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Report of Diane F. Halpern  
Prepared in the matter of  
Civil Action No. 6:09-cv-01565

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Issue of Single-Sex Education

Rene A. Rost Middle School

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Report Prepared for the  
Plaintiffs  
November 11, 2009

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## Table of Contents

INTRODUCTION AND BACKGROUND INFORMATION

6

EVIDENCE OF EXPERTISE

THE ISSUE

OUTLINE FOR THIS REPORT

BRIEF SUMMARY OF RESEARCH FINDINGS

9

### **WHAT IS SOUND RESEARCH AND WHY DO WE NEED IT?**

To Make Causal Claims

Confounded Research Designs

### **WHAT CRITERIA WERE USED FOR INCLUDING RESEARCH IN THIS REVIEW?**

LEVELS OF EVIDENCE

### **WHAT ARE THE CONCLUSIONS FROM THE BEST AVAILABLE RESEARCH?**

U. S. DEPARTMENT OF EDUCATION: DOC # 2005-01

CANADIAN CENTRE OF KNOWLEDGE MOBILISATION SINGLE SEX SCHOOLING  
FINAL REPORT (NOVEMBER 30, 2004)

REPORT FOR THE EDUCATION SECTOR (JUNE 2006)

ANALYSIS FROM SCHOOLS IN GREAT BRITAIN

CALIFORNIA'S SINGLE-SEX EXPERIMENT

SINGLE-SEX EXPERIMENT IN THE SOVIET UNION

INTERNATIONAL LESSONS: CO-EDUCATION IS THE NORM IN COUNTRIES WITH HIGH ACHIEVEMENT SCORES ON INTERNATIONAL ASSESSMENTS

**IF THE EVIDENCE CLEARLY FAILS TO SUPPORT THE BENEFITS OF SINGLE-SEX EDUCATION, THEN WHY DO MANY PEOPLE, INCLUDING SOME TEACHERS, PARENTS, AND ADMINISTRATORS, BELIEVE THAT IT IS EFFECTIVE?**

THE NEED FOR INDEPENDENT RESEARCH

SELF-FULFILLING PROPHECIES

UNCONSCIOUS BIAS

THE HAWTHORNE EFFECT IN EDUCATION—CLOSE SCRUTINY OF A NOVEL PROGRAM WILL IMPROVE ACHIEVEMENT FOR A SHORT TIME, REGARDLESS OF THE EFFECTIVENESS OF THAT PROGRAM

ANECDOTES ARE NOT SCIENTIFIC DATA

STUDY BY THE AMERICAN ASSOCIATION OF UNIVERSITY WOMEN

THE FEMALE-MALE ACHIEVEMENT GAP

22

**WHAT ARE THE RHETORIC AND REALITY OF GAP CLOSING?**

GAP CLOSING MAY NOT BE THE RIGHT GOAL

PUBLIC POLICIES BASED ON GROUP DIFFERENCES

24

**WHY ARE POLICIES BASED ON GROUP AVERAGES UNFAIR TO INDIVIDUALS?**

GIRLS AND BOYS ARE SIMILAR AND DIFFERENT

NO ONE IS AVERAGE

THE FLAWED LOGIC OF SINGLE-SEX EDUCATION

OVERVIEW OF SEX DIFFERENCES IN BRAIN DEVELOPMENT

27

## **WHY CAN'T WE USE BRAIN IMAGING DATA TO CONCLUDE THAT BOYS AND GIRLS LEARN DIFFERENTLY?**

THE GAP BETWEEN BRAIN RESEARCH AND EDUCATIONAL PRACTICES

MORE THAN NATURE VERSUS NURTURE

THE PSYCHOBIOSOCIAL MODEL IN WHICH CAUSE AND EFFECT ARE CIRCULAR

DATA DO NOT SUPPORT THE IDEA THAT GIRLS AND BOYS LEARN DIFFERENTLY

THE CRISIS IN EDUCATION

32

## **IS THERE A BOY OR GIRL CRISIS, AND IF SO, WILL SINGLE-SEX EDUCATION FIX IT?**

THE CRISIS IS REAL—FOR LOW INCOME CHILDREN FROM RACIAL, ETHNIC, AND LANGUAGE MINORITIES, AND YES, ESPECIALLY, BUT NOT EXCLUSIVELY, FOR LOW INCOME BOYS

COEDUCATION DID NOT CAUSE THE CRISIS AND SINGLE-SEX EDUCATION WILL NOT FIX IT

IMPLICIT AND EXPLICIT STEREOTYPING

34

## **WILL SINGLE-SEX EDUCATION INCREASE SEX ROLE STEREOTYPING?**

STEREOTYPES AND OTHER GROUP-BASED BELIEFS

THE HARM OF CREATING GOVERNMENT-SUPPORTED SINGLE-SEX EDUCATION

RECOMMENDATIONS

37

**HOW CAN WE REDESIGN THE EDUCATIONAL SYSTEM SO THAT  
ALL CHILDREN DEVELOP THEIR FULL POTENTIAL?**

A FUTURE ORIENTED PLAN FOR EDUCATION

REFERENCES

43

APPENDIX A: CURRICULUM VITAE

APPENDIX B: STATEMENT OF CONSULTING RATE

## INTRODUCTION AND BACKGROUND INFORMATION

This Report reflects the expert opinion of Diane F. Halpern on the matter of single-sex education in public schools and specifically on the psychological and psychobiological theories motivating many such single-sex arrangements; the psychological effects of sex segregation in education; and the social science data regarding the efficacy of single-sex arrangements in achieving educational goals. The credentials which qualify me as an expert on these subjects are summarized in the following paragraphs in this section and in my curriculum vitae, which is attached.

### EVIDENCE OF EXPERTISE

I am the Trustee Professor of Psychology (an endowed chair) at Claremont McKenna College, where I have worked as a professor since fall, 2001. Prior to my current appointment, I was a professor of psychology at California State University, San Bernardino for 20 years (with early promotions from Assistant Professor to Associate Professor to Full Professor). I received a Ph.D. in psychology from the University of Cincinnati in 1979. Prior degrees include a Master's degree in psychology from University of Cincinnati, a Master's degree in psychology from Temple University, and a B. A. in psychology from the University of Pennsylvania.

I have been an officer in numerous professional societies including, president of the American Psychological Association (the largest psychological organization in the world with approximately 145,000 members in 80 countries), the Western Psychological Association, the Society for Teaching of Psychology, and others (complete list can be found in my curriculum vitae). I have been the recipient of a large number of awards for my teaching and research, which includes an Honorary Doctorate from Mount St. Mary's College, Rockefeller Foundation Scholar-in-Residence Award, Fulbright Scholar Award, and the Outstanding Professor Award from the California State University (state-wide).

My record of scholarship reflects decades of work on topics relevant to single-sex education in public schools. My textbook entitled *Sex Differences in Cognitive Abilities* is going into its fourth edition. The first edition was published in 1986. I chaired the U. S. Department of Education Taskforce on *Encouraging Girls in Math and Science*, which is an Institute for Educational Sciences Practice Guide. It is available on line at <http://its.ed.gov/ncee/wwc/pdf/practiceguides/20072003.pdf>. I also chaired the American Psychological Society's juried peer-review group which wrote the article entitled, *The Science of Sex Differences in Science and Mathematics*. This article won the George A. Miller Award for 2009-2010 for "the outstanding journal article in psychology." It was excerpted and rewritten for a general audience and published in *Scientific American Mind*.

I have provided expert testimony to the U. S. Congress on general matters relating to education (application of principles from cognitive psychology to education) and on sex-related matters relating to education. My testimony on the topic of the underrepresentation of women in science was presented to the Senate Science and Technology Caucus.

Evidence of my expertise in the broad area of education is also documented on my curriculum vitae. I am a co-Principal Investigator on a Department of Education grant that is developing computer-based instruction on scientific reasoning and critical thinking. I served as a consultant to the Hong Kong public schools in their plan to begin instruction in critical thinking in all high schools in Hong Kong. I chaired the American Psychological Association taskforce on undergraduate education and edited a recent book on that topic entitled, *Undergraduate Education in Psychology: A Blueprint for the Future of the Discipline*. Additional qualifications are listed in my curriculum vitae.

**THE ISSUE:**

*THERE HAS BEEN AN INCREASE IN THE NUMBER OF SCHOOLS OFFERING SINGLE-SEX EDUCATION IN VARIOUS FORMATS INCLUDING SEX-SEGREGATED CLASSES. THIS REPORT DISCUSSES RESEARCH FINDINGS ON THIS QUESTION. THE PRIMARY QUESTION IS WHETHER SINGLE-SEX CLASSES OFFER ADVANTAGES OR DISADVANTAGES RELATIVE TO EDUCATION IN COEDUCATIONAL CLASSES AND WHETHER GAINS, IF THERE ARE ANY, CAN BE ATTRIBUTED TO THE SINGLE-SEX ENVIRONMENT OR TO OTHER CHANGES THAT WERE MADE AT THE SAME TIME AS THE SWITCH TO SINGLE-SEX EDUCATION.*

**OUTLINE FOR THIS REPORT**

This Report is written in response to the many questions raised by the practice of segregating children by sex for instruction in public schools. In this report, I explain why the questions about single-sex education need to be answered with empirical evidence conducted by independent researchers. I then explain why some people might believe that single-sex education is a superior option over coeducation even though virtually every major analysis of multiple studies fails to support this view, and there is considerable evidence that these program harm boys and girls by perpetuating sex role stereotypes. Small scale studies that have shown academic gains when classes are segregated by sex are confounded because changes to single-sex education have been undertaken along with other changes such as an increased emphasis on academic achievement, stricter monitoring and enforcement of regulations, and other changes that are unrelated to the sex of the children in the classrooms. There are fundamental flaws in the logic that single-sex education will close the achievement gap between boys and girls. I review the literature on brain and other biological differences between females and males and explain how these data do not support the need for segregated educational practices. There is a crisis in American education, but it is not as simple as a boy or girl crisis; there is no evidence that the current crisis is caused by coeducational practices and there are few reasons to believe that single-sex education will alleviate the crisis. Each sex, on average, excels on different measures of academic and career achievement, a finding that shows that the problem is far more complex than the sexes are different. The data do not support the idea that girls and boys differ in how they learn. Finally I conclude with recommendations for enhancing the achievement of all children.

