During the next hour, while you are reading this chapter, 250 Americans will die, and the chances are one in a million that you’ll be one of them. Don’t stop reading, however, since that won’t reduce the probability. In fact, putting your book down might even increase the probability, especially if you decide to leave your room and go outside to engage in some high-risk activity.

According to the TV special Against All Odds, if you go rock climbing, the probability of you getting killed is 200 in a million; or parachuting, 250 in a million; or hang gliding, 1140 in a million. So, sit safely still and read on, and while doing that let’s look at some more of life’s probabilities: the probability of having your car stolen this year, 1 out of 120; of a pregnant woman having twins, 1 out of 90 (or triplets, 1 out of 8000); of a young adult (18–22) being paroled from prison and then being rearrested for a serious crime, 7 out of 10; and of any single American baby becoming a genius (IQ of 135 or higher), less than 1 out of 100. Incidentally, by the time you finish reading Chapter 6, you’ll be able to calculate that genius probability value—even if you’re not a genius yourself.

As you probably know, most accidents occur at home, since typical Americans spend most of their time there. And 25% of all home accidents occur in the bathroom—falling in the tub, getting cut while shaving, and so forth. Don’t assume, however, that you’ll be safe if you decide to shave in the kitchen instead. Also, we can predict with a high degree of accuracy that during the next year, 9000 pedestrians will be killed by a moving car. But this statistic does not tell us which 9000. Understanding probability situations is an important aspect of life, so maybe there are some good reasons for getting involved in statistical thinking.

Rather than continuing to list reasons why you should take a first course in statistics, let’s assume that it is probably a required course and that you have to take it anyway. Perhaps you have put it off for quite a while, until there is no choice left but to “bite the bullet” and get it over with. This is not to say that all of you have been dragged, kicking and screaming, into this course; however, as statisticians would put it, the probability is high that this hypothesis is true for some of you.
STUMBLING BLOCKS TO STATISTICS

Let us look at some of the most common objections raised by students when confronted with this seemingly grim situation. Perhaps your feelings of intimidation arise because you know you have a math block. You’re still being buffeted by lingering anxieties from some math course taken in the perhaps distant past. Or maybe it’s that you have read or heard a research report and been totally confused by the seemingly endless and seemingly meaningless stream of jargon. Perhaps you’re a person who simply does not trust statistical analysis. If this is the case, you’re in good company. Benjamin Disraeli, Queen Victoria’s prime minister, once said, “There are three kinds of liars: liars, damned liars, and statisticians.” Disraeli obviously agreed with the sentiment expressed by many—that you can prove anything with statistics.

Before he died, Malcolm Forbes had been a hot-air balloon enthusiast, and one day the winds took his balloon in so many directions that he became completely lost. Spotting what appeared to be a farmer down below tilling his field, Forbes lowered the balloon and called out to the man, “Please tell me where I am.” The man called back, “You’re up in a balloon, you goddamned fool.” And Forbes answered, “You must be a statistician, since although your answer is complete, accurate, concise, and precise, it tells me absolutely nothing that I don’t already know.” And then there’s the story of the three statisticians who go hunting and after a while spot a solitary rabbit. The first statistician takes aim and overshoots. The second aims and undershoots. The third shouts out, “We must have got him.”

Mention the term standard deviation and watch the room clear. Your friends will run for cover and look for something fun to do, like holding one hand over a hot stove. Even casually mentioning something as seemingly innocuous as the arithmetic mean may generate total boredom.

Whatever their basis, your doubts about taking this course will probably prove unfounded. You may even, believe it or not, get to like it and voluntarily sign up for a more advanced course.

Math Block

First, although it is obvious that people do differ in math ability, a case of true math block is extremely rare and difficult to substantiate. It is true that some very fortunate people have a kind of perfect pitch for math. They take to math as gifted musicians take to harmony. (You remember the kid we all hated in high school, the one who completed calculus during his sophomore year and was angry because the school didn’t offer any more advanced math courses.) At the other end of the continuum, we find those people who are definitely math phobics. To them, merely drawing a number on the chalkboard evokes strangulating feelings of sheer panic. They avoid any course or situation (even keeping a checkbook) that deals with those spine-chilling little inscriptions called numbers. If you’re one of those who suffer from or border on this condition, relax—this is not a math course. While numbers are involved and certain
arithmetic procedures are required, thanks to the magic of electronics you won’t have to do the arithmetic yourself.

