

# Why Boys Are Smarter, but Girls Make Better Grades

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## Abstract

On average, males score higher on standardized tests while females make higher grades in school. This is true for the 2004 SAT test takers. The combined mean score for males is 1049 and 1005 for females. Males taking the test have a mean high school grade point average of 3.19, females 3.35. A reasonable assumption is to ascribe this anomaly to the human attribute of motivation. I attempt to indirectly measure male-female differences in this attribute of academic motivation by assuming ability plus motivation is equal to achievement.

SAT data are available to directly measure gender differences of academic ability, or *IQ*, from combined SAT score distributions and academic achievement from class rank statistics using the construct of diversity space developed by La Griffe du Lion. I find females have a mean *IQ* of  $0.186 \pm 0.006$  SD (or  $2.8 \pm 0.1$  *IQ* points) lower than males but surpass males in academic achievement by  $0.12 \pm 0.01$  SD.

The distribution of motivation is then easily determined from the difference between the achievement and intelligence distributions. I find females have a mean academic motivation of  $\Delta = 0.41 \pm 0.03$  SD higher than males. Also, the dispersion of the distribution for females is slightly less than their male counterpart by the ratio  $\rho = 0.976 \pm 0.015$ .

These results imply that academically, there are more than twice as many highly motivated females than males (i.e. above the male 2 SD level of motivation). Also, high school grades are determined approximately 38% by intelligence and 62% by motivation. Girls make better grades because they are more motivated than boys and grades are determined more by motivation than intelligence.

# 1 Introduction

La Griffe du Lion has already identified and measured several differences between men and women: intelligence, aggressiveness, mathematical aptitude, and criminality (see <http://lagriffedulion.f2s.com/>). Having raised two children, a boy and a girl, I found the major difference between my two children is motivation. In high school, my daughter was motivated to get good grades and get into a good college. My son was motivated to play video games, study martial arts, and hang out with his friends. They both had a very high level of motivation, just for different endeavors. They are both very intelligent (each scored  $\sim 1500$  (out of 1600) on the SAT I). But my daughter maintained a high school GPA of 4.0 while my son's was only 3.2. I tried everything to motivate my son academically, from the carrot to the stick – nothing worked. I came to believe that my children's motivation was innate, and that I couldn't change it.

My anecdotal evidence is not unique. While males score higher on the SAT, females make better grades. For the 2004 SAT test takers the combined mean score for males was 1049 and 1005 for females. Males taking the test had a mean high school grade point average of 3.19, females 3.35.

Lack of academic motivation does not necessarily equate to lack of success. The two most successful people in the high tech industry today are both college dropouts: Steve Jobs and Bill Gates. Perhaps the ultimate example is Albert Einstein. Einstein was not the most impressive student in college. While he made good grades he did not always attend class or do his homework, giving him the reputation of being lazy. The university hired the best students upon graduation. Einstein was not offered a job. Instead, to earn a living, he took a job as a Swiss patent office clerk.

Regardless of examples to the contrary, academic motivation is a valuable human quality. Top colleges look for students with both high SAT scores and high grades. An applicant with an SAT I score of 1600 (out of 1600) and a C average sends out a red flag to admissions officers. After college, employers seek to hire students with the highest grades. High college grades imply a work ethic required to achieve those grades. Low college grades indicate someone unmotivated or more interested in playing than studying.

The difference between ability and achievement cannot be attributed entirely to motivation. For example, a student with good study skills (e.g. organization, planning, discipline, etc.) may achieve a higher grade than an equally motivated student due to these skills (although one might argue motivated students develop better study skills because they are motivated to make better grades). Parental involvement is another often-cited requirement for academic

success. So while the word “motivation” may not be completely accurate, for lack of a better word, I use it to describe the difference between ability and achievement.