A NOTE ON TERMS: Some authors prefer to use the term “gender” when referring to female and male differences that are social in origin and “sex” when referring to differences that are biological in origin. I will use the word “sex” in this report, in part because the term



“single-sex” is used more frequently in the literature than “single-gender” and because assignment to single-sex classes is based on biological sex, not sex differences that many have arisen from societal or cultural expectations or practices. Children are not assigned to classrooms based on the extent to which they represent male or female stereotypes, which is what the term “gender” suggests. They are selected on the basis of biological sex, and placed in all-girl or all-boy classrooms regardless of whether they prefer dolls or trucks or conform to other sex role stereotypes.

## BRIEF SUMMARY OF RESEARCH FINDINGS

### WHAT IS SOUND RESEARCH AND WHY DO WE NEED IT?

The topic of differences between boys and girls in how and how well they learn is fraught with political minefields that are often ignited with sound bites by the media and astounding claims of success made by groups with a vested financial interest in maintaining and expanding single-sex education. For example, the May 26, 2003 cover of *Business Week* on “The New Gender Gap” provided a long list of the ways in which boys and men are trailing girls and women in measures of academic achievement and in leadership positions. This list outraged many who saw the gap from the other side as an unbridgeable chasm-- those who still see a male advantage on most high-stakes tests that are used for admissions for college and post-graduate school and who read the statistics showing that women still earn considerably less than comparably educated men. The questions about single-sex and coeducational classrooms are a highly politicized topic. For this reason, I have stayed close to the data and explain my reasoning as I present an overview of what we know about single-sex and coeducational education. The issues are complex and emotional. They involve multiple concepts of fairness, which are rooted in societal values and assessed with statistical methods that many of the stakeholders in education (e.g., parents and the general public) do not understand. But parents and the general public know that they want the best for their children, and they are dissatisfied with the current state of education. Not surprisingly, when data about differences in the achievement of boys and girls are made public, it does seem that one way of improving achievement for all students might be single-sex education. Despite the fervent beliefs of some participants in the move to single-sex education and from groups that stand to gain financially by the establishment of single-sex classes and schools, the data do not support the conclusion that single-sex education is better than coeducational educations in enhancing student achievement, reducing sex role stereotyping, or creating classrooms that are more conducive to learning. In addition, there are data that show that there are unintended negative consequences of single-sex education.

Before addressing the questions of whether single-sex education can cause better educational outcomes, it is important to understand how researchers are able to make causal claims and why some studies do not permit a causal conclusion (e.g., single-sex

education causes higher achievement or some other outcome). Sometimes the word “evidence” is used when the evidence is weak or even worthless. Causal claims rest on sound research practices. Sound research uses methods that are appropriate for the research question being investigated. Empirical results can be obtained from systematic observation or experimental manipulations, but these different types of methods do not permit the same type of conclusion. This may seem like an overly technical distinction for an overview report, but understanding when a researcher can claim that single-sex or coeducational education *caused* something to happen is important in understanding the strength of the evidence for research conclusions.

## TO MAKE CAUSAL CONCLUSIONS

If educators want to conclude that something causes something else to happen, they need to have employed research designs that used random assignment of participants to different conditions. What that means is that in order to conclude that single-sex or coeducational education causes better achievement, less sex role stereotyping, or some other outcome, researchers must assign children at random to either single-sex or coeducational classrooms (or programs) and then assess the effect of the two educational experiences. With random assignment, the individual children receiving single-sex and coeducation will differ in many ways—some will come from low income homes, some will have parents who read to them every night, and some will come from homes that value educational achievement-- but on average, the groups will be approximately the same across these variables. The children in the two groups will differ systematically only in the type of educational experience they receive. Random assignment means that every student has an equal chance of being in any of the groups being studied—single-sex or coeducational. With random assignment, researchers can meaningfully conclude that any differences in the educational outcomes between these educational groups are due to the educational experience and not some other variable.

In the United States at this time, it is illegal to require any child to enroll in a single-sex class. Until recently children in single-sex educational environments were enrolled almost exclusively in private schools (except for some experimental public school studies described below), most of which are religious schools. There are many pre-existing differences between children in private and religious schools and those in publicly funded schools. In general, children in private schools come from (primarily) higher income families who are committed to monitoring their children’s education. In addition, low performing and troublesome children are often expelled from private schools and end up in public education. We cannot make meaningful comparisons between children in private single-sex classes and those in public coeducational classes when they differ in so many other ways.

## CONFOUNDED RESEARCH DESIGNS

If researchers want to know if being educated in a single-sex classroom affects educational outcomes, then the only difference between the single-sex classrooms studied (and other educational settings studied) would be assignment by sex. If a district decided to

implement single-sex education and at the same time increased its emphasis on academics, for example, by assigning more homework or monitoring student performance more closely, or by including motivational speakers, adding mentors and tutors, requiring uniforms, maintaining closer communication with parents, or the myriad of other changes designed to enhance student performance, they could not conclude that any gains (or losses) were attributed to single-sex education.

Neuroscientist Eliot (2009) explains the problem of confounded research this way: "There are unquestionably many top-notch single-sex schools out there. The caveat, however, is that the advantage of such schools is not demonstrably related to their single-sex structure. As study after study confirms, the differences in test scores, AP course enrollment, and other objective measures of academic success between single-sex and coed schools melt away when researchers statistically adjust the data to correct for preexisting differences between these groups of students" (p. 308).

The highly touted Young Women's Leadership School in East Harlem is an example of this problem. It boasts an enviable college-going rate and is clearly doing several things right. But even a quick visit to the website for this school will show that much more than single-sex education is going on. Their college-bound initiative shows a well structured plan to help every student achieve at a high level (college awareness activities starting in 6th grade, financial and enrollment support, alumni support, partnerships with committed colleges, a demanding curriculum and more). They can boast about an impressive level of success, but there is no reason to believe that the same high rate of success would not be achieved if the same school were co-educational or that the success of the girls in this school would be diminished if boys were enrolled.

## WHAT CRITERIA WERE USED FOR INCLUDING RESEARCH IN THIS REVIEW?

Researchers on both sides of the single-sex education debate have been accused of "cherry-picking" research results that support their position, while ignoring the large number that fail to support it. This criticism is well-founded. The research literature on single-sex and mixed-sex classrooms consists of thousands of studies, and no single study can be considered definitive in answering the question of whether either of these educational programs is superior. Evaluators need to consider the research literature as a whole because many unrelated variables affect the outcomes of any single study (e.g., there might be particularly good teachers in one type of school or unequal resources between the types of classes in any single study). This Report summarizes research findings that were conducted by independent researchers with no (known) financial or other potential gain that could result from findings in either direction. The research selected for this Report had to summarize multiple studies and to screen studies for inclusion using standard scientific criteria for quality research (e.g., large sample size, reliable measurement, peer review, adequate experimental controls) or be based on large-scale random assignment studies or

population data or sample sizes over 500,000. No single study can provide an answer to a question as complex as the effectiveness of single-sex schooling. The research literature is very large, and just as there are "studies" that support a wide variety of ways to "cure autism," for example, there are "studies" that report equally fantastic claims for educational practices, including single-sex education.

### LEVELS OF EVIDENCE

The Institute of Education, which is part of the U. S. Department of Education, has established guidelines for rating various levels of evidence in education. Strong evidence meets the standards of the What Works Clearinghouse (<http://ies.ed.gov/ncee/wwc>). These standards include the random assignment of students to different conditions, accounting for students who drop out of a study, use of reliable outcome measures, assurance that the intervention of interest was not combined with other interventions, and other quality practices. The Department of Education is increasingly funding and requiring high quality research practices. Moderate studies would include correlational research with strong statistical controls for selection bias and experiments with conditions that limit the generalizability of the results. Other examples of moderate levels of evidence include the use of comparison groups where participants are not equated at the start of the study, but the research meets other standards for quality such as no threats to validity (a threat to validity would be have one teacher or one class per condition). Using these standards, the California experiment, described below, comes closest to a strong research design. The results of this experiment and all of the other high quality reviews or very large sample designs all show the same conclusion: there is little or no support for single-sex education.

Meta-analysis is a statistical procedure that summarizes multiple studies in one analysis so studies that find advantages for either single-sex or mixed-sex education or no difference between them are combined in a single statistical conclusion. As its name implies, it is an analysis of multiple analyses or studies that have already been conducted. Several different meta-analyses have examined the data in support of the claim that single-sex education is advantageous for either girls or boys. They have examined the effect of single-sex and coeducational education on student achievement, sex-role stereotyping, and bully and harassment behaviors. What are the conclusions?

