian and Canadian samples, the correlation coefficients with absolute foot length were .23 ( $p=.05$ ) and .21 ( $p=.08$ ), respectively. Pooled analysis of the samples resulted in a significant association ( $r=.22$ ,  $p<.01$ ). The corresponding correlations with relative foot length were negligible in both samples and in the combined analysis.

*Relationships of Own Foot Length with Extremity Scores on Modified Fessler Task*

In the Canadian data set, there were significant correlations between absolute foot length and the same-sex extremity score on the modified Fessler task. Men's own absolute foot length was positively associated with their extremity score for male stimuli on the modified Fessler task ( $r=.34$ ,  $p<.01$ ). Likewise, women's own absolute foot length was positively associated with their extremity score for female stimuli ( $r=.23$ ,  $p<.05$ ). The corresponding associations with other-sex extremity scores were negligible. In the Canadian sample, the very same pattern, albeit weaker, was seen when relative foot length was correlated with the extremity scores. In contrast, in the Austrian sample all of these correlations were statistically not significant (data not shown).

*Relationships of Preference for Female Foot Size and Female Extremity Scores on the Modified Fessler Task*

Preference responses for foot size in women (coding: 0 "smaller feet" and 1 "larger feet") were consistently related to the extremity scores for the feet of female stimuli in the modified Fessler task. In the Austrian sample,

correlation coefficients were .39 ( $p < .01$ ) for the responses of men and .22 ( $p = .06$ ) for the responses of women. This means that both men and women who, on the forced-choice item, stated a preference for smaller over larger feet in women, had also chosen a female image with smaller feet as the most attractive and an image with larger feet as the least attractive (thereby resulting in a negative extremity score) on the previously administered modified Fessler task. In the Canadian sample, the correlations were .09 (ns) and .24 ( $p = .04$ ), respectively. Combined-sample analysis showed that both correlations were significant (men's responses:  $r = .33$ ,  $p < .001$ ; women's responses:  $r = .20$ ,  $p < .05$ ). Paralleling the results of supplemental analyses pertaining to the preceding hypotheses tested, controls for participants' age left these results essentially unchanged (data omitted).

#### DISCUSSION

This study contributes to the literature on human physical attractiveness by investigating an underresearched physical attribute, namely, the sex-differentiated anatomical trait of relative foot length, and a number of novel interrelations between foot length, physique, and preference ratings for feet in samples of Austrian and Canadian men and women. The following results were obtained as numbered corresponding to the hypotheses.

First, the sex difference in relative foot length appears to be robust, replicating in both samples. Relative to stature, women have smaller feet than men, and the magnitude of this sex effect is large, as the group-mean difference amounts to about 0.8 or 0.9 *SD* units. Second, the repeatability of foot-length measurements with standard anthropometric methods is excellent. Third, a trend for the hypothesized sex-differentiated pattern in foot-length asymmetry (i.e., right foot larger in men, left foot larger in women) could only be observed in one sample, but this was statistically not significant. Foot-length asymmetry was unrelated to footedness and only weakly (statistically not significantly) related to side susceptibility for aching feet. Fourth, nulliparous women appear to have relatively smaller feet than women who have born children, but this effect is attenuated to nonsignificance when adjusted for age. Relative foot length is smaller in younger than in older women. It is also smaller in slimmer women than in those with a higher Body Mass Index, and this effect (a medium-sized correlation) is preserved when adjusted for age. Fifth, the sex difference in the number of outdoor shoes currently owned is notably large. There was no indication in the data that women (but not men) tend to wear too small shoes; in fact, the trend was in the opposite direction. Sixth, the wearing of pointed-toe or high-heel shoes may be related to aspects of women's physique, such that they are preferentially worn by smaller, lighter, and slimmer women, but these effects were weak and statistically not reliable in the present data sets. Relative foot length

was not related to the wearing of these shoe types. Seventh, there is a sex difference in the liking of other-sex feet (men reported liking women's feet more than vice versa), but no sex difference in the liking of other-sex shoes. Presented with a forced-choice item, a vast majority of both men and women favor small feet in women and large feet in men. Eighth, on the same forced-choice item, women who have small feet in absolute terms prefer small over large feet in women in general. This correspondence is not seen with women's own relative foot length. Ninth, for both sexes, one's own absolute foot length corresponds to attractiveness evaluations of same-sex feet different in relative length (performance on the modified Fessler task). Again, this correspondence is not seen with one's own relative foot length. Tenth, for both sexes, there is a correspondence, i.e., medium-sized positive correlations, between attractiveness evaluations of female feet different in relative length (the modified Fessler task) and the forced-choice preference for smaller or larger female feet. These convergent findings from different methods should be construed as a validity cue for the modified Fessler task. Given present knowledge, the lines of inquiry reported here are the first of their kind. The investigation of the factors influencing aesthetic judgments relating to feet as one aspect of physical attributes is a promising area of research, with many opportunities for additional exploration.

