Marathon Performance as a Predictor of Competitiveness and Training in Men and Women

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Recent research demonstrated that more males than females run proportionally close to gender-specific world-class standards, which may serve as an estimate of gender differences in competitiveness and training commitment. The current study is a reexamination of three datasets, totaling 844 male and female marathoners, and focuses on testing the associations among relative performance (i.e., lifetime best performance relative to gender-specific world-class standards), competitiveness, and training volume. Relative performance predicted both training and competitiveness similarly for men and women (volume, R^2 = .15 - .21; competitiveness, R^2 = .07 - .08). Homogeneity of slopes and analysis of covariance models revealed no evidence that relative performance underestimated female training or competitiveness. These findings support the hypothesis that differences in relative performance reflect a gender difference in competitiveness and training commitment. Documenting gender differences in relative performance across sports, cultures, and time periods may provide novel insights into the expression of motivation.

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Gender differences in competitiveness have been frequently reported. In general, males are more likely than females to compete for status, whereas females are more likely to compete for attributions of attractiveness or sexual exclusiveness (Buss, 2008; Campbell, 2004). Furthermore, males are more likely to compete using direct means, such as aggression or physical displays, while females more frequently compete by indirect means, such as ostracizing rivals (Bjorkqvist, 1994; Buss, 2008; Campbell, 2004; cf. Hawley, Little, & Card, 2008).

Because sports can be considered, at least in part, formalized physical competitions for status (Miller, 2000; Williams, Park, & Wieling, 2010), males can be expected to show greater sports competitiveness. Although several studies have found this gender difference (Cashdan, 1998; Gill, 1986; Weinberg, Tenenbaum, McKenzie, Jackson, Anshel, Grove, & Fogarty, 2003), exceptions have been reported (Longhurst & Spink, 1987). Furthermore, it remains unclear what social and biological factors produce the gender difference.

Progress in understanding the generality of the gender difference in competitiveness and the factors that produce it might be made if an approach were developed to readily quantify competitiveness across contexts. Deaner (2006a) hypothesized that performances in endurance sports, specifically distance running, could serve as a basis for such an approach. This hypothesis is predicated on the well established links among performance, training, and motivation: greater competitiveness is associated with larger training volumes (Masters, Ogles, & Jolton, 1993; Ogles & Masters, 2000; Ogles & Masters, 2003; Ogles, Masters, & Richardson, 1995;); larger training volumes are associated with faster performances (Hagan, Upton, Duncan, & Gettman, 1987; Masters et al., 1993; Slovic, 1997); and faster performances are associated with greater competitiveness (Masters et al., 1993; Ogles & Masters, 2000; Ogles & Masters, 2003). Given these relationships, if a difference in the occurrence of fast male and female runners were found, it should estimate a gender difference in motivation to compete and maintain large training volumes.

Deaner (2006a) noted that absolute comparisons of male and female running performances are unwarranted because, all else being equal, males are expected to run substantially faster than females due to hormonally regulated differences in aerobic capacity and body fat deposition (Shephard, 2000; Willmore & Costill, 2004). Nevertheless, because gender differences in world-class performance have stabilized at roughly 10 -12% across all distances (Noakes, 2001; Seiler & Sailer, 1997; Sparling, O'Donnell, & Snow, 1998) gender-specific world-class performances can be used as denominators in making relative comparisons across genders. For example, if 20 men ran within 2% of the male world record in a given event during one particular year while 10 women ran within 2% of the female world record that year, one could say that twice as many men ran relatively fast.

Using this approach, Deaner (2006a, 2006b) demonstrated a highly robust gender difference: across virtually all distances, in matched populations of elite, sub-elite, and recreational U.S. runners, two to four times as many males as females ran relatively fast in 2003. Given the relationships among performance, training, and motivation noted above and the fact that male runners generally report greater competitiveness (Callen, 1983; Johnsgard, 1985; Ogles & Masters, 2003) and larger training volumes (Callen, 1983; Clement, Taunton, Smart, & McNicol, 1981; Ogles et al., 1995), Deaner (2006a, 2006b) interpreted the gender difference in relative performance as representing a gender difference in competitiveness and training commitment. Although this interpretation is consistent with previous research, alternative explanations for the pattern warrant attention.