## WHAT ARE THE CONCLUSIONS FROM THE BEST AVAILABLE RESEARCH?

### U. S. DEPARTMENT OF EDUCATION: DOC # 2005-01

Most importantly for this context, the independent review commissioned by the United States Department of Education found that "Not a single study in the quantitative review reported findings from a sample of middle school students. One possible explanation for this is that the preponderance of single-sex schooling research has been conducted in Catholic schools. In Catholic schools, students are separated by gender only when entering

adolescence, which coincides with the beginning of high school" (U.S. Department of Education, 2005, pp. 86-87). The authors failed to find evidence for or against single-sex education at the middle school level despite beginning their analysis with 2,221 potential studies. From this number, only 379 studies were considered "appropriate for review as quantitative or qualitative studies." Using the research standards of "What Works Clearinghouse," which publishes high quality educational research, virtually all of the single-sex studies would have been eliminated, so the authors decided to "relax these standards" and include correlational studies that used statistical controls in their review. Even after relaxing standards, the researchers were left with only 40 quantitative studies for review. Thus, the majority of the studies in the research literature did not meet basic scientific standards and were not included in the final review, and those that were included often did not reach the What Works Clearinghouse standards for quality in education research. In addition, many of the studies were used in multiple comparisons, all of which would lead to an overestimate of the effectiveness of single-sex education.

The general conclusion of this review was that the existing data are equivocal, with some data suggesting that single-sex education could be helpful, much data showing no evidence, and some data suggesting that single-sex education can be harmful. For example, the strongest finding with regard to single-sex schools was in subject achievement tests. But, within each subject-specific category, "roughly a third of all studies reported findings favoring SS schools, with the remainder of the studies split between null and mixed results." Conclusions about long-term quantifiable gains are more negative: "No differences were found for postsecondary test scores, college graduation rates, or graduate school attendance rates." The researchers also examined concurrent and long-term socio-emotional development. These categories included a mix of outcomes such as self-esteem, self-concept, locus of control and several others. "Regarding self-concept and locus of control, the studies are split between those showing positive effects for SS schooling and those showing no differences. In the case of self-esteem, a third of the studies supported CE schooling while half found no difference." One study found more single-sex students to have eating disorders than co-educational students, which although troublesome, needs replication before it is considered a reliable finding. **Thus, the U. S. Department of Education's own independent review fails to support the idea that single-sex education is better than coeducation, and there may be negative consequences to single-sex education.**

Although no other studies exist that have compared single-sex and co-educational school outcomes using the rigorous design that was used in the independent report commissioned by the U. S. Department of Education, there are several conceptual overviews in which conclusions are based on the results of many different studies.

#### CANADIAN CENTRE OF KNOWLEDGE MOBILISATION SINGLE SEX SCHOOLING FINAL REPORT (NOVEMBER 30, 2004)

In a review of the literature on single-sex and coeducational education conducted for The Canadian Centre for Knowledge Utilization and funded by the Canadian Education

Statistics Council, the authors reviewed multiple studies (47 separate studies that met the qualifications for inclusion) and concluded: "A question that policy makers must consider is: What is our purpose for initiating public single-sex classes and schools? If in fact it is about improving achievement for students, then one must consider the sound research which suggests that the single-sex environment itself does not have an effect on achievement" (Thompson & Ungerleider, 2004, p. 17). The authors of this report conclude that **"The research we reviewed is too tenuous to support the organization of single-sex classrooms or schools"** (p. 16). In a project overview written by one of the authors of this study, Underleider (2008) concluded, **"The majority of studies found no significant difference in achievement between students' education in single-sex and co-educational environments."**

### REPORT FOR THE EDUCATION SECTOR (JUNE 2006)

Consider the conclusions from a policy piece written for the Education Sector, which is an independent, nonprofit and nonpartisan think tank that produces original research and policy analysis. The Education Sector is "nonprofit and nonpartisan, both a dependable source of sound thinking on policy and an honest broker of evidence in key education debates." They used data from the 2003 and 2005 National Assessment of Educational Progress, thus they had an extremely large and unbiased sample. Mead (2006), a senior policy analyst wrote: "Boys are routinely characterized as 'falling behind' even as they improve in absolute terms. A dizzying array of so-called experts have seized on the boy crisis as a way to draw attention to their pet educational, cultural, or ideological issues. This debate benefits neither boys nor girls while distracting attention from far more serious educational problems--such as large racial and economic achievements gaps--and practical ways to help both boys and girls succeed in school. **Educators, parents, and policymakers should therefore be skeptical of simplistic proposals aimed at fixing the boy crisis, such as expanding single-sex schooling, implementing gender-based instructional techniques, or funding new federal programs aimed at improving boys' achievement"** (p. 18).

Although much of the research on the many questions about single-sex education is of poor quality, a few large scale studies, some with random assignment are available.

### ANALYSIS FROM SCHOOLS IN GREAT BRITAIN

Great Britain, particularly England, has a long history of both single-sex and co-educational schools. In a review of data from over 500,000 students, Robinson and Smithers (1999) concluded that "The outstanding performance of single-sex schools in the examination league tables has much more to do with academic selection, socioeconomic background, and the standing of the school itself than with the segregation of the sexes. When, as far as possible, like is compared with like, the apparent academic differences between single-sex and co-educational schools largely disappear. . . . Furthermore, nearly all those who had been to co-educational schools said they would also send their own children

to co-educational schools, but only about a third of those who had been to single-sex schools said they would send their children to single-sex schools" (p. 23). In a later review, these authors conclude: "**The paradox of single-sex and co-education is that the beliefs are so strong and the evidence is so weak**" (Smithers & Robinson, 2006, p 31).

### CALIFORNIA'S SINGLE-SEX EXPERIMENT

The California Experiment is the most comprehensive study of single-sex education in the public schools in the United States. In 1997, then Governor Pete Wilson established six pairs of single-sex schools (called academies—often schools within a school) in six districts in California to assess the consequences of single-sex education (Datnow, Hubbard, & Woody, 2001). A \$500,000 state grant was provided to fund academic and social support structures for the needs of the students in these experimental academies, so these schools were funded at a substantially higher level than their coeducational counterparts. The additional funding provided students in the single-sex schools with additional computers, field trips, smaller class sizes, and other resources related to the enhancement of student achievement. What was the outcome of this public school experiment with single-sex education? The evaluators, whose work was funded by the Ford Foundation and other nonprofit groups, concluded that "**Traditional gender stereotypes were often reinforced in single gender academies.** Boys tended to be taught in a more regimented, traditional, and individualistic fashion, and girls in more nurturing, cooperative and open environments" (p.7). "By teaching to perceived differences, in many cases, educators unwittingly ignored the power of schooling in shaping gender ideologies" (p. 39). [Note—this criticism of the single-sex academies is a stated goal of some proponents of single-sex education—to teach in sex-stereotyped ways.] **After two years of operation, four of the six districts closed their single-sex academy; a fifth district closed theirs after three years.**

### SINGLE-SEX EXPERIMENT IN THE SOVIET UNION

As a means of informing the single-sex versus coeducation debate, researchers recently studied a massive single-sex experiment that was conducted over an 11-year period in the Soviet Union (Ewing, 2006). The author focused the report on boys' schools in response to current concerns that coeducational schools and classes are harmful to boys. These same concerns are what gave rise to the Soviet experiment in single-sex education. **But, single-sex education worsened the problem** and was rejected after 11 years. The author of this study warned that: "this case study involving more than a million male pupils can serve as a cautionary tale about the possible difficulties and potential consequences of a large-scale gender segregation policy" (p. 621). "**Discipline actually worsened . . .**" The author recognized that there are limits to the generalization from a study of Soviet boys' schools to the present situation in the United States that has caused many to consider single-sex education as a possible improvement over coeducation, especially for boys. He concluded that "claims of significant advantages [for single-sex education] are rarely supported by measurable educational outcomes" [followed by a list of 11 studies that support this conclusion].

## INTERNATIONAL COMPARISONS: CO-EDUCATION IS THE NORM IN COUNTRIES WITH HIGH ACHIEVEMENT SCORES ON INTERNATIONAL ASSESSMENTS.

Children from the United States continue to score low relative to same-aged peers in other countries. The Final Report of the National Mathematics Advisory Panel (U. S. Department of Education, 2008) found that American students achieve at "a mediocre level by comparison to peers worldwide" (p. xiii). Co-educational schools are the norm in countries that are outscoring us in math, science, and reading. In fact, the only countries with a national policy of single-sex education are fundamentalist regimes such as Iran and Afghanistan--places that few, if any, Americans would want to emulate. These countries do not have high levels of achievement on international assessments. Although there are obviously many differences between the U. S. and fundamentalist regimes, these data make it clear that single-sex education is not a panacea that will automatically or necessarily lead to enhanced learning for girls and boys.

Other international data support the idea that sex-segregated education is not an optimal environment for student achievement. "Studies from Australia, North America, New Zealand, Ireland, and the United Kingdom reviewed by Alan Smithers and Pamela Robertson of Buckingham University found **that gender is not an important factor in education**" (Cable & Spradin, 2008, p. 7).

## **IF THE EVIDENCE CLEARLY FAILS TO SUPPORT THE BENEFITS OF SINGLE-SEX EDUCATION, THEN WHY DO MANY PEOPLE, INCLUDING SOME TEACHERS, PARENTS, AND ADMINISTRATORS, BELIEVE THAT IT IS EFFECTIVE?**

Given the increased interest in single-sex education, it may be surprising that all of the systematic and independent reviews of the research literature fail to support its benefits. Most people will agree that high quality research should inform social and public policies, yet in this case, the research literature has largely been ignored. With over 2000 separate studies that were identified in the report performed for the U. S. Department of Education, anyone can find a study that supports their beliefs. Psychologists know that people process information differently when it supports or fails to support what they believe to be true. The tendency to seek information that confirms what we believe to be true is called confirmation bias. Of course, most people believe that they fairly assess all of the available information, but even research with NASA scientists has shown that they prefer information that supports their beliefs (Mynatt, Doherty, & Tweney, 1977). We know that belief biases are automatic and not conscious, but they are real.