## 2 Data and Approach

I am not aware of a direct way to measure academic motivation (hereinafter referred to as  $M$ ). However, academic achievement ( $A$ ) is a combination of ability and motivation. If by academic ability we mean general intelligence,  $g$  or  $IQ$ , then

$$IQ + M = A. \tag{1}$$

Differences in gender  $IQ$  can be estimated directly from SAT I statistics and achievement can be calculated directly from class rank statistics using the construct of diversity space developed by La Griffe du Lion (see *Intelligence, Gender and Race*, La Griffe du Lion, vol. 9, Number 1, January 2007). Motivation can then be found by subtraction:

$$M = A - IQ. \tag{2}$$

I use data from *2004 College Bound Seniors: A Profile of SAT Program Test Takers*, The College Board Summary Reporting Service, 2004 (see the Appendix). For the  $IQ$  analysis, I calculate the percentage of students scoring within or above each score range (i.e. greater than 750, 700, 650, etc.). I average the math and verbal percentages obtained for each sex to give eleven data points for males and eleven for females. For the academic achievement analysis, I calculate the percentage of students achieving above the class rank in five categories (i.e. above 10%, 20%, 40%, 60%, and 80%).

I then plot the data on Diversity Space plots and calculate the least squares fits for  $IQ$  and  $A$  using the method described in *Intelligence, Gender and Race*. This method assumes both  $IQ$  and  $A$  are distributed normally in large populations with a probability density function of

$$P(x; \mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2}, \tag{3}$$

where  $\mu$  is the mean and  $\sigma$  is the standard deviation. I arbitrarily choose the male mean to be zero and the male standard deviation to be one for all metrics ( $IQ$ ,  $A$ , and  $M$ ).

For a given metric, the fraction of males that reaches or exceeds a threshold,  $\Lambda$ , is

$$f_{\mathcal{M}} = \int_{\Lambda}^{\infty} P(x; 0, 1) dx \tag{4}$$

and the corresponding fraction of females that reaches or exceeds the same threshold,  $\Lambda$ , is

$$f_{\mathcal{F}} = \int_{\Lambda}^{\infty} P(x; \Delta, \rho) dx \quad (5)$$

where  $\Delta$  is the mean difference between the groups and  $\rho$  is the ratio of standard deviations,  $\sigma_{\mathcal{F}}/\sigma_{\mathcal{M}}$ , between the groups.<sup>1</sup>

I use equation (4) to find the threshold  $\Lambda$  in SDs for males numerically. I use equation (4) again to find a corresponding threshold  $\Lambda$  in SDs for females. Plotting  $\Lambda$  for males on the  $x$ -axis and the corresponding  $\Lambda$  for females on the  $y$ -axis produces a set of data points that form a straight line. This is essentially the same as the Diversity Space plot found in *Intelligence, Gender and Race*, but values are in terms of  $\Lambda$  instead of the fraction of the group above a threshold. Solving the equation for this line where  $y = a + bx$  using linear least squares regression analysis gives  $\Delta$  from the  $y$  intercept  $a$ , and  $\rho$  from the inverse slope of the line  $b$ .

The left panel of Figure 1 shows the data for the SAT I test scores in Diversity Space. Each circle represents a data point. The data points would all be located on the dashed line if there is no difference between the groups. The right panel of Figure 1 shows the same data points converted to  $\Lambda$  values using equation (4) and solving numerically. Figure 1 also shows the results of the linear least squares fit for  $a$  and  $b$ , as well as the line produced by the best fit.

Using standard linear least squares formulas, I also calculate the uncertainty implied in the parameters  $a$  and  $b$ , which are easily converted to uncertainty in  $\Lambda$  and  $\rho$ . I also use standard formulas to calculate the coefficient of correlation,  $r$ , and the probability that  $r$  is the result of random data,  $P_{rnd}$ . A probability lower than 0.5% implies a highly significant relationship between the variables being compared.

### 3 Academic Ability

The Diversity Space plot of  $g$  from the 2004 SAT I test data appears in Figure 2. The results of the linear least squares fit for the data show a mean difference in  $g$  between the sexes,  $\Delta = 0.186$  SDs, or 2.79 *IQ* points. This is quite close to La Griffe's result of 0.162 SDs (2.43 *IQ* points) found in *Intelligence, Gender and Race*. This slight discrepancy is understandable, as La Griffe uses many more sources than just the one that I use. I find a standard deviation ( $\mathcal{F}/\mathcal{M}$ ) ratio of  $\rho = 0.958$  versus La Griffe's  $\rho = 0.957$ .