One possibility is that males and females might show differential responses to training. In particular, for any given level of training, males might generally perform closer to gender-specific world-class standards. Challenging this idea are several studies indicating that when fitness-matched males and females undertake aerobic training programs, they show highly similar physiological responses and relative performance gains (Dolgener, Kolkhorst, & Whitsett, 1994; Skinner, Jaskolski, Jaskolska, Krasnoff, Gagnon, Leon, Rao, Wilmore, & Bouchard, 2001; Wilmore & Costill, 2004). Nevertheless, these studies had modest sample sizes. In addition, they generally did not express performance gains in terms of gender-specific world-class running standards (cf. Dolgener et al., 1994). Thus, the hypothesis that males and females might show differential responses to training requires further investigation.

Similarly, although previous work indicates that greater competitiveness is associated with faster running performances (Masters et al., 1993; Ogles & Masters, 2000; Ogles & Masters, 2003), it is possible that the relationships differ for males and females, especially when relative measures of performance are employed. Thus, although there is a gender difference in relative performance, this might not automatically indicate a difference in male and female competitiveness.

Therefore, the goal of this cross-sectional study, based on previously published data, is to test whether the relationships between relative performance and training volume and relative performance and competitiveness differ between male and female marathoners.

Method

Participants

Data used in this study is an amalgamation of information used in previous studies (Masters & Ogles, 1998; Masters et al., 1993; Ogles et al., 1995), raising the issue of previous/duplicate publication (American Psychological Association, 2010, pp.13-14). However, none of these previous studies computed relative performance or assessed the relationships between relative performance and training volume or relative performance and competitiveness. More importantly, none of these previous studies addressed the central question of this paper, whether these relationships differ among men and women

Participants in marathons in the Midwestern and Southeastern U.S. were recruited during pre-race registration. While registering, they were asked to take home and anonymously complete a demographic and training questionnaire and, in some cases, the Motivations of Marathoners Scales (MOMS; Masters et al., 1993). They were asked to return these materials by mail. Across all of these studies, roughly 33% of runners who were approached agreed to participate. Although the data used in this study were published 12-17 years ago and are therefore somewhat dated, we know of no reason why the fundamental relationships among the variables of interest would have changed since then; we thus believe our conclusions will still hold in the present.

The present study only included runners who reported a previous marathon time, a weekly training volume, and three to 12 years of running experience. The final sample included 694 men and 150 women; 518 men and 103 women completed the MOMS. Participants were predominantly Caucasian (95%), and their ages ranged from 16 to 79 years. Their best finishing times in previous marathons averaged three hours 23 minutes (*SD* = 37 min) and ranged from two hours 15 minutes to seven hours four minutes. Prior to the marathon, runners were training an average of 71.6 km/wk (*SD* = 25.4 km); 4% reported training less than 30 km/wk.

Instruments

The demographic and training questionnaire included many items, but the relevant ones for this study are age, gender, ethnicity, number of previous marathons attempted, best lifetime finishing time in a previous marathon, mean finishing time in all previous marathons, and distance, hours and days training per week during training for the upcoming marathon. Because the study was completed anonymously, information was not available on participants' performance in the marathon that occurred the day after they received the questionnaires. To partially overcome the problem that runners' best lifetime performances may have occurred many years ago, we restricted the analysis to runners who reported on their survey (completed in late 1980s to early 1990s) that they had, at that time, run 12 years or less.[1] Because runners' performances are expected to improve as they gain experience, we attempted to minimize variation due to experience by only including runners with three or more years of experience.

The MOMS consists of 56 items that are rated as to the degree to which the runner considers them a reason for training and running in a marathon. Items represent nine internally consistent motivational scales: affiliation, competition, health orientation, life meaning, personal goal achievement, psychological coping, recognition, self-esteem, and weight concern. Each item is rated on a one (not a reason) to seven (a very important reason) scale. The score for each scale is calculated by averaging the score for each item included in the scale. Evidence for the internal consistency (Cronbach's alphas range from .80 to .93), test-retest reliability (*r*s range from .71 to .90), and factorial and construct validity of the scales has been presented previously (Masters & Ogles, 1995; Masters et al., 1993; Ogles et al., 1995). In this study, only the motivation for competition scale was considered (alpha = .83; $r = .90$). This scale consists of the following four items: (1) to compete with others; (2) to see how high I can place in races; (3) to get a faster time than my friends; and (4) to beat someone I've never beaten before.