## THE NEED FOR INDEPENDENT RESEARCH

Most people are rightfully skeptical when they read studies conducted by the tobacco industry showing that there are no harmful effects of smoking. Similarly, few



people would accept a claim from a chicken grower that his chickens are healthier than other brands unless it was verified by independent researchers. If the researcher stands to benefit from some research outcomes and not others, readers need to rely on independent studies before deciding what to believe. For example, if positive findings for single-sex schools meant more business for a company or individual, it is more likely that the finding was affected by the researchers' biases than research conducted by individuals with no personal gain that would result from a particular outcome. Thus, groups and individuals who are likely to gain financially and in other ways from particular research outcomes cannot provide unbiased assessments of the effectiveness of the programs they support. The medical community is well aware that researchers with financial ties to drug companies cannot conduct unbiased research on the effectiveness of drugs made by that company. The Cochrane Collaboration, which conducts reviews of healthcare interventions, will not accept funding from any group or individual that may have a conflicted interest. We need to apply the same standards to educational research. For these reasons, we cannot use data from the National Association for Single-Sex Public Education (NASSPE), which stands to gain in significant financial ways by having districts adopt single-sex classes.

## SELF-FULFILLING PROPHECIES

Once individuals make a personal commitment to something, it is difficult for them to see evidence for the other side. Although no one believes that they are biased, a large body of research shows that our personal beliefs influence educational and other outcomes. Most teachers and others in education are familiar with experimenter expectancy effects. In several classic studies in the 1960s, Robert Rosenthal found that when teachers were told that certain children were expected to "bloom," these children were performing at a higher level at the end of the term than other children who were not identified as potential bloomers. These results were obtained consistently even though Rosenthal selected the children he identified as bloomers at random. Teacher beliefs and expectations had either created conditions that enhanced the achievement of these students (perhaps they were given more praise for correct responses or more assistance when they had difficulty learning a concept) or the teachers assessed their performance as being higher than they would have assessed the same performance if they did not believe the children were "bloomers." Over 345 studies showed experimenter expectancy effects in the decade following the original studies (Rosenthal & Rabin, 1978).

## UNCONSCIOUS BIAS

In addition to the findings with experimenter expectancy effects, there are reasons to believe that teachers unknowingly rate student performance higher when they expect it to be high than they rate identical (or similar) performance for other children whose performance they do not expect to be high. For example, the research literature on single-sex versus coeducational education shows a disconnect between teacher ratings and standardized test scores. In a study of the effects of single-sex and coeducational education on 5<sup>th</sup> grade African-American children, researchers found that "Class grades were consistently higher in the single-sex classes, although the difference was not always

statistically significant. Standardized test data showed no trend” (Singh, Vaught, & Mitchell, 1998, p. 157). In other words, although teachers in single-sex classrooms rated the children in their class as performing at a higher level than the ratings given by teachers in coeducational classes to their students, the groups did not differ in their standardized test scores.

Recent research has shown that unintended bias can exert strong effects. There are many examples of the way an individual’s beliefs can alter a wide range a biological systems, including hormone secretions, motor responses, breathing rates, and digestion, just to name a few, so it is probable that individual beliefs will influence how teachers and others rate student progress. Experimenter or teacher expectations can unconsciously influence how people respond to situations. Medical researchers are well aware of these types of effects, which is why double-blind, placebo-controlled, cross-over studies are the “gold standard” for medical research. A double-blind study is one in which neither the participant nor the researcher knows which group is getting the experimental treatment and which is getting a placebo or control treatment. It is not possible for children to “be blind to” whether they are in single-sex or coeducational classes, but it is possible for independent raters who do not know which group each child was in to rate their behaviors, attitudes, and achievements. A cross-over study is one in which everyone starts in one group (assigned at random), a (blind) assessment is made and then everyone crosses over to the other group and another (blind) assessment is made. When applied to the question of single-sex versus coeducational classes, every student would be assigned at random to one of these educational conditions (to permit causal claims), then after a reasonable time period (perhaps a year), independent assessors would measure the achievements, behaviors, and attitudes of each child, without know which class setting the children were enrolled in. Then all of the children in the single-sex class would move to coeducational classes and vice versa for a reasonable amount of time. Independent assessors would again rate each child without knowledge of which class the children were in. If for example, single-sex classes were superior, then the children in these classes for the first year would show superior performance, which would decline in the second year when they are moved to coeducational classes, with the reverse pattern for children initially enrolled in coeducational classes. This strong design would provide good evidence for concluding if single-sex and coeducational classes provide similar outcomes or if one of these programs is superior. As long as the teachers who are teaching in these classes are also assessing the children, it is likely that unintentional (and unconscious) bias will occur in ratings of student performance. Without appropriate experimental controls, other variables such as smaller class size or increased monitoring of student performance or some other variable could be the underlying cause for any outcomes and not the sexual composition of the classes.

**THE HAWTHORNE EFFECT IN EDUCATION—CLOSE SCRUTINY OF A NOVEL PROGRAM WILL IMPROVE ACHIEVEMENT FOR A SHORT TIME, REGARDLESS OF THE EFFECTIVENESS OF THAT PROGRAM**

What is most likely to happen when schools initiate single-sex education? One reasonable prediction is that, in general, and in the short term, performance will improve for students in these classes, but not because they are single-sex classes. There is a well-known phenomenon in psychology known as the Hawthorne Effect: People respond differently when they are being scrutinized and made accountable, but these effects are short-lived. An example of this happened in a series of studies of the effects of workplace conditions, such as different levels of lighting, different pay incentives, and different break schedules, on productivity at the Hawthorne Works manufacturing plant of Western Electric in Cicero, Illinois, between 1924 and 1933 (Merrett, 2006). This series of studies has become a classic in the psychological literature because the researchers were among the first to apply the principles of the scientific method to real-world questions in a workplace setting. The workers knew they were being observed and they had a special status as test participants, so they responded to changes in their working conditions with increases in their productivity, regardless of the nature of the manipulation—including taking longer or shorter breaks and various changes in the pay system. They did not get continuously faster at assembling relays (which was their work place task) throughout the various studies, which was the main dependent variable, but they did speed up at the start of a new type of manipulation. The Hawthorne effect refers to short-term changes in behavior that occur when people know that others are observing them and they have a special status as a participant in a novel program.

Can you think of ways that the Hawthorne effect might operate in educational studies? Consider, for example, a study of the effectiveness of a new reading program in elementary schools in which the teachers know that they have been specially selected to try out a new program. In addition, the teachers know that the reading progress of their students is being monitored closely and reported to their superintendent. It is easy to see how the teachers assigned to teach with the new program might be more enthusiastic in their teaching or pay more attention to each child's reading progress than teachers using the old program. In this example, one likely outcome is that the students receiving the new program of instruction would show gains in reading that were caused by the teacher's increased attention to their reading progress and not by the new program. People respond positively to increases in (positive) attention. But, as soon as the reading program is no longer new, the enthusiasm and extra effort will dissipate and reading levels will return to their former levels. Similarly, as long as single-sex education is an exciting new alternative and teachers are reporting achievement results to interested boards and governmental monitoring agencies, short-term gains may be expected, but as the newness fades, achievement will return to former levels, assuming no real negative effects of single-sex education drive them even further down. If the Hawthorne Effect shows positive gains, who cares if the gains are caused by the excitement, scrutiny, and accountability of single-sex education and not sex-segregation per se? Why should we care if the gains attributed to single-sex classrooms are really just a placebo effect, which is the term for a "sugar pill" or inert substances that often helps people feel better because they believe they will feel better? Negative outcomes and increased costs that could be funding improvement for all children are two important reasons.

As shown below, there are many ways that single-sex education can have unintended negative effects with substantial evidence of increased sex role stereotyping, and bullying, and harassment when the sexes come together after being apart in their classrooms.

#### ANECDOTES ARE NOT SCIENTIFIC DATA

It is often difficult for people to realize that their personal stories are no substitute for multiple large scale analyses by independent researchers. Many people will find a single personal story more persuasive than a review of over 2000 separate studies that included millions of students and rigorous measurement. This point was made in a recent review of the book *Snake Oil Science* that examines why some people do not care what the studies say about medical cures because they distrust science and statistics; people prefer their own personal experiences, and cannot see their own biases (Zuger, 2007). Despite the near-unanimous conclusion from multiple independent reviews of the literature, many people believe that single-sex education is beneficial. For example, here are two quotes from teachers who underwent training at the Gurian Institute, which is based on the idea that girls and boys learn differently, so teachers need to teach them differently. (The Gurian Institute home page on the internet features many books and training programs for sale.)

"Before the switch to the new methods, the boys had several Fs and the average was a low C for all of the classes. The girls generally had better grades—only a few Fs--but the overall girl average was high C to low B. In these particular classes were all of our special education students, because we don't have a resource class for 7<sup>th</sup> and 8<sup>th</sup> grade students."

"After the change, both classes had higher grades. And, by the end of the school year, the boys' average was within 5 points of the girls' average. In total, at the end of the year, out of 180 students, I had only 3 boys with the F average and 2 girls. I credit this outstanding improvement to the gender specific classes."