Go to your friendly neighborhood discount store, and, for less than two dollars (less than the price of a good slide rule), purchase a small electronic calculator. You don’t need a fancy calculator with several memories, but do insist on one with a square root key. Statisticians, as you will see, love to square numbers, add them, and then extract the square root. In fact, you really must get a calculator, for this text assumes that you own one. The back of this book is not cluttered with page after page of square and square root tables. It’s not only that such tables are a relatively expensive waste of space, but it is easier for you to push a button than it is to interpolate from a table. Your job is to focus on the logic of statistics. To rephrase the bus ad that says “leave the driving to us,” leave the arithmetic to the calculator. While we’re on the topic of arithmetic, a quick word of caution is in order. Do not scare yourself by thumbing through later chapters of the book. Until you have been provided with a contextual background, some of the procedures and equations found later on will seem absolutely harrowing to contemplate. When the time comes for you to confront and use these techniques, the mystery and fear will have long disappeared. With the background provided by the early chapters, the later chapters will, like a perfect bridge hand, play themselves. If you can follow step-by-step directions well enough to bake a cake or assemble a simple model airplane, you can do any of the procedures in this book, and, even more important, you can understand them. You may even come to have more appreciation for and less fear of quantitative thinking. Actually, instead of fearing numbers, students should learn to appreciate what Professor Posamentier has called the “beauty of mathematics and the charm of some numbers.” For example, the years 1991 and 2002 are palindromes, numbers that read the same both forward and backward. Experiencing two palindromic years in one lifetime won’t occur again for over a thousand years (Posamentier, 2002).

Persons who can’t read or understand words suffer from what we all call illiteracy, and persons who can’t read or understand numbers suffer from an equally disabling, although apparently less embarrassing, condition called innumeracy. As Professor Paulos wrote, “The same people who cringe when words such as imply and infer are confused react without a trace of embarrassment to even the most egregious of numerical solecisms” (Paulos, 1988, p. 3). Professor Paulos then recounts a story of someone at a party droning on about the difference between continually and continuously. Later that evening, a TV weathercaster announced that there was a 50% chance of rain for Saturday and also a 50% chance for Sunday, and then erroneously concluded that there was therefore a 100% chance of rain that weekend. “The remark went right by the self-styled grammarian, and even after I explained the mistake to him, he wasn’t nearly as indignant as he would have been had the weathercaster left a dangling participle.”

That’s like concluding that since there is a 50% chance of flipping a head with a fair coin on one toss and a 50% chance of flipping a head on a second toss, then there must be a 100% chance of flipping a head on at least one of the two tosses. Get out a coin, start flipping, and check it out.
Unlike other personal failings that tend to be kept offstage, innumeracy may even be flaunted: “I can’t even balance my checkbook.” “I’m a people person, not a numbers person.” Or, as we have seen, the proverbial “I have a math block.” Professor Paulos believes that one reason for this perverse pride in innumeracy is that its consequences are not perceived to be as damaging as those of other handicaps; but they really are. Not understanding what interest rates you’re paying, or what the total cost of a loan might be, or how to tip a waiter, or what the probabilities are in a certain bet you’ve just made, or what a newspaper headline or story is really saying may in the long run be more personally damaging than not knowing the difference between a gerund and the subjunctive mood.

**Statistical Jargon**

As to the objection concerning the jargon or technical language, again, relax—it’s not nearly as bad as it seems. Too often students are dismayed by the number of technical terms and the seemingly endless statistical lexicon, written in (oh no!) both Greek and English. Too often students are traumatized by the rigors of statistical analysis and its vast and mysterious body of symbols. Social scientists especially seem to make a fetish of the intricacies of significance tests and measurement theory. They seem to spend countless hours debating and fretting over statistical details that often seem trivial to the casual observer. There is also the psychology instructor who gives exam grades back in the form of standard scores. “Never mind about the standard error, or the amount of variance accounted for—did I pass?” is the oft-heard plea of many a student.

Is the researcher’s use of statistical terms simply a case of sound and fury, signifying nothing? Obviously, it is not. The jargon of the trade represents an attempt to be precise in the communication of meaning. This effort is especially important in the social sciences because the concepts being considered are not always as precise as they are in the physical sciences like physics and chemistry. In short, there are some terms and symbols that must be learned. However, you can also get some help. At the end of this book, important terms, concepts, and equations are set down and defined. Faithful use of these glossary items definitely increases the retention of learned material. There will also be a page showing all the statistical and math symbols used in the book.

**Statistical Sleight of Hand**

Finally, the objection that the field of statistics resembles a sleight-of-hand show (now you see it, now you don’t) is valid only when the research consumer is totally naïve. The conclusions that “Figures don’t lie, but liars can figure” and that one can prove anything with statistics are true only when the audience doesn’t know the rules of the game. To the uninitiated, liars can indeed figure plausibly. But an audience with even a patina of statistical sophistication will not be easily misled by such artful dodgers. Unscrupulous persons will probably always employ faulty statistical interpretations.
to gain their ends. By the time you finish this course, however, they will not be able to lie to you.

Frankly, some statistical studies, especially correlation studies, have been grossly misinterpreted by certain researchers. This does not mean that all statisticians are charlatans. If statistics, as a result of some trickery and deceit, has a bad name, it is a result of the misuse and not the use of statistics.

The misuse and bad name of statistics have spawned many allegedly comical definitions within the field of statistics. For example:

1. Logic is a systematic method for getting to the wrong conclusion with 100% confidence. Statistics is a systematic method for getting the wrong conclusion with 95% confidence.
2. Statistics means never having to say you’re certain. It’s also the art of never having to say you’re wrong. Then again, any two statisticians are probably at variance.
3. A statistician is a person who draws a mathematically precise line from an unwarranted assumption to a foregone conclusion.
4. Statistician: Someone who doesn’t have the personality to be an accountant.
5. If there is a 50–50 chance that something can go wrong, then nine times out of ten it will.