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<sup>1</sup>The italic  $M$  represents academic motivation and the calligraphic  $\mathcal{M}$  is the symbol for males.

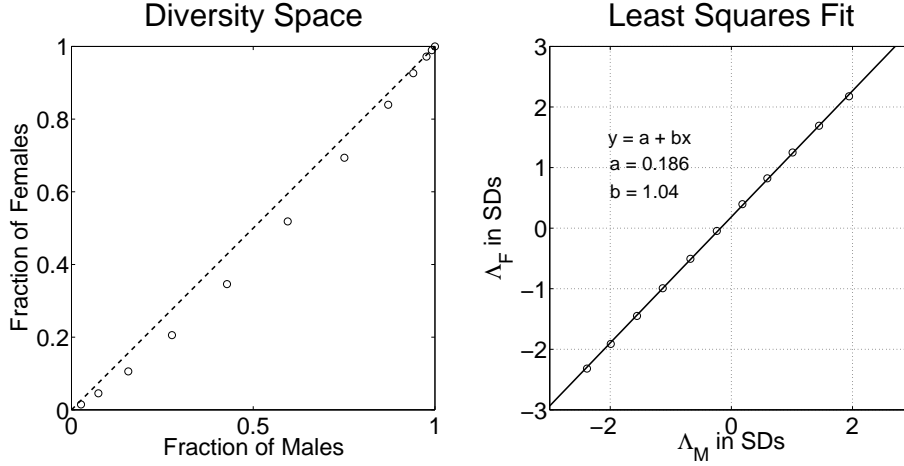


Figure 1: Diversity Space plot with linear least squares fit.

I also calculate the implied uncertainty in  $\Delta$  and  $\rho$ , as well as the correlation coefficient,  $r$ , and the probability that random data points could result in a correlation coefficient at least as large as  $r$ ,  $P_{rnd}$ . I find  $\Delta = 0.186 \pm 0.006$  and  $\sigma_F = 0.958 \pm 0.005$  SD's. In terms of  $IQ$  points,  $\Delta = 2.8 \pm 0.1$  and  $\sigma_F = 14.36 \pm 0.07$ . The correlation coefficient,  $r$ , for this fit is  $\sim 1.0$  with  $P_{rnd} \ll 0.5\%$ .

These are very good results for a least squares regression analysis. Very low uncertainty, very high correlation, with a very low chance that the data are not truly correlated at that level. The resulting distribution chart, Figure 3, is almost identical to La Griffe's.

A linear least squares analysis of a non-linear relationship has an inherent error in the results. The linear analysis may yield a close approximation of the non-linear analysis, but it is not the best fit. When I calculate  $\Delta$  and  $\sigma_F$  using a non-linear least squares approach, I find  $\Delta = 2.9$  and  $\sigma_F = 14.36$  in  $IQ$  points. In this analysis, the difference between the linear and non-linear technique is less than 4% for  $\Delta$  and 1% for  $\sigma_F$ . While the linear approach is easy to use and accurate enough for my purposes, it may not always be appropriate.

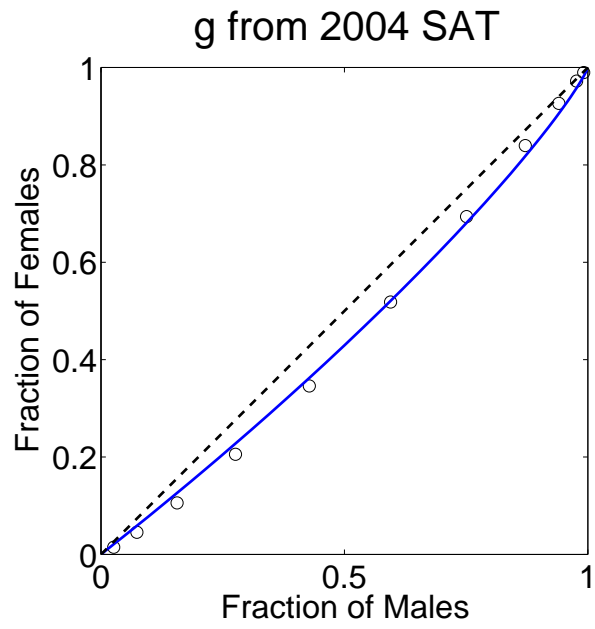


Figure 2: Diversity Space Plot of  $g$ .