Statistical Analysis

To assess performance, we used lifetime best, rather than mean, marathon performance because only 94% of those reporting lifetime best performance also reported mean performance. A second reason for using lifetime best performance is that mean performance could be sensitive to the occurrence of one or more unusually slow races due to injury or sub-optimal race conditions. To make comparisons of relative performance across males and females, we divided best performances by a gender-specific world-class performance standard. Because current world records could be biased against females (Seiler & Sailer, 1997), we used the 10-Fastest standard (Deaner 2006a), which is defined as the mean best time of the 10 fastest performers in the world in that event (only one performance included per individual). For initial analyses we used the "all-time" 10-Fastest standard, which was 2:05:52 for males and 2:19:50 for females as of April 1, 2005. (data from MarathonGuide, 2010). We also repeated some analyses (see below), using only the best times of 2004, which produced a 10-Fastest standard of 2:06:54 for males and 2:23:11 for females.[2]

To estimate runners' training volume (hereafter training volume) in the months preceding their completion of the questionnaires, we used distance run per week, rather than days or hours run. We used distance because almost all (99%) marathoners in our original sample reported training volume in distance, whereas fewer reported training in duration (days: 48%; hours: 83%); we excluded the 1% of runners who did not report training distance. In addition, training distance is known to be highly correlated with other training indices, including the frequency and intensity of training (Ogles & Masters, 2003; Slovic, 1977).

We used linear regression, rather than correlation, to examine the relationships between relative lifetime performance and each of the variables of interest (training volume, motivation for competition). This allowed us to subsequently employ homogeneity of slopes and analysis of covariance (ANCOVA) models to test whether regression slopes and intercepts differed between males and females. For all analyses, we used two-tailed statistical tests and set α at

0.05. All analyses were conducted with Statistica 6.1 (Statsoft Inc.,Tulsa, OK USA)

Results

Relative Performance, Running Volume and Motivational Variables

To assess the predictiveness of relative best lifetime performance (hereafter relative performance), we first regressed upon it training volume and motivation for competition (hereafter competitiveness). For both males and females, faster relative performances (shorter marathon durations) significantly predicted larger training volumes (Figure 1; Table 1) and greater competitiveness (Figure 2; Table 1).

To test if the regression slopes differed significantly for males and females, we used separate homogeneity of slopes models. Neither of the gender by dependent variable interactions approached significance (training volume: $F(4,843) = 0.7, p = .39$; competitiveness: $F(4,617) = 0.2, p = .62$), indicating that the relationships between relative performance and training volume and relative performance and competitiveness were not moderated by gender. We then used separate ANCOVA models to test whether the intercepts of the regressions differed. There was no significant main effect of gender for training volume ($F(3,844) = 1.5, p = .23$; male adjusted mean = 72.1 km/wk, $SD = 26.1$; female adjusted mean = 69.7, $SD = 22.5$). Nevertheless, after taking the effect of relative performance into account, males reported significantly greater competitiveness ($F(3,618) = 6.4, p = .01$; male adjusted mean = 3.2, $SD = 1.5$; female adjusted mean = 2.8, $SD = 1.5$; see Figure 2).

Table 1. *Relative performance as a predictor of training volume and competitiveness*

Dependent Variable	Gender	n	β	R^2	F	p
Training volume	M	697	-0.46	0.21	184.2	<.0001
Training volume	F	150	-0.39	0.15	26.5	<.0001
Competitiveness	M	518	-0.27	0.07	39.6	<.0001
Competitiveness	F	103	-0.29	0.08	8.9	.003

Figure 1. Relative performance predicts training volume. Relative performance refers to an individual's best lifetime marathon performance divided by a gender-specific world-class standard (see text); faster performances, approaching world-class standards are on the left. Males are indicated with filled circles; females are indicated with open circles. Solid line indicates males regression: km/wk = 141.85 - 41.69 * relative performance. Striped line indicates female regression: km/wk = 127.98 - 34.94 * relative performance. Lighter lines (solid and striped) indicate 95% confidence limits.