**But, there are also testimonials attesting to the failure of single-sex classes. For example, Newport Middle School in Kentucky and Eagle Rock Junior High School in Idaho eliminated single-sex classes after just one year. A major concern was with disciplinary issues which escalated in single-sex classes.**

"Becky Lenihan, a 14-year teaching veteran, says she has written up more boys [in single-sex classrooms] for discipline problems this year than in her entire career." (Calbe & Spradlin, 2008).

Faust, principal of Newport Middle School in Kentucky was quoted as saying: "Without girls as a calming influence, the rowdiness of boys seems to escalate" (Gutierrez, 2004).

There are many ways that personal beliefs support our perceptions. Once a personal attachment is made to certain beliefs, especially when people exert considerable effort in pursuit of that belief, it is difficult (but possible if people are open to the findings from carefully controlled research) to see other realities. Anecdotes are not evidence of effectiveness, regardless of how enthusiastic or heart-felt they are.

**ANECDOTE WARS:** Just as there are many anecdotes (tales of personal experiences that support a point of view) that support single-sex education, there are at least as many that are opposed. Proponents on each side are convinced that their personal experiences provide evidence for their position. Which side has the better anecdotes or the longer list with more superlatives? This is not a valid way to evaluate programs.

#### STUDY BY THE AMERICAN ASSOCIATION OF UNIVERSITY WOMEN

In keeping with the theme that when there is a personal commitment to a certain type of outcome, research results should be considered weaker than similar work done by independent researchers, I did not include the conclusion from a group of experts convened by the American Association of University Women (AAUW) in 1998 in my opening list of results from multiple studies. The AAUW studies did, however, review multiple data sets to conclude that **“There is no evidence that single-sex education in general ‘works’ or is ‘better’ than coeducation.** The ‘success’ or ‘failure’ of any K-12 single-sex education initiative is relative to a particular group of students in a particular setting and a given set of academic or social objectives” (p. 2). I also did not include the conclusions from their more recent report (2008) in which they presented an extensive review of the data and “refuted the boys’ crisis” (p. 1). There are some concerns that the Association of University Women is committed to coeducation and their reviews would have the same unintentional bias that might be expected from any group or individual with strong a priori biases for a certain conclusion, although it is not clear why AAUW would be committed to coeducation if single-sex education showed superior results for advancing women and girls, which is their mission. Thus, although a summary of the findings from these studies must be included in this report because both studies reviewed multiple outcome measures, I am mindful of the possibility of unintentional bias from all sides of the question about single-sex versus coeducational education and present the results under this section on unintended bias.

#### THE FEMALE-MALE ACHIEVEMENT GAP

It is true that boys and girls and men and women, on average, show different patterns of achievement in different academic domains. Boys are more likely to be diagnosed with reading disorders and to be held back a grade in the early elementary school years than girls are, although these percentages have been declining for boys in the last decade and remained stable for girls (Freeman, 2004). There are disproportionately more males who are diagnosed with mental retardation for genetic reasons (X-linked alleles for mental retardation, which puts males at greater risk; See Turkheimer and Halpern, in press for a discussion). Educational settings will do little to alter the excess representation of males in some types of mental retardation. Average differences in cognitive abilities are well documented in numerous books and journal articles that I have written (e.g., Halpern, 2000). For example, girls are well ahead of boys in writing and some of the other language skills with a fairly large gap in high school, and boys score consistently higher than girls on the mathematics portion of the college admissions test, the SATs, but these difference, and

other differences in achievement patterns, do not imply that boys and girls need separate and different methods of instruction. Boys have been gradually narrowing the reading gap between them and girls (on average) since 1971 and the consistent advantage that boys have on the SAT math test can be attributed, at some large part, to the fact that many more girls take the SATs.

Girls are attending college at higher rates than boys, but again the reasons are complex and not amenable to remediation with single-sex education, if that was a goal of "closing the achievement gap." Boys have more job opportunities for good-paying jobs in their early adult years than girls do--jobs in construction, trucking, and heavy manufacturing are overwhelming filled by men and most do not require any education beyond high school, which can explain at least some of the difference in college-going rate. And, men have been enrolling in college at higher rates than ever before, but women are enrolling at much higher rates, which makes the males' gains in college attendance appear to be a decline. In the independent policy analysis written for Education Sector, Mead (2006) summarized the data well: "Overall, there has been no radical or recent decline in boys' performance relative to girls. Nor is there a clear overall trend--boys score higher in some areas, girls in others."

## WHAT ARE THE RHETORIC AND REALITY OF GAP CLOSING?

The title of this section was taken from a research article that explains why interventions designed to close achievements gap do not work (Ceci & Papierno, 2005). Educational psychologists refer to the attempt to equalize group achievements as the *Matthew Effect*, which is borrowed from the Gospel idea that an initial advantage in any area leads to cumulative differences that widen pre-existing gaps. If an intervention is designed to close the gap between any two groups, and it is available to everyone in both groups, then the gap inevitably widens. Thus, if the goal of single-sex education is to reduce achievement gaps, and if instruction is somehow designed to maximize learning for both girls and boys, then in fact, any existing gap would be expected to widen, as both girls' and boys' achievement would be expected to improve. This phenomenon has been observed across a wide range of interventions designed to reduce the gap between groups of students. (See Ceci and Papierno, 2005, for a review of the literature).

### GAP CLOSING MAY NOT BE THE RIGHT GOAL

The rhetoric of gap closing is also based on weak reasoning. In middle school, girls are ahead of boys in some, but not all areas, of the curriculum. Boys catch up in later grades with better performance in some areas of math and science. Which gap is being targeted for closing? The easiest way to reduce a performance gap between any two groups is to reduce the performance of the higher achieving group, which is undeniably an undesired outcome. If single-sex education really were ideally suited for promoting learning for both girls and boys, then it would not reduce the achievement gap; it would increase it. As educators, our primary responsibility is to help every child achieve his or her highest potential. In their

article on closing achievement gaps, Ceci and Papierno (2005) conclude: "The goal of an enlightened nation's policies should be to remove impediments rather than reduce the spread of individual differences" (p. 159). Thus, the goal of reducing achievement gaps between boys and girls will not be achieved with any intervention that benefits both boys and girls and may be the wrong goal for educational institutions.

## PUBLIC POLICIES BASED ON GROUP DIFFERENCES

### WHY ARE POLICIES BASED ON GROUP AVERAGES UNFAIR TO INDIVIDUALS?

School is preparation for adult life. How can boys and girls learn how to interact as equals in the workplace if they have no experience interacting as equals in school? Can we expect a male, for example, to work comfortably with a female supervisor if he has never interacted with females as intellectual equals? Children need to learn how to respect and get along with a wide variety of other people, which includes the other half of the human race. Too many valuable lessons in working together and learning from each other are missed when education is segregated by sex.

### GIRLS AND BOYS ARE SIMILAR AND DIFFERENT

One argument for single-sex classes is that boys and girls learn differently, which is the mantra and title of a book by Gurian (2001). The question about sex differences in learning is not whether boys and girls are the same or different. Girls and boys are both the same *and* different. On average, girls score higher than boys on standardized tests of reading and boys score higher than girls on standardized tests of mathematics, but these data depend on socioeconomic status and a host of demographic variables. Boys from low income families and racial and ethnic minority groups do not show the same pattern of results as children from middle and upper class families. Despite the general advantage for boys on standardized tests of mathematics, low income African-American boys score below low income African American girls. African American boys from low income families are no less "male" than boys of other races, which shows that the education crisis is not caused by male-female differences, but by income and racial disparities that combine with sex—both biological sex and sex role expectations. It is an oversimplification to expect that classrooms segregated by sex will help low income children of either sex to succeed.

### NO ONE IS AVERAGE

By designing education that is differentiated for boys and girls, educators are implicitly endorsing the idea that there is little diversity among girls or among boys. The notion that girls learn one way and boys another way ignores the massive ways in which girls differ from each other and boys differ from each other. In fact, there is considerable diversity within each sex. For example, most males from middle to upper class homes are currently succeeding at high rates in their coeducational classrooms, yet the goal of closing achievement gaps between girls and boys is often given as a reason for single-sex education.

Although there are more females than males enrolled in colleges, a fact that has been true in the United States since 1982, 8 of the top 10 universities have higher male enrollments. In addition, there are many more males than females in top tails of standardized tests of math and science, with girls maintaining the lead in reading. Approximately 25% of the jobs in science, math, and engineering are filled by females, whose workforce participation is now close to 50% and women head only 2% of the Fortune 500 companies (Halpern & Cheung, 2008). None of these differences suggests that girls learn differently from boys or that single-sex classrooms are needed for each sex. These data on female and male achievement are group averages, and *no child is average*. By treating all children based on some notion of an average child will harm boys and girls who are not average, especially the vast majority who are succeeding under coeducation. With sex-differentiated classes, boys who love to read quietly and girls who love to move about are sentenced to an education that poorly fits their inclinations and abilities.

