

Original Article

More Males Run Relatively Fast in U.S. Road Races: Further Evidence of a Sex Difference in Competitiveness

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Abstract: Deaner (2006) recently showed that among elite U.S. runners, two to four times as many males as females run fast relative to sex-specific world-class standards. Previous questionnaire studies of non-elite runners suggest this phenomenon may reflect a sex difference in motivation to train competitively. If this hypothesis is correct, then the sex difference in performance depth should also hold in non-elite running populations. Here I tested this prediction by analyzing the finishing times at 20 of the largest 5000 m road races and 20 of the largest marathons held in the U.S. in 2003. For both types of races, overall population distributions of relative performance were similar in males and females. However, at the fastest relative performance levels, males were over represented by two to four times. This difference could not be explained by the presence of professional runners or as an artifact of biased world-class standards. This result shows that the sex difference in performance depth occurs generally and thus supports the hypothesis that sex differences in competitiveness partly reflect evolved predispositions.

Keywords: running, athletics, sports, gender differences, motivation.

Introduction

For much of the twentieth century, the difference between male and female world-class running performances steadily diminished (Furlong and Szreter, 1975; Jokl and Jokl, 1968; Whipp and Ward, 1992). By the early 1990s, however, the sex difference in speed had stabilized at roughly 10-12% across all distances (Cheuvront, Carter, DeRuisseau, and Moffaet, 2005; Noakes, 2003; cf., Seiler and Sailer, 1997; Sparling, O'Donnell, and Snow, 1998). This historical pattern has been interpreted as reflecting two factors. First, although female runners have generally enjoyed far fewer competitive opportunities than males, this difference had been minimized by the 1980s, at least in some countries (Deaner, 2006; Murphy, 2000; Noakes, 2003). Second, even when females train similarly to comparably talented males, they run slower due to hormonally regulated differences in aerobic capacity and body composition (Shephard, 2000; Sparling and Cureton, 1983; Wilmore and Costill, 2004). The reality of biological constraints is underscored by highly similar gender gaps in other timed sports, such as rowing and cycling (Schumacher, Mueller, and Keul, 2001; Yoshiga and Higuchi 2003).

Recently, Deaner (2006) described a new type of sex difference: in similar sized U.S. populations, two to four times as many males as females run fast relative to sex-specific world

class performances. For instance, in the 10,000 m run in 2005, 25 U.S. males recorded times that were less than 110% of the current male world record, whereas only six females performed within 110% of the corresponding female record (Track and Field News, 2006). This sex difference in performance depth was demonstrated across all commonly contested distances, from sprints to the marathon, and for Open (i.e., mainly professional), Division 1 collegiate, and high school runners.

Based on studies of distance runners indicating sex differences in motivation and training (Callen, 1983; Johnsgard, 1985; Ogles, Masters, and Richardson, 1995; Ogles and Masters, 2003; Walter, Hart, McIntosh, and Sutton, 1989), Deaner (2006) hypothesized that the sex difference in performance depth was due, at least in part, to more males being motivated to train competitively. Furthermore, Deaner (2006) showed that despite steady growth in opportunities and incentives for female athletes in the U.S., this sex difference, which greatly narrowed in the 1970s, has been stable since the mid-1980s. Together, Deaner (2006) argued, these results provide a potentially powerful new line of evidence for one of evolutionary psychology's fundamental claims: sex-differences in competitiveness and related psychological attributes cannot be completely attributed to sociocultural conditions (Eagly, 1987; Eagly and Wood, 1999; West and Zimmerman, 1987) but instead partly reflect evolved predispositions (Campbell, 2002; Daly and Wilson, 1988; Geary, 1998).

One weakness in Deaner's (2006) argument is that the sex difference in relative performance was demonstrated among elite runners, whereas the studies indicating sex differences in motivation and training were primarily based on road race participants, the vast majority of whom are non-elite. If the hypothesis of a sex difference in motivation is true, then the sex difference in relative performance should occur at road races. The purpose of the present study is to test this prediction.