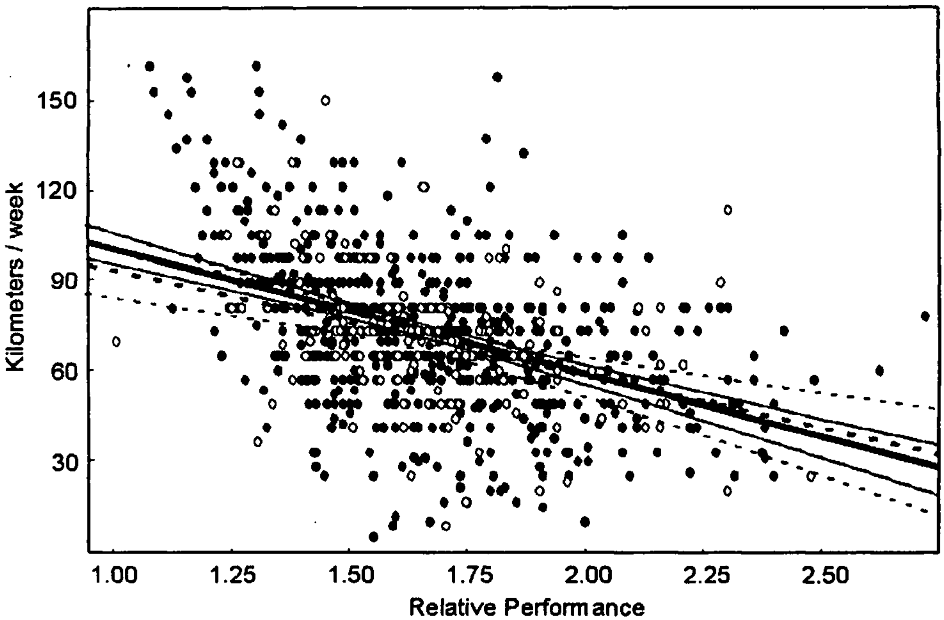


Table 2. *Age and experience as predictors of training volume and competitiveness*

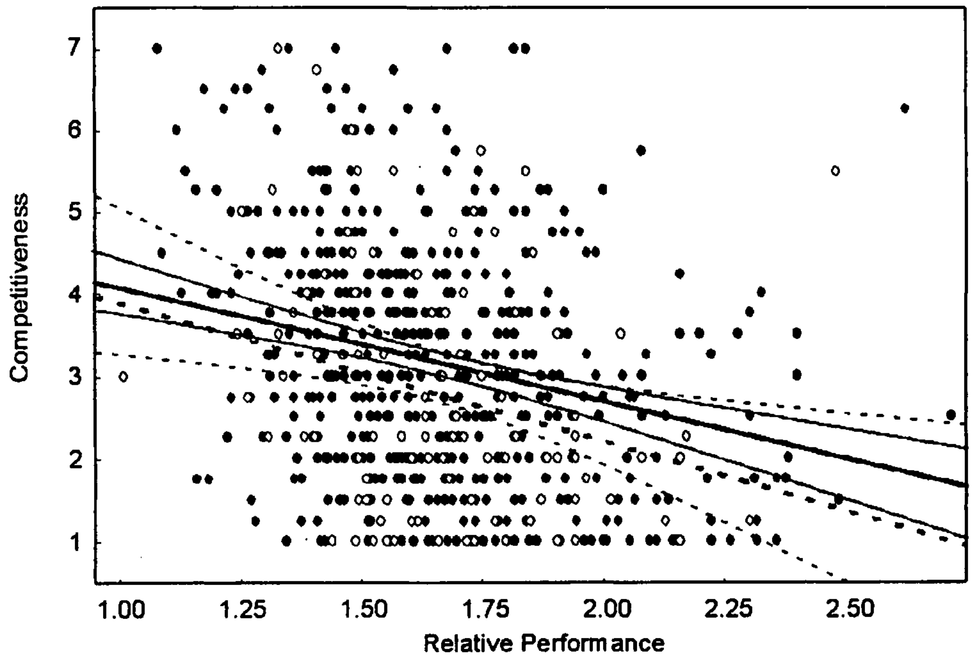
Independent Variable	Dependent Variable	Gender	n	β	R^2	F	p
Age	Training volume	M	694	-.17	.03	19.6	<.0001
Age	Training volume	F	150	-.12	.02	2.2	.14
Age	Competitiveness	M	517	-.06	.0	2.1	.15
Age	Competitiveness	F	103	-.22	.05	5.3	.02
Previous Marathons	Training volume	M	682	.26	.07	49.8	<.0001
Previous Marathons	Training volume	F	149	.06	.0	.58	.45
Previous Marathons	Competitiveness	M	510	.14	.02	10.7	.001
Previous Marathons	Competitiveness	F	102	.15	.02	2.4	.22
Years running	Training volume	M	697	.01	.0	0.3	.86
Years running	Training volume	F	150	.04	.0	0.2	.66
Years running	Competitiveness	M	518	.001	.0	0.0	.92
Years running	Competitiveness	F	103	.06	.01	0.4	.52