Consider an alternative model of education that is based on each student's learning profile. Several studies have documented that females score substantially lower than males on visual-spatial tests of mental rotation (Halpern & Collaer, 2005). These tests require the individual to maintain an image in working memory while imaging what it would look like if it were rotated in space. (There are other visual-spatial tests that show little or no sex differences.) In one study, researchers (Sorby & Baartmans, 2000) designed and implemented a course to improve the spatial visualization skills of first-year engineering students. In this course, students learned effective strategies for mentally representing objects, and for using graphs, diagrams, charts, and maps as tools for thinking about topics in science and mathematics. Notably, retention for female engineering students who took the spatial visualization course was 77 percent, whereas among those who did not take the course it was only 47 percent. Although both females and males participated in the spatial training course, more females were identified at the start of the program as scoring low on tests of spatial visualization, and females showed greater gains in retention in the engineering program as well as in grades. The spatial visualization training was provided for all students with low initial scores, however, which included both males and females. In this example, the educators did not treat males and females as two distinct groups that needed separate education. Everyone who would benefit from the specialized training was provided with the training and everyone who did not need it did not have to take the training. Similar educational programs that do not treat individuals as though they were the group average will provide the best way of enhancing the achievement of all students. There are boys who love poetry and girls who love mathematics, but by grouping children around some hypothetical average girl or boy, we are doing a serious disservice to children who do not fit into stereotypical roles.

#### THE FLAWED LOGIC OF SINGLE-SEX EDUCATION

The underlying premise for single-sex education is that males and females are so fundamentally different that they need qualitatively different learning experiences. There is no (quality) evidence based on multiple studies by independent reviewers that shows that girls learn better than boys do in cooperative groups or boys excel when they are placed in



competitive situations, or any of the other hypothesized ways that show differences in how girls and boys learn. But even if these stereotyped beliefs were true (on average), they would not support the need for single-sex education. In preparing students for their adult lives, everyone needs to know how to work cooperatively in groups, how to lead, and how to compete. If girls were “innately” wired for group work, it could logically be argued that they need to learn competitive strategies with the reverse for boys. There is no logical justification to teaching to groups of children according to the perceived strengths of their group. A reverse argument would be just as logical, which is always an indicator of flawed reasoning.

It is unclear as to whether the goal of single-sex education is "separate, but equal" or "separate and different." If the theoretical rationale for single-sex education is that boys and girls need different learning experiences, then the lesson plans and learning activities must be different for each sex. For example, some schools implementing single sex education assign different books for girls and boys to read. If the learning activities are different, then they cannot be getting the same education; if they are the same, then why are they being segregated? Using a wide variety of reading assignments for girls and boys is the best way to get children to read and to expand their reading to include a variety of topics. Some girls love sports and some boys love poetry and more children will develop interests in different topics when they learn about them, which is why everyone needs to read widely.

Some proponents of single sex education believe that "boys, generally, are capable of abstract thought," while girls in most cases needed hands-on demonstrative props to understand the same mathematical concepts. This statement has no scientific basis and there is no rationale for believing that both groups would have similar learning outcomes from different curricula or different learning experiences designed to teach content area materials. Thus, the general argument that separate is inherently unequal in education is not relevant in the design of single-sex education because it is not intended to be equal. If the same learning experiences were duplicated in each single-sex classroom then there is no basis for segregation by sex, and if different curricula and learning experiences are employed, then they are not equal. Single-sex classrooms cannot be both the same and different, so it is not reasonable to expect that girls and boys would have similar learning outcomes.

## OVERVIEW OF SEX DIFFERENCES IN BRAIN DEVELOPMENT

### WHY CAN'T WE USE BRAIN IMAGING DATA TO CONCLUDE THAT BOYS AND GIRLS LEARN DIFFERENTLY?

Beginning in the early 1980s many different safe methods for providing images of the structure of intact brains and their function became available. These studies showed that although all human brains are essentially similar, there are some systematic differences between the brains of females and males. Key structure that show differences include the

overall size of the brain, the size and shape of a key structure that coordinates communication between the two halves of the brain, and areas that are involved in emotion (See Halpern et al., 2007, for a review). As with all areas of sex differences and similarities, we could focus on the overall similarities or on the average differences between the sexes.

In a paper entitled, "Mind the Gap," Halpern (2000) cautioned about making the leap from brain differences that are revealed with new imaging techniques to behaviors, especially complex behaviors that are needed to achieve in school. Similarly, the data on sex differences in perception have been misused to make statements like girls and boys need different lighting in their classrooms or that we need to talk to girls in a softer voice than we should use with boys. These statements show a misunderstanding of the perception literature. Perception thresholds are measures of the smallest amount of stimulation (e.g. intensity of a sound) that is needed for someone to just be able to perceive the stimulations. Girls are often able to perceive stimuli (a light or a sound) at with lower levels of stimulation than boys. Differences in absolute thresholds (minimum amount of stimulation needed for detection) do not mean that boys and girls live in perceptually different worlds. If a constant level of sound is used in normal conversations both sexes will recognize that it is a normal talking voice, and it will NOT sound like shouting to girls or whispering to boys (which is what some advocates for single-sex education claim--see the National Association for Single Sex Public Education web site for a misunderstanding of these data, <http://www.singlesexschools.org/research-learning.htm>).

#### THE GAP BETWEEN BRAIN RESEARCH AND EDUCATIONAL PRACTICES

None of the data regarding brain structure or function or sex differences in perceptual thresholds suggests that girls and boys learn differently or that either sex would benefit from single-sex schools. Six independent experts with very different perspectives on the topic of "The Science of Sex Differences in Science and Mathematics" were selected by the Association for Psychological Science (APS) to create a document for the use of *Psychological Science in the Public Interest*. The author of this report chaired the "consensus statement" from these independent experts (Halpern, Benbow, Geary, Gur, Shibley-Hyde, & Gernsbacher, 2007): "None of the data regarding brain structure or function suggests that girls and boys learn differently or that either sex would benefit from single-sex schools"; yet that is exactly the claim that is driving a rapid increase in single-sex schools. Those who support single-sex schools have argued that new information about brain differences for girls and boys should change how we think about single-sex education and that each sex should be taught in a way that is compatible with their brain. There are no empirically-validated ways of teaching to female and male brains.

In the independent analysis written for Education Sector, their senior policy analyst highlights the misapplication of brain research to education. She quotes first from a passage on girl and boys brains written by Gurian and Stevens (2004): "Girls have, in general, strong neural connections in their temporal lobes than boys have. These connectors lead to more sensually detailed memory storage, better listening skills, and better discrimination among the various tones of voice. This leads, among other things, to greater use of detail in writing

assignments." In response to these statements, Mead (2006) notes that "This paragraph offers a classic example of how some practitioners misapply brain research to education and gender. . . The real problem here is that Gurian and Stevens attempt to string together a series of cause and effect relationships for which no evidence exists. Yes, there is some evidence of greater interconnection between different parts of women's brains. . . And some teachers may say that boys do not use detail in writing assignments. But there is no evidence causally linking anyone of these things to another. Gurian and Stevens simply pick two factoids and claim they must be related. They also ignore many other potential explanations for the behavior they describe."

### MORE THAN NATURE VERSUS NURTURE

It is common to think about sex differences in cognition in terms of a dichotomy and ask if they are they due to factors inherent in the biology of maleness or femaleness or are they due to differential sex-related experiences and expectations. The questions being posed here are familiar to most psychologists and educators—they are variations on the age-old question of nature and nurture. The argument for single-sex schools is based on the nature explanation.

For many psychologists and others concerned with questions about sex differences and similarities, explanations can usually be identified as falling somewhere along a continuum anchored at one end by "nature" or biologically-oriented causes or "nurture" or environmentally-oriented causes, with few contemporary psychologists or educators expecting that any complex human behavior would be entirely explainable by either nature or nurture. It is common to ask about the proportion of the variance in our data that can be accounted for by biological and environmental/social variables and their interaction. Inherent in this question is the idea that biology and environment/social variables can be separated into "independent variables," and their interaction can be separated from the main effects. An implicit assumption when questions about the percentage of explained variance are asked is that there is a single number attributable to each of these sources of variance that exists in the population, and if researchers are clever in their experimental designs and analyses, they can discover the "true" population parameters. Questions about the proportion of variance explained by environmental and biological variables and their interaction are based on faulty premises about the separability of biological and environmental/social variables. The psychobiosocial model offers a better alternative to the nature-nurture dichotomy or nature-nurture continuum.

### THE PSYCHOBIOSOCIAL MODEL IN WHICH CAUSE AND EFFECT ARE CIRCULAR

The psychobiosocial model is based on the premise that even simple distinctions like dividing variables into biological and psychosocial (i.e., environmental) categories are impossible. Consider for example, the fact that there are differences and similarities in female and male brains (e.g., Cahill, 2005; Gur et al., 1999). The differences and similarities in brain structures could have been caused, enhanced, or decreased by environmental stimuli, so data showing that the brain is sexually-dimorphic are reflective of both nature and nurture. It is now well documented that brain size and structures remain plastic

throughout life, which means that they change as a result of experience (Stefan, Kunesch, Cohen, Benecke, & Classen, 2000). Contemporary researchers have used brain-imaging techniques to show changes in cortical representations that occurred after specific experiences (e.g., Draganski, Gaser, Busch, Schulerer, Bigdahn, & May, 2004). What individuals learn influences neural structures like dendritic branching and cell size; brain architectures in turn, support certain skills and abilities, which may lead us to select additional experiences. The interface between experience and biology is seamless. Biology and environment are as inseparable as conjoined twins who share a common heart. A psychobiosocial framework provides a more integrated way of thinking about the inextricable processes that influence brain structures and behaviors.