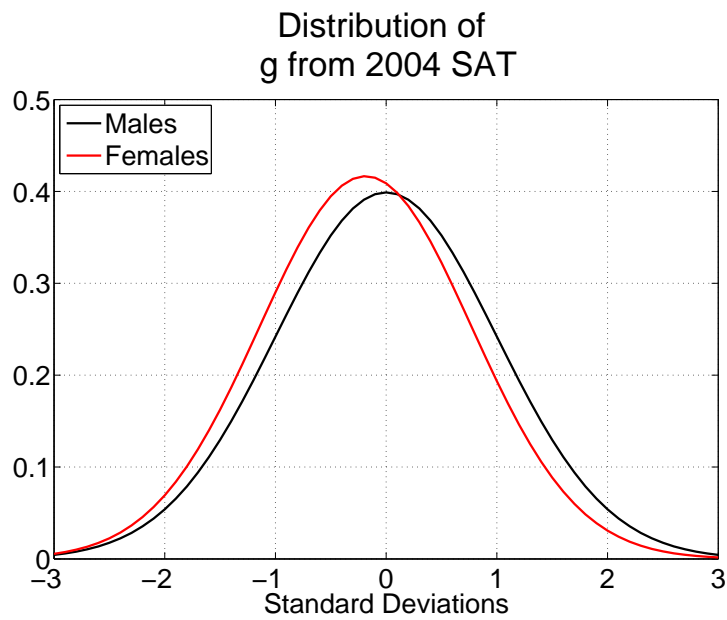


Figure 3: Probability Distribution of  $g$ .

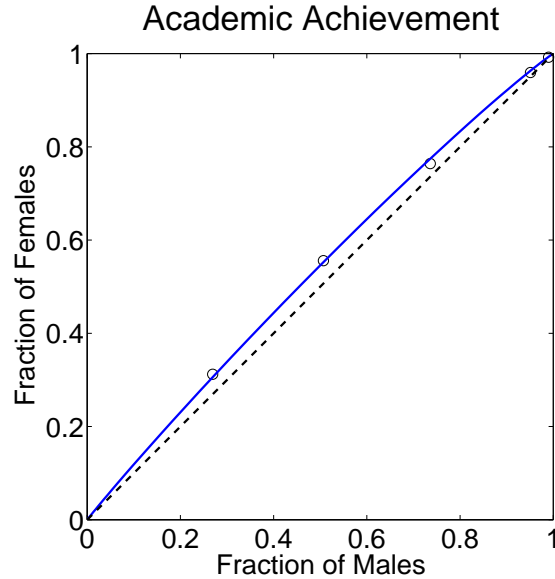


Figure 4: Academic Achievement Diversity Space.

## 4 Academic Achievement

The Diversity Space plot of academic achievement,  $A$ , appears in Figure 4. The results of the least squares fit for class rank are  $\Delta = -0.12 \pm 0.01$  and  $\sigma_F = 1.020 \pm 0.004$  SD. The correlation coefficient,  $r$ , is  $\sim 1.0$ , and  $P_{rnd} \ll 0.5\%$ . The resulting academic achievement distribution is shown in Figure 5.

Females have overcome their cognitive ability disadvantage and managed to edge slightly past their male counterparts in academic achievement.

## 5 Academic Motivation

The final step is to back into academic motivation using the prior results for ability and achievement. This is not as straightforward as it may seem. I assume that the achievement,  $A$ , distribution is the result of combining the ability,  $IQ$ , and motivation,  $M$ , distribution. So to find the  $M$  distribution, I subtract the  $IQ$  distribution from the  $A$  distribution. I then calculate the mean and standard deviation of the remaining distribution.

$$P_M = 2P_A - P_{IQ} \quad (6)$$

Where  $P$  is the probability distribution from equation (3). The two in equation (6) is necessary to normalize all three distribution functions to a value of one.