Age and Experience

Age and experience are known to be related to running performance and motivation (Hagan et al., 1987; Masters & Ogles, 1995; Ogles & Masters, 2000; Slovic, 1977).To test whether our results might be sensitive to these potential confounds, we first performed separate linear regressions for training volume and competitiveness on age and two assays of experience—number of previous marathons attempted and number of years running. We performed each of the six regressions independently for males and females and found the following: age was a significant predictor of training volume for males and competitiveness for females, number of previous marathons was a significant predictor of training volume and competitiveness for males, but number of years running was not a significant predictor of either dependent variable, for either males or females (Table 2).

We then returned to the homogeneity of slopes and ANCOVA models, but this time added either age or number of previous marathons. (Number of years running was not explored since it was not predictive.) When age, relative performance, and gender were entered as independent variables and training volume was entered as the dependent variable in a homogeneity of slopes model, there were no significant interactions involving gender (all $ps > .14$); ANCOVA with these variables indicated no gender difference in training volume ($F(4,840) = 2.4, p = .12$; male adjusted mean = 72.3, $SD = 26.0$; female adjusted mean = 69.0, $SD = 22.5$). With

Figure 2. Relative performance predicts competitiveness. Conventions as in Figure 1. Solid line indicates male regression: competitiveness = 5.46 - 1.38 * relative performance. Striped line indicates female regression: competitiveness = 5.56 - 1.68 * relative performance.



the same independent variables and competitiveness as the dependent variable, there were again no significant interactions involving gender (all *p*s > .62); however, ANCOVA with these variables indicated greater competitiveness among males, just as was found above in a model without age ($F(4,616) = 6.8, p = .01$; male adjusted mean = 3.2, *SD* = 1.5 ; female adjusted mean = 2.8, *SD* = 1.5; see Figure 2).

We then repeated these analyses using number of previous marathons, rather than age, and obtained virtually identical results (training volume: homogeneity of slopes, all *p*s > .52, ANCOVA ($F(4,830) = 1.9, p = .16$; competitiveness: homogeneity of slopes, all *p*s > .59, ANCOVA ($F(4,608) = 6.0, p = .01$, adjusted means and *SD*s as in previous ANCOVA). In summary, age and experience did not moderate the relationships among relative performance, gender, and either of the two dependent variables of interest, training volume and competitiveness.

Alternative Performance Measures

We next explored whether our results were sensitive to the particular relative performance measure that we employed. We did this by repeating our analyses using the 2004 10-Fastest standard as the denominator in relative performance calculations, rather than the all-time 10-Fastest standard. For males, the 2004 10-Fastest standard is 1.5% greater in duration than the all-time 10-Fastest standard, while it is 3% greater for females. Thus, using the 2004 10-Fastest standard makes female performances somewhat "faster" compared to male performances.

For both males and females, the regression slopes for all dependent variables on relative performance based on the 2004 10-Fastest standard were identical to those computed with the all-time 10-Fastest standard (see Table 1). ANCOVA revealed that after controlling for performance with this alternative standard, there was again no evidence of a gender difference in training volume ($F(3,844) = 2.9, p = .09$; male adjusted mean = 72.3, $SD = 26.1$; female adjusted mean = 68.9, $SD = 22.5$). As was found above, however, ANCOVA showed that, after controlling for performance with this alternative standard, males reported greater competitiveness ($F(3,618) = 7.6, p = .006$; male adjusted mean = 3.2, $SD = 1.5$; female adjusted mean = 2.7, $SD = 1.5$). We repeated these analyses after separately entering age and number of previous marathons into the ANCOVAs and found that the results did not change. These results suggest that the kinds of analyses performed here are generally insensitive to the particular world-class standard employed in deriving relative measures.