The psychobiosocial model consists of multiple, sequentially interacting variables that cause and effect changes in hormone levels, brain structures and organization, the environments we select, and those that are correlated with our genetic predispositions. It recognizes the way psychological, biological, and social variables operate reciprocally on each other. The nature-nurture dichotomy is, and always has been, false. The psychobiosocial model replaces a continuum anchored at its ends by nature and nurture with a continuous feedback loop. Learning is both a biological and environmental phenomenon. Each individual is predisposed by his or her biology to learn some skills more readily than others and everyone selects experiences in ways that are biased by prior learning histories and beliefs about appropriate behaviors for females and males. Similarly, many stereotypes about male and female differences reflect real group differences and by learning and endorsing them, individuals may also be selecting environments that increase or decrease these differences. A schematic diagram of the psychobiosocial model is depicted in Figure 1.

There are many studies that show that the brain changes in response to experience. In a study of London taxi cab drivers, the size of the hippocampus, a critical brain structure involved in visual-spatial tasks, was correlated with the number of years they spent driving cabs (Maguire, Frackowiak, & Frith, 1997). Drivers with the longest driving records had the largest hippocampi (plural of hippocampus). The evidence suggests that driving experience caused changes in the size of the hippocampi. (Other data support this conclusion. This study is being used as one example of the way in which experiences alter the brain.) With sex-differentiated education, we are providing girls and boys with different educational experiences, which in turn will be reflected in their brains. Thus, the single-sex classroom movement is both basing its rationale on the fact that there are some sex differences in the brain and enhancing these differences by providing different educational experiences.

## A Psychobiosocial Model to Understand Cognitive Sex Differences

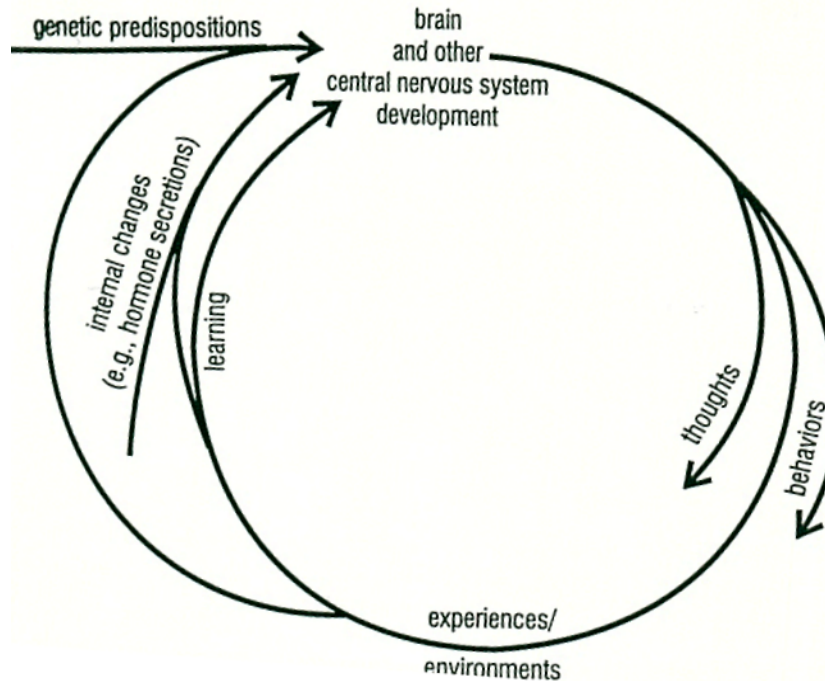


Figure 1. A psychobiosocial model as a framework for understanding cognitive sex differences. It replaces the older idea of nature versus nurture with a circle that shows the way biological and psychosocial variables exert mutual influences on each other.

### DATA DO NOT SUPPORT THE IDEA THAT GIRLS AND BOYS LEARN DIFFERENTLY

One of the recommendations for creating single-sex classrooms is to use cooperative strategies with girls and competitive strategies with boys. A review of the literature shows no convincing evidence that cooperative learning strategies work better for girls versus boys, high versus low achievers, and majority versus minority students. On the other hand, there is some evidence that specific peer-assisted learning strategies (dyadic groups, peer tutoring) work better for low socioeconomic status (SES), minority students (Rohrbeck, Ginsberg-Block, Fantuzzo, & Miller, 2003; Slavin, Hurley, & Chamberlain, 2003). I would not use these data to advocate for separate schools for low SES minority students, but I would

advocate for a variety of learning experiences, including dyadic groups and peer tutoring for all students.

We have amassed considerable knowledge about the biological basis of learning, which involves relatively permanent changes in the brain that result from exposure to environmental events. To understand learning in the brain, researchers have investigated a phenomenon known as *long-term potentiation*. The word *potentiate* means to strengthen, to make something more potent. Long-term potentiation (LTP) is the strengthening of the neural connection so that groups of neurons are more easily activated. Neural connections are strengthened when neurons fire together. Scientists have also identified the neurotransmitters involved in different types of learning. A more complete review is beyond the scope of this report; however, none of these processes differ for males and females. The underlying biology of learning is essentially the same. For an introduction to the biology of learning, see Gazzaniga, Heatherton, & Halpern, 2010.

## THE CRISIS IN EDUCATION

### IS THERE A BOY OR GIRL CRISIS, AND IF SO, WILL SINGLE-SEX EDUCATION FIX IT?

There is a contemporary and acrimonious debate over who the winners and losers are in the war of the sexes. This is an unfortunate and unproductive debate because there are cognitive areas in which girls, on average, excel, and cognitive areas in which, boys, on average, excel.

#### THE CRISIS IS REAL—FOR LOW INCOME CHILDREN FROM RACIAL, ETHNIC, AND LANGUAGE MINORITIES, AND YES, ESPECIALLY, BUT NOT EXCLUSIVELY, FOR LOW INCOME BOYS

The crisis in education is not a boy or girl crisis. It is a crisis for low income children, but more often boys, from low income families and racial, ethnic, and language minority groups. There is no crisis for boys from middle class and wealthy homes. They are achieving at higher rates than ever before—entering college in greater numbers and achieving far better than girls from similar economic backgrounds at the highest levels of standardized tests. The four-year high school graduation rates for Asian boys and girls are 70% and 73%. The same data for White boys and girls are 74% and 79%. But the real gap is not the few percentage points for boys and girls, but it is gap for Hispanic (49% for boys and 58% for girls) and Black students (48% for boys and 59% for girls; Green & Winters, 2006). Sex differences in learning styles cannot be used to explain the large differences among boys and girls from different racial and ethnic groups, which swamp differences between the sexes.

Girls, on average, get higher grades in school in most classes at all grade levels and also do slightly better on international assessments in algebra, which may be more

language-like in its structure. But boys shine on the math portion of the SAT, a difference of about 35 points that has been maintained for over 35 years. However, when all the data on quantitative ability are assessed together, the differences between the average quantitative ability of girls and boys are actually quite small. What sets boys apart is that there are many more mathematically “gifted” boys than girls. What these achievement data do not show is the high drop out rate from high school for low income boys from racial and ethnic minority groups. The real crisis in education is the loss of these boys—not all boys because most are doing very well—but racial and ethnic minority boys from low income homes. Despite the higher college graduation rates for women, they still earn approximately 70% of what men earn and few have broken through the glass ceiling to the highest levels of achievement in business or politics. A recent analysis estimates that approximately 20% of the earning gap between women and men cannot be accounted for by occupation, hours worked, and other relevant variables (Government Accounting Office, 2003). There are many reasons for these disparities, including the fact that most child care and other care-giving is done by women. Single-sex classes will not affect these differences.

#### COEDUCATION DID NOT CAUSE THE CRISIS AND SINGLE-SEX EDUCATION WILL NOT FIX IT

Sex differences in academic achievement and career choices are complicated, but the fact that there are some tests and some areas of mathematics and science in which females tend to excel, and some in which males tend to excel, and these data vary by family income levels, racial, and ethnic groups, make it difficult for any single theory such as boys and girls learn differently to explain or to fix.

Both girls and boys are attending college in record high numbers, which represent increased academic and career success for both sexes over decades when the number of single-sex schools has declined. These data do not support the reasoning that these differences reflect basic differences in how males and females learn. The relative success of girls in academic settings has been labeled a “Boy Crisis” in the popular media (e.g., Newsweek, 2006, January 30). Thus, one reason for proposing single-sex schools is to stem the loss of boys from higher education. But the fact that boys score higher than girls on standardized tests in math and science from the end of secondary school and through graduate school, shows that it is not true that boys are failing to learn in co-educational schools—each sex is showing superior performance on different types of measures of learning, with only one segment of the population failing at crisis proportions.

The crisis in education is not a boy or girl crisis—it is a crisis for all children, but more often boys, from low income families and racial and ethnic minority groups. Middle class and above boys and girls are doing just fine. The question of whether grades in school or scores on standardized tests are better or more valid measures is a matter of considerable dispute. Some critics have argued that the grade-test disparity shows that schools are biased against boys; while others have argued that standardized tests are biased against girls. The data show different patterns of achievement on different types of

assessments, so it could also be argued that given an appropriate assessment, both sexes show evidence of learning.

## IMPLICIT AND EXPLICIT STEREOTYPING

### WILL SINGLE-SEX EDUCATION INCREASE SEX ROLE STEREOTYPING?

#### STEREOTYPES AND OTHER GROUP-BASED BELIEFS

The Proposed Rules, Department of Education, 34 CFR Part 106, nondiscrimination on the basis of sex in education programs or activities receiving federal Financial Assistance (May 8, 2002), states: “In developing a regulatory proposal, we will ensure that educational opportunities are not limited to students based on sex and that single-sex classes are not based on single-role stereotypes” (p. 3). Yet, the planning of lessons based on supposed differences between girls and boys does exactly that. There is no evidence (NONE!) that girls learn better if they decorate their papers with pastel colors, or boys learn better when they shout out the answers in a competitive manner, which are recommended educational practices among those who teach the teachers for single-sex classrooms. This sort of distinction which is described in lesson plans designed for boys and girls are based on sex-role stereotypes.