## Distribution of Academic Achievement

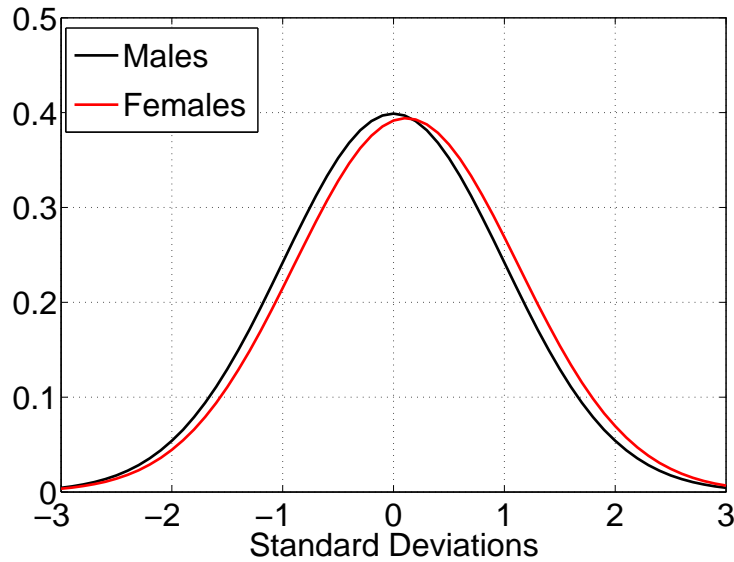


Figure 5: Probability Distribution of Academic Achievement.

I did this subtraction numerically. From the remaining distribution the mean is also obtained numerically from

$$\mu_M = \int_{-\infty}^{\infty} x P_M(x) dx \quad (7)$$

and, similarly, the standard deviation is obtained from

$$\sigma_M = \sqrt{\int_{-\infty}^{\infty} (x - \mu_M)^2 P_M(x) dx} \quad (8)$$

I find  $\mu_M = 0.41 \pm 0.03$  and  $\sigma_M = 0.98 \pm 0.02$ . A graph of the resulting motivation distribution is shown in Figure 6.

An obvious question arises. What is the relative importance of intelligence and motivation to achievement? The results in this sample show that females have overcome their *IQ* deficit to males and then some to achieve significantly better academic performance. These results imply an approximate weighting of 38% for intelligence and 62% for motivation in determining academic achievement. Study and hard work are still the best way to make good grades in high school. Girls make better grades because they are more motivated than boys and grades are determined more by motivation than intelligence.

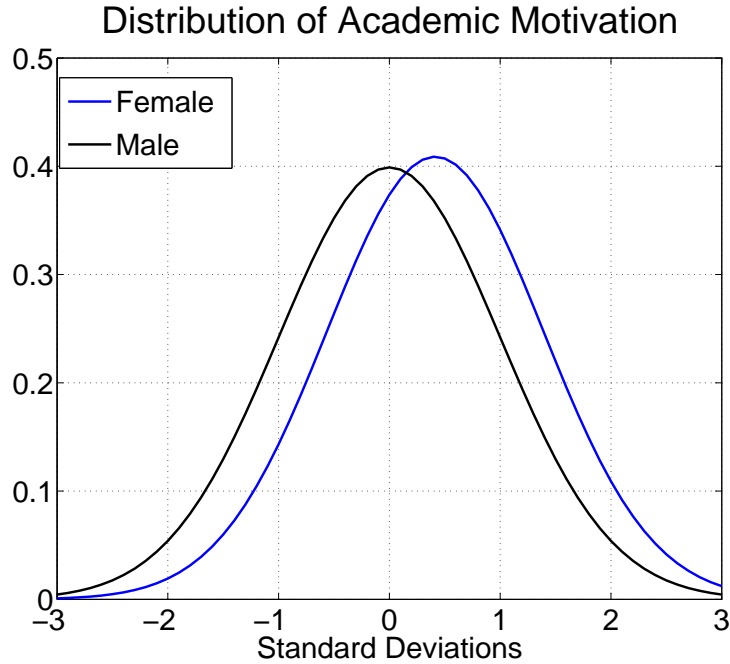


Figure 6: Probability Distribution of Academic Motivation.