Methods

The sample consisted of 20 of the largest 5000 m road races and 20 of the largest marathons held in the U.S. in 2003. Races were identified from an internet site that provided a list of the largest road races in 2002 (Running USA, 2003). It was assumed that the largest races of 2002 would generally be the largest races of 2003 or would at least provide an unbiased sample of large races. All competitors' ages and times were downloaded from individual race websites, although only competitors aged 20-39 were included in the analyses. "Race for the Cure 5Ks" were held in several locations, but they were not included in the sample because preliminary analyses indicated that these events differed from other 5000 m races in having substantially different population distributions; most notably, fast runners were vastly under represented and walkers were substantially over represented. Ten other 5000 m races were excluded because they did not occur in 2003, were less than 50% as large as they were in 2002 ($n = 4$), were women's only races ($n = 2$), served as a national men's championship race ($n = 1$), or data could not be readily obtained from the internet ($n = 2$). Two of the largest marathons were excluded because data could not be readily obtained from the internet. In cases where races were excluded, the next largest race with available data was employed.

To compare the proportion of relatively fast male and female runners, 40 of the fastest male and female finishers in each race were considered. In particular, for each race, the fastest 40 performances of whichever sex had fewer finishers were used, and 40 comparable performances based on percentiles were used for the other sex. Thus, if a race had 400 males and 800 females,

the fastest 40 male performances were compared to females finishing 2nd, 4th, 6th...80th. Population size was controlled separately for each race, rather than using regressions of relative speed on population size across the entire sample of races (Deaner, 2006, Fig. 2). This was done because road races differ greatly in the types of runners they attract owing to variation in prize money, course location, and amenities; moreover, road race courses can differ substantially in difficulty due to several other factors, including altitude, turns, hills, and weather.

In calculating the relative speed for each finisher, the “10-Fastest” standard was used, rather than the world record, because there is some evidence that world records may artificially inflate the sex difference in relative speed (Deaner, 2006; see also Seiler and Sailer, 1997). For any given distance, the 10-Fastest standard is defined as the mean best time of the 10 fastest performers in the world in the year of the race (Deaner, 2006). For males and females respectively, the 10-Fastest standards for 2003 were 12:52 and 14:40 for the 5000 m and 2:05:57 and 2:20:54 for the marathon (Track and Field News, 2004). Calculations were also performed with world records, and highly similar results were obtained, although world records produced a much larger sex difference in the marathon.

Races that are longer in distance and duration are associated with relatively slower performances (Deaner, 2006). This could spuriously produce a sex difference in relative performance due to the fact that female performances are generally longer in duration than comparable male performances. Therefore, male performances were duration-corrected following Deaner (2006), although this procedure did not substantially affect the results.

To estimate the magnitude of the sex difference in relative performance depth, a bias-ratio was computed for each race. A bias-ratio is defined as the ratio of 40 over the number of females equaling or bettering the relative performance of the 40th fastest (duration-corrected) male (Deaner, 2006). Thus, if 20 females met or exceeded the relative performance of the 40th ranked male, the bias ratio would be 2.0, indicating that twice as many males ran relatively fast. Comparisons of male and female relative speed measures among the 40 performances in each race were made using t-tests with separate variance estimates, since female performances might be more variable (Deaner, 2006). All statistical tests were two-tailed and α was set at 0.05.

Results

For 18 of the 20 large 5000 m races and for 18 of the 20 large marathons, the time of the percentile-comparable fastest 40 male finishers was significantly closer to the 10-Fastest standard than were the times of the comparable female finishers (Tables 1 and 2). Males were also relatively faster in the four races where there was not a significant sex difference. The mean bias-ratio across the 20 5000 m races was 2.1 (*median* = 2.0; Table 1), whereas the mean bias ratio across the 20 marathons was 2.6 (*median* 2.1; Table 2). Thus, across broad samples of U.S. road races, there were about twice as many relatively fast males.

To better illustrate the nature of the sex difference, population distributions of relative speed were constructed for each race based on all finishers of each sex between the ages of 20 and 39 (i.e., 120 – 11,528 runners). This was done by plotting the percentage of finishers running faster or equal to each succeeding 0.25 increment of the 10-Fastest standard. Across all relative speed groups, the distributions of males and females were broadly similar (Fig. 1). However, in the fastest group, those that ran ≤ 1.25 of the 10-Fastest standard, there was a pronounced sex difference with males being substantially over represented (Fig. 1).