To further assess the importance of employing relative performance measures, we repeated these analyses with absolute best marathon times, i.e., not using a relative standard, a procedure that makes female performances substantially "slower" compared to male performances. Regression slopes again were unaffected by using a new performance measure. However, unlike the all of the analyses presented above, ANCOVA revealed that after controlling for performance with this alternative standard, females reported larger training volumes ($F(3,844) = 5.6, p = .02$; male adjusted mean = 70.8, $SD = 26.1$; female adjusted mean = 75.6, $SD = 22.5$). Also contrary to previous analyses, gender difference in competitiveness no longer reached, or even approached, significance ($F(3,618) = 0.6, p = .42$; male adjusted mean = 3.1, $SD = 1.5$; female adjusted mean = 3.0, $SD = 1.5$). We again repeated these analyses after separately entering age and number of previous marathons into the ANCOVAs and found that the results did not change. The key point is that when assessing gender differences, the choice of using an absolute or a relative performance measure can affect the results.

Discussion

This study demonstrates that relative (lifetime best) performance does indeed predict competitiveness and training in a large sample of male and female marathon runners. Because the regression slopes did not differ between males and females, for either training volume or competitiveness, these results suggest that relative performance can serve as an estimator of gender differences for both variables of interest, as Deaner (2006a) hypothesized. An additional and crucial question for Deaner's hypothesis is whether the intercepts of the regressions differ. Because Deaner had interpreted the finding that a larger proportion of male runners run relatively fast as indicating that more males are motivated by competition and maintain large training volumes, the most damaging possibility for this hypothesis would be if relative performance were found to systematically underestimate female competitiveness and/ or training volume. In fact, the regression intercepts for training volume did not differ for males and females (Figure 1), although the intercepts differed for competitiveness, such that relative performance somewhat underestimated male competitiveness (Figure 2.) This poses no great difficulty for Deaner's hypothesis; it merely suggests that a male bias in relative performance depth may somewhat underestimate the male bias in competitiveness.

Absolute vs. Relative Performance

One of this study's pivotal claims is that relative performance should be superior to absolute performance in terms of providing an unbiased predictor of training volume and competitiveness across genders. Our results clearly supported this claim for training volume because, with either relative performance measure, relative performance predicted training volume for males and females in an unbiased fashion. By contrast, absolute performance significantly underestimated female training volume. In other words, this result implies that to achieve any given marathon finishing time, a typical woman will have to train more than a typical man. This makes perfect sense given males' physiological advantages for distance running (Shephard, 2000; Wilmore & Costill, 2004) and their consequently faster world-class performances (Noakes, 2001; Seiler & Sailer, 1997; Sparling et al., 1998).

By contrast, the fact that relative performance underestimated male competitiveness, whereas absolute performance was an unbiased predictor, does not support the use of relative performance measures. In addition, this result raises the question of why a typical female can generally run as relatively fast as a typical male with apparently less competitive motivation. We cannot definitively answer this question but can provide a plausible speculation.

To begin we note that for both males and females, competitiveness was only modestly associated with relative performance (Table 1.) Moreover, further analyses of our data set showed that, as expected (Masters et al., 1993; Ogles & Masters, 2000; Ogles & Masters, 2003; Ogles et al., 1995), competitiveness was a significant predictor of training volume, but that the strength of the relationship was quite weak (males: R^2 = .06; females: R^2 = .02). (We also analyzed other MOMS scales and found that some scales (e.g., personal goal orientation, social recognition) also significantly predicted training, but these associations were even weaker than for competitiveness.)

We believe that such modest associations should not be taken to imply that competitive motivation, or motivation in general, is largely irrelevant to training; instead we believe that a one-time-only, self-report questionnaire, even if well designed, can only measure a small portion of the many internal variables that govern individuals' decisions about how they will or will not train over the extended periods necessary for achieving fast running performances. In fact, we suggest that, to a large extent, an individual's training represents the sum total of his or her actual motivation to compete and excel. We offer this argument as a parallel to the economics concept of revealed preference, where instead of asking individuals how much they value a good, behavioral economists measure how much they will pay or work for it (Aharon, Etcoff, Ariely, Chabris, O'Connor, & Breiter, 2001; Samuelson, 1938).