Studies of single-sex classrooms show that teachers unintentionally reinforce sex role stereotypes, although it could also be argued that the reinforcement of sex role stereotypes is intentional when classroom enrollments are based on whether the child is a girl or boy. For example, a study of students at a Catholic University compared women and men from single-sex and coeducational high schools (Karpiak, Buchanan, Hosey, & Smith, 2007). They found that young men from single-sex high schools (multiple schools were used in the analysis which had a large sample) had less egalitarian attitudes than men who attended coeducational high schools. The authors concluded that “It appears that something about the single-sex setting—perhaps direct sexism, exacerbation of macho male cultures’ in schools corresponds with less egalitarian attitudes in males” (p. 287).

The review of the California experiment in which six different public school districts initiated single-sex academies (described earlier) agrees with this conclusion. As described in the opening section, the California Experiment in creating single-sex academies in six different districts is one of the best studies for examining unintended negative consequences because it was conducted in public schools across multiple districts. Despite considerable extra funding available for the single-sex classrooms, 5 of the 6 districts discontinued the academies within three years. Researchers found that constant comparisons “pitted boys and girls against one another and reinforced gender stereotypes” (Datnow, Hubbard, & Woody, 2001, p. 43). **The authors concluded that girls received unwanted harassing comments and were touched when they came together in**



**coeducational spaces. The single-sex public school experiment in California showed that sex role stereotypes were enhanced when contact between boys and girls was reduced.**

In one academy, we found in one class that the girls' teacher permitted them to sit on their desks and to move around to make sure they were more comfortable and able to pay attention. This scene was in sharp contrast to the boys' class where their teacher constantly reprimanded them and insisted that there be no talking and no movement. The girls responded by being thoroughly engaged in the interview, the boys responded by being extremely rowdy and inattentive, yelling rude comments to each other and making every attempt to get out of their seats (p. 44).

Similar results from the recent review of the 11-year Soviet experiment with single-sex education were cited earlier (Ewing, 2006). Thompson and Ungerleider (2004) reached a similar conclusion in their review prepared for The Canadian Centre for Knowledge Utilization. **They found that boys suggested that in boys-only classes there were more fights, more noise, and more cheating. Some boys reported increased feelings of intimidation and bullying in all-boy classes.** These are not conditions that will enhance the academic achievement of boys, regardless of how well-intended the advocates for single-sex education are.

We now know that sex-role (and other types) of stereotyping can have negative effects on academic performance. The following conclusion is taken from a U. S. Department of Education taskforce of independent experts (Halpern, Aronson, Reimer, Simpkins, Star, & Wentzel, 2007) who were selected by professional staff at the Department of Education to write a practice guide designed for "Encouraging Girls in Math and Science." (Report and related materials are available at [dww.gov.edu](http://dww.gov.edu).) The term "stereotype threat" refers to a psychologically threatening concern about confirming a negative stereotype, both in one's own eyes and in the eyes of others. For both self and others, the existence of the stereotype fosters negative beliefs about the meaning of difficulty or low performance—namely, that one lacks ability. Stereotype threat operates when (a) the task is important to test-taker; (b) the test taker belongs to group about which there are negative stereotypes relevant to test, such as girls perform less well in math; and (c) when the test-taker's membership in that group is made salient, such as asking about one's sex at the start of the test. One way of making one's sex salient is by grouping children by sex--this sends the clear message that girls and boys are different, and with that message that each is less good at some tasks. Thus, when a girl's sex is made salient, perhaps by telling her that she is about to take a difficult math test on which boys usually perform better, she is likely to perform worse than an equally smart boy because of the anxiety, deficits in short term memory, and negative thoughts that have been shown to accompany stereotype threat. Studies also show that stereotype threat can lead young adolescent girls and women to choose unchallenging problems to solve, lower their performance expectations, and devalue mathematics as a career choice. Thus, negative stereotypes can impair engagement and confident performance of girls and women in science, technology, engineering, and mathematics.

Similarly if boys are told that girls usually do better on a test of reading, the negative stereotype that boys are less able in these areas will depress their performance. By segregating classes by sex, the fact that each child is a boy or girl becomes salient in multiple ways—from the type of behavior that is permitted in class to the way learning activities are designed, and even if some of the recommendations of single-sex schooling advocates are taken seriously, to the lighting used in the room and how loud a teacher should talk when addressing boys or girls. According to the massive stereotype threat literature, by making each child's sex more salient, we will ultimately increase sex differences in sex-typed academic domains.

Steele and Aronson (1995) argued that when aware of widespread stereotypes that impugn a group's intelligence (e.g., "black people are stupid," "Girls can't do math," etc.) test-takers frequently experience the threat of devaluation—by the self, by others, or by both at the same time. The resulting arousal and anxiety can impair executive functioning on complex tasks such as standardized aptitude tests. Since the publication of Steele and Aronson's 1995 article, some 300 replications of the effect have been published, extending the findings to women and mathematics abilities, Latinos and verbal abilities, elderly individuals and short term memory abilities, low income-students and verbal abilities, and a number of non-academic domains as well. (See Steele, Spencer, and Aronson, 2002 and Aronson and McGlone, 2009 for reviews of the literature.)

#### THE HARM OF CREATING GOVERNMENT-SUPPORTED SINGLE-SEX EDUCATION

The 1954 historic racial discrimination case *Brown v. Board of Education*, was a fascinating interplay of psychology, law, and social reform. Thirty-two eminent social psychologists drafted a Social Science Statement for the Supreme Court. These psychologists used the best available data to document their finding that there are no racial differences in the ability of school children to learn and that segregation is harmful to African-American and White children. The basic premise for racially-segregated schools was the races learn differently and that an "equal education" would be possible with segregated education. Of course, there were differences in the average level of achievement of African-American and White school children, but the social scientists who signed that historic statement argued that these differences do not mean that the races learn differently. The proponents of single-sex education deny the obvious parallels between racial segregation and single-sex education, yet the both rely on the basic premise that education needs to be segregated based on a biological characteristic that is not directly related to education.

In a historical account of that fateful decision, we learn that Kenneth B. Clark, past-president of the American Psychological Association, and other psychologists noted the *particular harm of legally-sanctioned segregation*. The decision of the court in *Brown V. Board of Education* states, "The impact is greater when it has the sanction of the law" (Wrightsmen, 2008, p. 34) There are still private schools that offer the option of single-race or single-religion education. There are even private schools that do not permit interracial dating. But Clark argued that when these segregated choices are supported with tax payer

dollars, the harm is greater than if segregated choices are limited to those who are willing to pay for the right to have their children attend school with same-race classmates. It is interesting to note that one argument in favor of single-sex schools is “Social Justice”—a strange use of the term. The argument is that children from low income families should have the same educational choices as those from high income families, and since high income families can choose single-sex private schools we should allow the same choices in public education. Would the same argument apply to single-race or single-religion private schools, which is available for private education? Should public education provide the same options? Such a choice would be a great step backward for education in the United States and a repudiation of the historic Brown versus Board of Education decision. There are many parallel arguments for racial segregation and segregation by sex, even though advocates for single-sex education are quick to disavow them.

## RECOMMENDATIONS

### HOW CAN WE REDESIGN THE EDUCATIONAL SYSTEM SO THAT ALL CHILDREN DEVELOP THEIR FULL POTENTIAL?

As concerned citizens, our goal (as I see it) is to understand how people learn, which includes studying group and individual differences in learning and cognition, so that we can find ways to enhance teaching and learning. The purpose of educational research is to help all learners achieve at the highest possible level while honoring individual talents, interests, and abilities. Recommendations need to be based on research findings and public policies need to be informed by social science research. The research does not support the claims of any benefit of single-sex education and suggest many problems that would be exacerbated by the proposed changes.

#### A FUTURE ORIENTED PLAN FOR EDUCATION

In thinking about educational reform, we need to ask the question, “Education for what purpose?” There are many critical questions that we need to address to achieve educational equity and to prepare a workforce and citizenry that can compete and cooperate in the new global economy and increasingly flatter world. Our students need more diversity in their everyday lives and learning environments, including learning with and from girls and boys. How else can we prepare them to work together?

Our students are entering a world with global problems that include pollution, poverty, racism, and terrorism, just to name a few. We need to improve high school graduation rates, literacy levels, and critical thinking skills for those students who are slipping through chasms in our educational system. There are many critical challenges that our schools must face and no evidence that single-sex education will fix what is broken.

There is a substantial body of knowledge on the science of learning. Increased use of empirically-tested pedagogies and an emphasis on how to think about controversial topics

(such as the case for and against single-sex education) will provide the best education for the citizens of the 21<sup>st</sup> century. We know what works to help all students learn better—they need to practice remembering information, they need to be able to explain what they are studying, they need to use visual-spatial and verbal modes of learning, they need to know how to learn with new technologies, and they need to learn how to cooperate and how to compete. A more complete list of the principles of learning can be found at the Life Long Learning at Work and at Home Website (<http://psyc.memphis.edu/learning/whatweknow/index.shtml>). These principles are the same for every human. We can all learn better if we use these empirically-validated principles in our own teaching and learning.

The most important question for most of us as we ponder the similarities and differences between girls and boys is not about average differences between the sexes. Keep in mind the words of Samuel Johnson, an 18th century British writer who was once asked who is smarter, men or women. He replied, “Which man, which woman?”

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