Inspection of the  $2\sigma+$  region of the distribution graph shows a large disparity between the sexes in what would be considered the highly motivated region. In fact, solving numerically equations (3) and (4) at  $\Lambda = 2\sigma$ , reveals that academically, there are 2.2 times as many highly motivated females as males.

In *Intelligence, Gender and Race*, La Griffe asks the question: What are the chances that a randomly selected woman is smarter than a randomly selected man? (La Griffe's answer is 45%.) Here, I raise a similar question: What are the chances that a randomly selected woman is more academically motivated than a randomly selected man? I use the approach La Griffe uses in *Intelligence, Gender and Race*, where

$$p = \int_{-\infty}^{\infty} \int_y^{\infty} P_{\mathcal{F}}(x; 0.41, 0.98) P_{\mathcal{M}}(y; 0, 1) dy dx \quad (9)$$

I find  $p = 0.62$ . That is, a female will be more motivated than a male 62% of the time, which perhaps sheds some light on why my daughter was a better student than my son.

## 6 Discussion

If females are more academically motivated than males, does that mean males are lazy? And if so, is laziness a good or bad quality? After all, we still live in a male dominated society (e.g. family, government, business, etc.). Somehow males have compensated for not studying for the spelling bee.

I imagine two cave men arguing about the days hunt.

Cave man one: “Lets circle the volcano looking for Elk. If we move quickly, we can be back in camp before nightfall.”

Cave man two: “Nah! Lets just lie here under the shade tree. An Elk usually walks by every few hours.”

I took handball in college to fulfill my PE requirement. The first thing the handball coach taught us was:

The best handball players are lazy. A good player will position himself in the center of the court and never leave. He will send his opponent all around the court keeping him off balance and on the run. At the end of the match his opponent will be exhausted and he will not break a sweat.

This is my first memory of someone recommending sloth as a strategy. My second memory follows.

Billionaire Warren Buffett wrote the following in Berkshire Hathaway’s 1998 annual report to shareholders:

Here, I need to make a confession (ugh): The portfolio actions I took in 1998 actually decreased our gain for the year. In particular, my decision to sell McDonalds [stock] was a very big mistake. Overall, you would have been better off if I had regularly snuck off to the movies during market hours.

On a more serious note, Albert Einstein had his most productive (and happiest) years while he was a Swiss patent clerk. Later in life, his advice to young people starting out was to take a menial job that gives one time to think and create without the demands and pressure that come with a more high-powered job.

## Appendix

I use data from *2004 College Bound Seniors: A Profile of SAT Program Test Takers*, The College Board Summary Reporting Service, 2004. The number of students in each score range follows:

Score Ranges	Males		Females	
	Math	Verbal	Math	Verbal
750-800	21,507	12,835	9,809	12,568
700-749	39,705	23,442	23,964	22,598
650-699	64,454	44,352	47,138	44,450
600-649	83,239	75,395	72,184	79,134
550-599	104,331	95,765	106,435	106,752
500-549	107,738	112,813	129,524	132,118
450-499	94,648	111,239	132,097	134,087
400-449	71,771	87,619	112,894	108,343
350-399	39,460	51,486	67,288	64,344
300-349	21,049	27,062	36,200	33,138
250-299	7,922	11,415	13,458	13,460
200-249	4,446	6,847	7,746	7,745
Total	660,270	660,270	758,737	758,737

For the academic achievement analysis, I use the class rank data from the same report:

High School Rank	Number	Percent	Percent	
			Male	Female
Top Tenth	206,012	29	42	58
Second Tenth	169,702	24	45	55
Second Fifth	153,531	22	48	52
Third Fifth	143,885	20	48	52
Fourth Fifth	25,036	4	50	50
Fifth Fifth	6,161	1	52	48
No Response	714,680			