More Males Run Fast in Road Races

Table 1. Comparisons of males and females in 20 large U.S. 5000 m road races.

* probability of a sex difference between 10-Fastest ratios.

10-Fastest ratios and Bias ratios based on the performances of the 40 fastest percentile-comparable finishers.

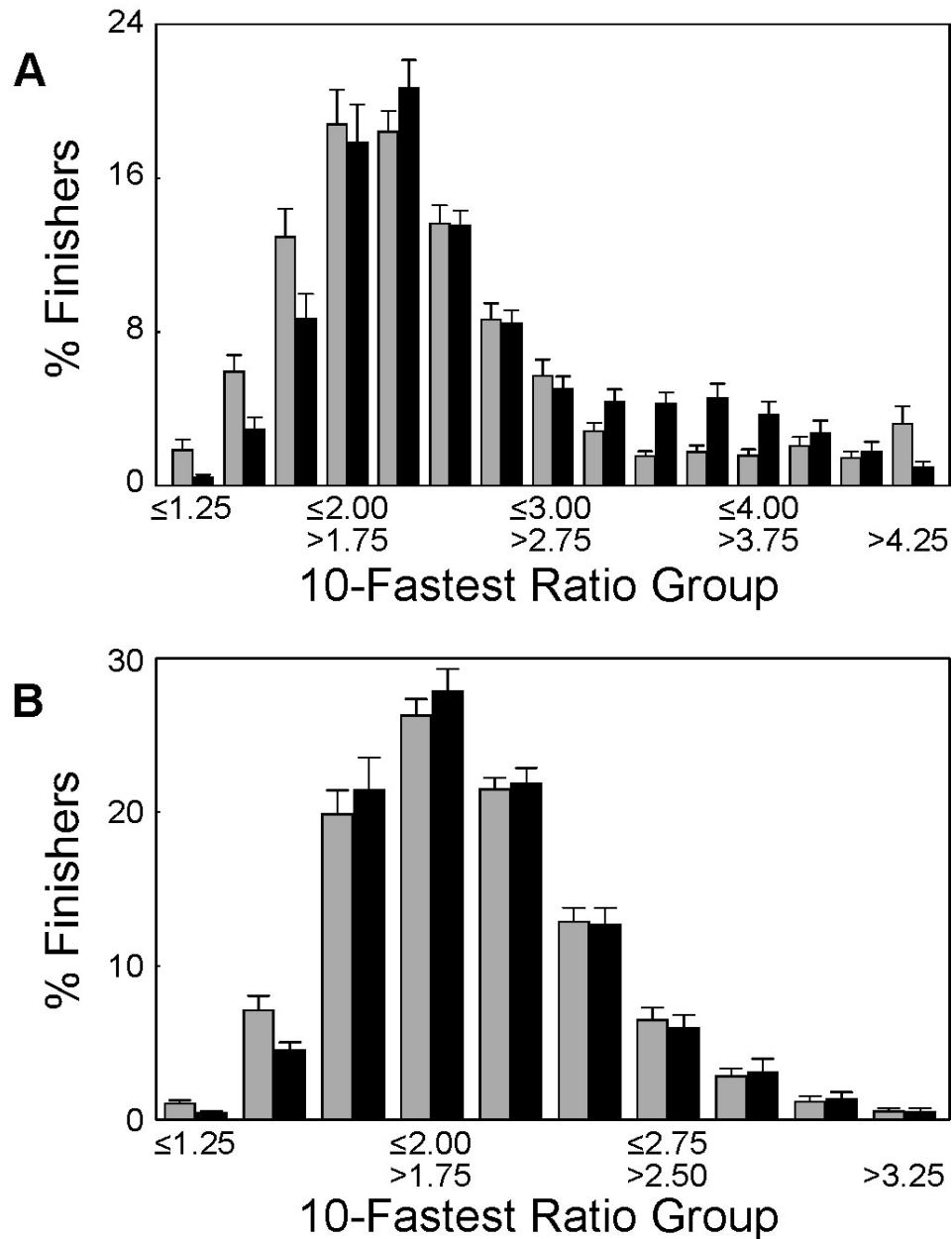
Race	Location	Male finishers	Female finishers	Mean male 10-Fastest ratio #	Mean female 10-Fastest ratio #	<i>p</i> *	Bias ratio
Carlsbad 5000 5K	Carlsbad, CA	1002	1053	1.20	1.26	<0.0001	3.33
Gridiron Classic 5K	New York, NY	933	839	1.37	1.45	<0.0001	2.00
Cigna HealthCare Corporate 5K	Manchester, NH	885	1014	1.21	1.37	<0.0001	3.33
Gasparilla Distance Classic 5K	Tampa, FL	866	1127	1.44	1.55	<0.0001	2.22
Jingle Bell Run 5K	Seattle, WA	854	1493	1.43	1.51	<0.01	2.11
Light the Night Against Crime 5K	San Diego, CA	767	544	1.46	1.59	<0.0001	2.00
Midsummer Night's Run 5K	Lexington, KY	668	631	1.41	1.44	<i>NS</i>	1.54
Naperville Noon Lions Turkey Trot 5K	Naperville, IL	513	573	1.44	1.49	<i>NS</i>	1.18
Fifth Third River Bank Run 5K	Grand Rapids, MI	489	728	1.48	1.59	<0.0001	1.74
O'Doul's Shamrock Run 5K	Baltimore, MD	585	608	1.39	1.46	<0.001	1.67
Arlington 9-11 Memorial 5K	Arlington, VA	483	492	1.52	1.59	<0.01	1.67
Spectrum Health: Irish Jig 5K	Grand Rapids, MI	478	505	1.30	1.39	<0.0001	2.00
Cowtown 5K	Fort Worth, TX	472	529	1.50	1.63	<0.001	2.00
Run to the Far Side 5K	San Francisco, CA	398	853	1.37	1.68	<0.0001	3.33
Los Angeles Times 5K	Los Angeles, CA	352	550	1.40	1.67	<0.0001	3.64
Cherry Creek Sneak 5K	Denver, CO	301	802	1.70	1.86	<0.0001	1.67
AmerUs Group 5K/Indianapolis 5K	Indianapolis, IN	224	768	1.70	1.88	<0.0001	2.86
The KION/Big Sur 5K	Carmel, CA	126	286	1.40	1.75	<0.0001	3.08
Primo's Run for Education 5K	San Ramon, CA	124	256	1.85	2.10	<0.001	1.54
Miller Lite Dinosaur Dash 5K	Milwaukee, WI	120	174	1.54	1.61	<0.05	1.25