In our view, the fact that relative performance predicts training volume in an unbiased fashion suggests that relative performance actually does assess motivation in an unbiased fashion, even if, for unknown reasons, males do tend to report greater competitive motivation than would be expected with the MOMS questionnaire. From a practical point of view, we believe our results support the idea that researchers should use relative rather than absolute performance measures when comparing males and females. At the very least, we suggest that they make relative comparisons in addition to absolute ones.

Limitations

We found that age and experience did not affect this study's main conclusions. Nevertheless, this study's cross-sectional design requires that we interpret our findings cautiously, because it remains possible that male and female marathoners differed in ways we could not control. For instance, if the females in our study tended, for some unknown reason, to be unusually responsive to aerobic training or have exceptionally efficient biomechanics (i.e., they were, in some way, exceptionally "talented"), then this could lead to unrealistic expectations of how more typical females might have performed with similar training. With respect to the possibility of random error, we note that our sample contained relatively few women (103 in competitiveness analysis; 150 in training volume analysis vs. 518, 650 for men). Unfortunately, conducting fully controlled, prospective studies with large samples of individuals engaging in months or years of athletic training is difficult because there can be substantial biases in recruitment and retention (Dolgener et al., 1994).

A second limitation of this study—noted in the Methods section—is that we asked runners to report their training and motivation just prior to an upcoming marathon and to also report their best lifetime marathon performance. This means that some runners would have reported modest training volumes and competitiveness because their goal in the upcoming marathon was merely to complete the distance; however, in the years prior to completing the survey, these runners may have trained more rigorously and ran much faster than they were prepared to run when they completed the survey. We attempted to limit this problem by excluding individuals who reported more than 12 years of running experience, but it's likely that this issue would have affected our results, at least to some degree.

In fact, the presence of some runners whose current training and motivation does not correspond with their lifetime best performance might explain why the association between training and performance in our study, although substantial (males: R^2 =.21; females: R^2 =.15), was less than has been reported in studies with smaller sample sizes that documented training for several months prior to performance (Hagan et al., 1987; Slovic, 1977). Thus, the actual predictiveness of marathon finishing times for training and competitiveness is probably greater than is indicated in the present study. The more general point, however, is that future studies addressing the relationships among training, motivation, and performance should focus on recent or current running performance, rather than lifetime best.

Revisiting Deaner's Hypothesis

This study supports Deaner's (2006a, 2006b) claim that the gender difference in the occurrence of relatively fast runners is at least partly due to a gender difference in competitiveness and training commitment. Nevertheless, alternative hypotheses for the gender difference in relative performance require exploration.

One possibility is that there is indeed a gender difference in training volume, but this reflects a gender difference in the opportunity to train, not in the motivation to do so. One version of this hypothesis is that females may be more susceptible to running injuries and so enjoy fewer opportunities to train consistently and reach high training volumes; however, this idea is not currently supported (Deaner, 2006a; van Gent, Siem, van Middelkoop, van Os, Bierma-Zeinstra, Koes, & Taunton, 2007). Another version of this hypothesis is that females cannot train consistently because they are constrained by pregnancy, child care, or similar constraints. Although this hypothesis must be true in some cases, it does not seem able to provide a general account for the gender difference in the occurrence of relatively fast runners. The reason is that the gender difference is at least as strong in high school runners as it is in road race populations (Deaner, 2006a, 2006b) , and pregnancy rates for U.S. high school females are low, especially among athletes (Sabo, Miller, Farrell, Melnick, & Barnes, 1999).

Perhaps the best way to further evaluate Deaner's (2006a) hypothesis is to test its chief prediction, that more males do in fact maintain large training volumes. Although several studies have reported this pattern (Callen, 1983; Clement et al., 1981; Ogles et al., 1995), the gender differences are usually modest, and interpreting such findings is difficult. One problem is that the gender difference in relative performance typically is pronounced only among the fastest 2-5% of runners (Deaner, 2006b). If, as expected, the gender difference in training commitment also only occurs among a small fraction of the population, then an overall gender difference in training volume might not be detectable when assessing the entire population. For example, in this study's data set, which is fairly large, proportionally more men (6.7%) than women (3.2%) reported running at least 140km/wk, yet this difference did not reach significance ($p = 0.12$).