This study has several limitations. The number of shoes owned was self-reported and could not be verified in this research context. Further, available income limits consumer behavior such as the buying of shoes but was not accounted for in the present research. In hindsight, the indicator used for the wearing of too small shoes was less precise than desired, since different types of shoes and manufacturers were not differentiated. Women frequently wear open shoes, considered to be more sexy than closed ones, and it is this shoe type which can be worn in far too small sizes. Instead of converting shoe size to shoe length in mm, it would be more appropriate to measure the inside of shoes from toe to heel. General liking of the shoes of the other sex was assessed with a single-item measure, which could therefore not differentiate between shoe types. This may have affected the results, and indeed no sex difference was found on this item. Construct clarification and usage of multi-item measures, illustrated with images of shoe types, is necessary to investigate this point further. The protocol for measuring foot length was such that the anterior landmark was the tip of the first toe, regardless of whether the subject's first or second toe was longer. A minority of people have a second toe equal in length or even slightly longer than the first toe, i.e., the "Greek Ideal" foot shape (Wood Jones, 1944, p. 38), and this peculiar pattern of toe-length succession appears to be more frequently seen in women than in men (cf. McFadden & Shubel, 2002). This may lead to underestimating relative foot length in women, thereby exaggerating the sex

difference in relative foot length and may in turn also affect comparisons of foot length with shoe size. Informative data on these issues are not known. A systematic measurement study is needed to clarify this point.

Presently, there is widespread interest in the investigation of the second-to-fourth digit ratio (2D:4D; Manning, 2002). On average, men tend to have a lower 2D:4D compared with women, i.e., they have a longer ring finger (4D) relative to their index finger (2D). There is now fairly strong evidence for the role of the 2D:4D ratio as a biomarker for the organizational, i.e., permanent, effects of prenatal androgens on the brain and behavior, and this inconspicuous anatomical trait of the hand has been shown to be related to a multitude of sex-dependent, hormonally influenced traits and phenotypes which reach into the domains of ability, attractiveness, behavior, fertility, health, personality, physical attractiveness, physique, sexuality, and sports (Manning, 2002; see also Voracek, *et al.*, 2006). In addition, sex differences in toe-length ratios have also been reported (McFadden & Shubel, 2002). The sex difference in relative foot length is large, and sex and individual differences in this trait could be influenced by the prenatal and perinatal action of sex hormones. In addition, with regard to the aesthetic appearance of legs, there is evidence that there is a sex difference in the leg-to-body ratio, which is higher in women than in men, and that men have a preference for a higher leg-to-body ratio, i.e., for longer legs, in women (Swami, Einon, & Furnham, 2006). Considering these different lines of investigation, it would be of interest to investigate whether sex and individual differences in relative foot length and leg-to-body ratio relate to those in the length ratios of the fingers and toes, and to explore how this relates to other aspects of physique and perceived physical attractiveness.

Among the present study's findings, that concerning men's greater liking of women's feet in general than vice versa suggests several avenues for future investigations. Apart from the sex difference in relative foot size, there clearly are further sex differences in human foot morphology, such as in foot shape, relative toe length, and in the length succession, i.e., digital formula, of the toes, hence investigations of pedal aesthetics may productively explore these topics. Research on human facial attractiveness differentiates between variation of different constituents and variation of general configurational aspects of the human face to elucidate their differential contributions to facial attractiveness (Rhodes & Zebrowitz, 2002). This sophistication has yet to be reached in the nascent field of research on the attractiveness of human feet. For comparison, recent research (Saino, Romano, & Innocenti, 2006; Voracek & Pavlovic, 2007) suggested that individual differences in 2D:4D, which affect the appearance of the palm, influence the sexual attractiveness, sex-typicality ratings, and other attributes ascribed to hands. Transferring this to feet, it may well turn out that they can be analyzed and read like human

faces, i.e., that the contributions of a variation of constituents and a variation of general configurational aspects of the human foot can be gauged.

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