More Males Run Fast in Road Races

Table 2. Comparisons of males and females in 20 large U.S. marathons.
See table 1 for conventions.

Race	Place	Male finishers	Female finishers	Mean male 10-Fastest ratio	Mean female 10-Fastest ratio	<i>p</i>	Bias ratio
New York City Marathon	New York, NY	11528	7525	1.19	1.23	<0.05	2.22
LaSalle Bank Chicago Marathon	Chicago, IL	11160	10200	1.09	1.14	<0.001	2.67
Marine Corps Marathon	Washington, DC	5078	4145	1.31	1.41	<0.0001	2.00
City of Los Angeles Marathon	Los Angeles, CA	4679	3290	1.25	1.38	<0.0001	2.35
Boston Marathon	Boston, MA	4549	3878	1.19	1.23	<0.05	2.22
Suzuki Rock 'n' Roll Marathon	San Diego, CA	4261	6220	1.19	1.32	<0.0001	2.00
Grandma's Marathon	Duluth, MN	2246	1746	1.15	1.23	<0.0001	2.35
Walt Disney World Marathon	Orlando, FL	2245	3064	1.31	1.45	<0.0001	4.44
Twin Cities Marathon	Minneapolis, MN	2222	1831	1.23	1.28	<0.01	1.60
Philadelphia Marathon	Philadelphia, PA	1823	1199	1.26	1.29	<i>NS</i>	1.25
Motorola Marathon	Austin, TX	1612	1421	1.24	1.29	<0.05	1.74
Portland Marathon	Portland, OR	1415	2109	1.34	1.43	<0.0001	2.67
Compaq Houston Marathon	Houston, TX	1347	980	1.34	1.47	<0.0001	6.67
St. George Marathon	St. George, UT	1054	1065	1.34	1.47	<0.0001	6.67
Columbus Marathon	Columbus, OH	1040	922	1.32	1.37	<0.01	1.60
Country Music Marathon	Nashville, TN	955	861	1.45	1.46	<i>NS</i>	1.05
Dallas White Rock Marathon	Dallas, TX	952	653	1.43	1.49	<0.0001	1.82
SunTrust Richmond Marathon	Richmond, VA	812	661	1.36	1.43	<0.0001	2.50
UPMC/City of Pittsburgh Marathon	Pittsburgh, PA	754	469	1.39	1.49	<0.0001	1.82
California Int'l Marathon	Sacramento, CA	729	670	1.21	1.29	<0.0001	1.60