A second problem is that the studies indicating gender differences in training volume in distance runners are generally based on surveys from the 1980s and early 1990s. During this time, marathons and other road races in the U.S. were comprised of roughly 75% males (Running USA, 2010). Since the so-called second running boom, however, beginning roughly in the mid-1990s, females have begun participating in far greater equal numbers; in 2007, females comprised 49% of participants in U.S. road running events (Running USA, 2010). Moreover, median finishing times of marathons and other road races have increased substantially since the 1980s, indicating a general shift among runners to a more participatory rather than competitive orientation (USA Track & Field, 2004). In fact, despite a nearly threefold increase in overall road running participation since 1987 (Running USA, 2010), the absolute number of fast male and female marathoners in the U.S. has declined slightly over this time period (Deaner, 2006a).

These points suggest that the gender difference in the percentage of relatively fast runners is probably far greater now than it was in the mid-1980s, although the absolute number of fast male and female runners may not have changed substantially. For instance, in the present study's sample, where there were more than four times as many males as females, we found that the overall population distributions of male and female training volumes and fast running performances were highly similar. Most strikingly, 27% of male runners and 25% of female runners reported best times within 150% of the all-time fast standard. Such a pattern would seem to be at odds with the recent demonstration (Deaner, 2006b) that in twenty of the largest U.S. marathons and 5Ks in 2003, the percentage of such relatively fast males was two to four times as great as the percentage of relatively fast females. However, if we imagine doubling or tripling the number of less competitive, low volume female runners in the present data set, then the results would concur. The bottom line is that a strong test of Deaner's (2006a) hypothesis requires obtaining information on training and performance from large numbers of distance runners at numerous events: if this hypothesis is correct, then the gender difference in the proportion of high volume, competitive runners should closely correspond with the gender difference in the proportion of relatively fast runners.

Practical Applications and Conclusions

If the gender difference in relative performance provides a reasonable estimate of the gender difference in competitiveness and training commitment, then this should facilitate new lines of inquiry into the factors that produce the gender difference in competitiveness. For example, Deaner (2006a) showed that the absolute number of fast female runners at elite and sub-elite levels in the U.S. has remained remarkably stable since the mid-1980s, despite substantial increases in participation and incentives for female runners. Deaner (2006a) thus argued that the gender difference in distance running competitiveness cannot be completely ascribed to sociocultural conditions favoring males (Eagly & Wood, 1999) but instead partly reflects an evolved male predisposition for competition (Campbell, 2004). Recent work has suggested a more complicated picture, however. It turns out that the gender difference in relative performance in U.S. swimmers has declined and that there is no longer a gender difference in relative swimming performance (Deaner, 2007). This finding shows that, although there could be an intrinsic gender difference in sports competitiveness, its expression depends crucially on sociocultural factors. Therefore, future studies documenting how gender differences in relative performance vary across sports, cultures, and time periods should provide further insights into the expression of training commitment and athletic competitiveness.

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Footnotes

[1]We chose 12 years as cut-off after considering a "years running experience" histogram categorized by sex. The histogram showed that for both men and women, the distributions were approximately normal, with a peak of about 9.5 years of experience. On the one hand, if we had chosen six (or eight) years as a cut-off we would have reduced our sample size by more than half, so this was not a viable option. On the other hand, if we had chosen 18 or 20 years as a cut-off, our sample would have been roughly 10-15% larger, but this would have introduced a potential bias because the vast proportion of such highly-experienced runners were men. Thus 12 years seemed like the optimal choice. We did explore whether our results differed substantially if we used slightly different cut-offs, e.g. 10 or 15 years; they did not.

[2]We used data from 2004 and 2005 because we initially conducted these analyses in 2005. However, it can be argued that the more relevant time period for our participants was when they completed the questionnaires, i.e., the late 1980s and early 1990s. We therefore computed "all-time" 10-Fastest standards based only on performances from 1990 and earlier. These standards were 2:23:11 and 2:07:31, a percentage difference of 12.2%. This falls between the percentage difference of the 2005 "all-time" 10-Fastest standard (11.1%) and the best 2004 10-fastest standard (12.8%). Thus, if our analyses were repeated using world-class times that would have been familiar to the participants (i.e., 1990 and earlier), our conclusions would not change.