Figure 1. Population distributions of relative speed for (A) 20 large 5000 m races and (B) 20 large marathons. Distributions based on all finishers of each sex between the ages of 20 and 39. Black bars represent females and gray bars represent males. Error bars represent one standard error of the mean. The bars on the far left of the x-axis indicate nearly world-class performances, whereas bars on the right indicate slow running or walking.



In the 18 5000 m races and 19 marathons with at least some runners in this group, there was a higher percentage of males in 17 of the 5000 m races and 18 of the marathons. Across all races, the mean ratio of males to females in this ≤ 1.25 group was 4.9 for 5000 m races (median 2.9) and 4.4 for marathons (median 2.5). There were generally more males than females in the

≤ 1.50 group for 5000 m races and marathons and in the ≤ 1.75 group for 5000 m races. However, these differences were far smaller than those in ≤ 1.25 group (Fig. 1). Thus, the sex difference in relative speed was most pronounced among the fastest runners, where there were generally about two to four times as many relatively fast males.

Discussion

This study demonstrates that the pattern identified by Deaner (2006) for elite U.S. runners—that proportionally more males run close to sex-specific world-class standards—also holds at U.S. road races where most runners are non-elite. Before considering the explanations for this phenomenon, two issues regarding the robustness of the present results must be considered.

The first issue is whether the sex difference in relative performance at road races actually represents a sex difference in non-elite runners. Although most participants in road races are non-elite, some large races do attract and recruit elite professionals. This fact, together with the finding that the sex difference was pronounced only among the fastest runners, raises the possibility that the sex difference merely reflects differences in the presence of professionals. This hypothesis seems unlikely because road races that feature professionals generally attempt to recruit similar numbers of world-class males and world-class females and uniformly offer equivalent prizes (Road Race Management, 2004). This suggests that the presence of professionals will generally obscure a sex difference in performance depth rather than produce one.

Nonetheless, I investigated the “professionals produce a sex difference” hypothesis by testing whether the races that award more prize money show greater bias ratios. Contrary to this hypothesis, across marathons, larger 1st place cash awards (square root transformed) did not predict greater bias-ratios (least squares regression: $\beta = -0.14$, $t(18) = -0.61$, $p = 0.55$). In fact, the mean bias ratio of the five marathons that did not award cash prizes or substantial non-cash prizes was 3.7 (*median* = 2.7), which was greater the mean bias ratio of 2.6 across all 20 marathons.

A similar analysis could not be performed for 5000 m races because information on prize money was generally unavailable. Nevertheless, only three 5000 m race websites indicated that they offered remotely large enough prizes (e.g. > \$200) to lure professional runners, and the modest times of the fastest 40 finishers at most 5000 m races (Table 1) also indicate that they generally draw few or no professionals. Thus, the sex difference in the occurrence of relatively fast runners in road races almost certainly does reflect, at least in part, a difference between non-elite males and females.

A second issue is whether the sex difference in relative performance could be an artifact of the 10-Fastest standard being somehow biased against females. The most obvious possibility is that the performances of the fastest 10 females of 2003 were unusually fast. Contrary to this idea, however, for both the 5000 m and the marathon, the 10-Fastest standard of 2003 was further from the all-time 10-Fastest standard for females than it was for males (male 5000 m: 12:52 / 12:46 = 1.008; female 5000 m: 14:40 / 14:30 = 1.011; male marathon: 2:05:57 / 2:05:52 = 1.001; female marathon: 2:20:54 / 2:19:50 = 1.009; all-time best performances taken from IAAF [2006]).

Another way to address this issue is determine what the 10-Fastest standard would have to be for females in order to yield no sex difference in relative speed. The mean female 10-

Fastest ratio across the 20 5000 m races detailed in Table 1 is 1.59, whereas the mean male 10-Fastest ratio was 1.46, a difference of 9%. Thus, if the female 10-Fastest standard was 16:02 rather than its actual value of 14:40, there would be no sex difference in relative performance. The sex difference in the marathon would similarly be eliminated if the female 10-Fastest standard was 2:29:36 rather than its actual value of 2:20:54. Although 16:02 and 2:29:36 are indisputably excellent performances, scores of females substantially surpass them each year (Track and Field News, 2004, 2006). Therefore, although the particular values of the 10-Fastest standard will somewhat affect results, the general finding that in U.S. road races more males run fast relative to world-class standards must be considered robust.

Proximate explanations for the sex difference

So why do more males run relatively fast? Achieving fast running performances requires that many conditions be met, but one of the most important is extended periods of consistent training. For distance runners, this generally entails maintaining running volumes of 100 – 200 km / wk (Bale, Bradbury, and Colley, 1986; Hagan, Smith, and Gettman, 1981; Hagan, Upton, Duncan, and Gettman, 1987; Masters, Ogles, and Jolton, 1993; Slovic, 1977). The maintenance of such training volumes is, in turn, associated with competitive motivational profiles (Masters et al. 1993; Ogles and Masters, 2003; Ogles, Masters, and Richardson, 1995), and, thus, faster runners generally report being more competitive (Masters et al. 1993; Ogles and Masters, 2000; Ogles and Masters, 2003). Because males generally report greater competitiveness and larger training volumes (Callen, 1983; Johnsgard, 1985; Ogles et al. 1995; Ogles and Masters 2003; Walter et al. 1989), Deaner (2006) hypothesized that the sex difference in relative performance was due, at least in part, to more males being motivated to train competitively.

One difficulty with this hypothesis is that the sex difference in relative performance was initially demonstrated among elite runners (Deaner, 2006), but studies of elite runners do not indicate sex differences in motivation or training (Billat, Demarle, Paiva, and Koralsztein, 2002; Morgan, O'Conner, Sparling, and Pate, 1987; Porter, 1985; Sparling, Wilson, and Pate, 1987). Thus, the following question arises: if there is a sex difference in relative performance depth for both elite and non-elite runners, and this difference is putatively due to a sex difference in competitiveness, then why has the sex difference in competitiveness only been found among non-elites?

The present results can potentially explain this paradox. The key is that the magnitude of the sex difference shown here for non-elite runners—that proportionally two to four times as many males run relatively fast—is similar to that found for elite runners (Deaner, 2006). Thus, it can be hypothesized that, although few runners are motivated to consistently train at levels that would potentially maximize their performance, the small fraction of such runners are more frequently male. Thus, the pool of runners who could potentially approach world-class or elite standards is substantially greater for males than for females. However, virtually all runners from these potentially elite pools, whether male or female, are highly competitive and dedicated in their training, meaning that no sex difference in motivation or training will be detected. Testing this scenario will require gathering data on training, motivation, and performance from broad populations of runners. If it holds, this pattern would provide a striking parallel with risk-taking, a behavior that may be closely related to competitiveness. Although there are robust sex differences in risk-taking in the general population, and many more males than females are employed as investment managers, a profession that requires risk-taking, male and female

investment managers show indistinguishable risk-taking (Atkinson, Baird, and Frye, 2003; see also Dwyer, Gilkeson, and List, 2002; Johnson and Powell, 1994).

Other explanations for the sex difference in relative performance depth are possible besides the “sex difference in competitiveness” hypothesis. One possibility is that there are particular morphological characteristics that preclude approaching gender-specific world-class performance levels and that more females possess such exclusionary characteristics. Studies investigating sex differences in running performance among elite runners generally ignore skeletal morphology, mainly because they find that almost all sex differences can be accounted for by hormonally regulated variation in body fat and the cardiovascular system (Shephard, 2000; Sparling and Cureton, 1983; Wilmore and Costill, 2004). Nonetheless, it seems plausible that there are some skeletal characteristics (e.g. an extremely wide pelvis) that would prevent an individual from remotely approaching world-class running performances regardless of their training habits or genetic predisposition for cardiovascular improvement (Simoneau and Bouchard, 1995). If such exclusionary characteristics exist and more frequently occur in women, this could explain the sex difference in relative performance depth.

One indicator of such a sex difference in the occurrence of exclusionary morphological characteristics would be that running economy, defined as the amount of oxygen required to maintain a given speed, would generally be poorer among women. Although existing studies do not point to consistent sex differences in running economy (Joyner, 1993; Noakes, 2003), these studies have typically focused on highly trained subjects. The crucial question for this hypothesis, though, is whether sex differences in running economy occur across broad populations of similarly trained males and females. Future studies should address this issue.

Another possible explanation for the sex difference in relative performance depth is that males and females might show differential responses to training, so that for a given level of training, males might generally perform closer to sex-specific world-class standards. Yet another hypothesis is that females may be more susceptible to running injuries and so enjoy fewer opportunities to train consistently. As reviewed by Deaner (2006; see also Deaner, Masters, Ogles, and LaCaille, in review), these hypotheses do not presently enjoy support, although they should be addressed with additional research.

Ultimate explanations for the sex difference

Although further study is needed to determine the proximate cause(s) of the sex difference in performance depth, the “sex difference in competitiveness” hypothesis is a strong candidate because, as reviewed above, competitiveness is known to be associated with fast running performances, and several studies indicate that, on average, male runners are more competitive than female runners. If the sex difference in performance depth is indeed caused by a difference in competitiveness, then this raises the question of what, from an ultimate perspective, causes the sex difference in competitiveness.

Two general hypotheses could explain the origin of a sex difference in competitiveness, as well as differences in related attributes such as dominance and egocentrism. One is that sociocultural conditions differentially socialize males and females and/or direct them into sex-differentiated roles (Eagly, 1987; Eagly and Wood, 1999; West and Zimmerman, 1987). The other is that sex differences partly reflect predispositions that evolved because they were associated with enhanced fitness in the past (Campbell, 2002; Daly and Wilson, 1988; Geary, 1998). Although much data has been marshaled to support both hypotheses, there are few direct

tests of the competing hypotheses where sociocultural conditions have unambiguously changed and psychological attributes have been measured.

Deaner (2006) argued that the performances of U.S. runners could represent such a test case because there has been steady growth in opportunities and incentives for female athletes over the past 35 years and the number of relatively fast runners potentially provides an index of athletic competitiveness. Because Deaner (2006) found that the sex difference in performance depth in elite U.S. runners has been stable since the mid-1980s, Deaner (2006) claimed this pattern supported the evolved predispositions hypothesis. The current study strengthens this argument by showing that, as predicted, the sex difference in performance depth generalizes to non-elite runners.

Nevertheless, several other assumptions and predictions of Deaner's (2006) argument require testing before it can be confidently accepted. For example, although the assumption that relative performance predicts competitiveness and training similarly in males and females is fully consistent with previous studies, it has not been directly tested (Deaner et al. in review). It also remains to be seen whether, as Deaner (2006) predicted, sex differences in performance depth occur in other sports where opportunities and incentives are not (greatly) biased against females (swimming: Deaner in prep.) Likewise, it will be of great interest to see whether the patterns found for U.S. athletes also hold in other countries and cultures.

Conclusion

The sex difference in world-class running performance has long been of interest (Jokl and Jokl, 1968; Sparling et al. 1998; Whipp and Ward, 1992). The present study, together with Deaner (2006), documents a related but novel phenomenon: in U.S. populations, proportionally more males than females run fast relative to sex-specific world-class standards. In contrast to the first phenomenon, which is now reasonably well understood (see Introduction), the cause(s) of the sex difference in performance depth is not clear, although the "sex difference in competitiveness" hypothesis appears viable. Whether or not this hypothesis turns out to be true, the fact remains that an evolutionary perspective has illuminated a widespread pattern that had previously been overlooked. It is hoped that this phenomenon will become an active research topic for a wide range of scientists interested in the social and biological bases of sex differences.

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