There are admittedly some real booby traps lying in wait out there, but you’ll be guided safely along the right path, and each potential pitfall will be carefully pointed out. It should be stressed that most statisticians do use the correct statistical tests, and it is almost unheard of that the data have been faked. The traps usually result from the way the conclusions are drawn from the data. Sometimes the conclusions are simply not logically derived. Let’s consider a few examples.

An often-heard argument against capital punishment is that it simply does not have a deterrent effect. To support this, it is stated that years ago in England when convicted pickpockets were publicly hanged, other pickpockets worked the crowd that was there to witness the hanging. Can you see any problems with the logic of this example? The fallacy is that there is no comparison (or, as it will later be called, control) group. What about the number of pockets picked in crowds at a horse race or a carnival? If the frequency of pocket picking was lower at the public hangings, then perhaps capital punishment did have a deterrent effect.

Or statistics show that, say, 50% of a certain country’s population are so illiterate they can’t read the morning newspaper. Watch it! Perhaps 25% are under age six, perhaps another 10% are blind, and so on.

Be especially careful when listening to infomercials that boast of various medical miracles, especially diet pills, when they tell you that their results come from “clinically supervised anecdotal studies.”

A long-running commercial tells us that “No other aspirin prevents more heart attacks than Bayer.” What does this actually tell us about the heart-protecting properties of Bayer aspirin? It doesn’t really tell us much about those properties. It could actually be saying that Bayer doesn’t prevent heart attacks, nor does any other aspirin. It is like saying that no other chocolate bar prevents more heart attacks than Hershey.
There is a dentistry study showing that sports drinks, such as Gatorade, do more harm to teeth than carbonated drinks, such as Coca-Cola (Frauhofer & Rogers, 2005). The researchers immersed extracted, cavity-free teeth in a variety of popular beverages for a period of 14 consecutive days (the healthy teeth having been extracted for orthodontic or periodontal reasons, not just for the sake of the experiment). They found that the most damage to tooth enamel occurred in sports drinks and the least, by a wide margin, in Coca-Cola. What other factors might you consider before you throw away your Gatorade and stock up on Coke?

1. Nobody holds a drink in his or her mouth for 14 days straight.
2. The extracted teeth in this experiment were, of course, composed of dead tissue and as such were not being replenished by any bodily functions.
3. The living tooth is buffered by saliva (which contains fluoride and calcium), a protection not in place for teeth that have been extracted.
4. The teeth in this study were not brushed or rinsed for 14 days, an unlikely scenario among the living.

A study by Phillips et al. (2004) found that deaths from heart attacks occur at a significantly higher rate (12%) on two major holidays, Christmas Day and New Year’s Day, than at any other time of the year. One explanation may be that the stress of last-minute shopping, arguments among family members, and traveling during the busy holidays make people more prone to tension and thus cardiac problems. What other explanations might you suggest?

Perhaps, as the authors suggest, there are several other explanations, such as depleted staffing at hospitals, as more employees take vacation time, making medical care less effective, or the fact that persons may delay getting medical advice and treatment until the holidays are over. Also, there may be financial strains of buying gifts, as well as the possibility that each of those holidays can result in considerable overeating.

A study reported in the June 2004 issue of the journal *Pediatrics* shows that the rate of both fatal and nonfatal gun injuries to children age 14 and younger declined by more than 50% during the decade of the 1990s (Pediatrics, June 2004). The National Rifle Association (NRA) has concluded that this good news is a result of its efforts to teach children about the danger of playing with guns. The NRA program, called the Eddie Eagle Gun Safe Program, has been presented to over 15 million children over the past 20 years and continues to teach injury prevention to almost a million children each year (Brody, 2004). Comment on the cause-and-effect implication and discuss what other factors may have contributed to this decline.

**The Working Poor.** *Business Week* magazine ran a misleading cover story containing this sentence: “One in four workers earn $18,500 or LESS, and have few if any benefits” (Conlin & Bernstien, 2004). If 25% of the workforce earns so little, it is indeed bleak news. However, let’s review the details, and in fairness, for the careful reader the details are in the article. It turns out that most of that group is composed of part-time workers and teenagers. After sorting it all out, only 10% of the full-time workers were in that lowly wage category. Too many? Yes, but not 25%.
**Small Classes.** A recurring theme in education is that reducing class sizes is always the best route to increased learning (Winerip, 2004). However, the supply of really good teachers may not be infinite. Therefore, it may be that reducing class size might actually reduce the quality of the education, since a class of 30 students taught by an outstanding teacher may be much better off academically than two classes of 15 taught by less able teachers.

**Traffic Snarls and Heart Attacks.** According to one study, exposure to traffic tie-ups is linked to heart attacks (Peters et al., 2004). A total of 691 heart-attack victims were interviewed and it was found that sitting in traffic was consistently related to heart attacks. In fact, it was found that after partialling out anxiety and strenuous activity, the likelihood of a heart attack was three times greater for those persons who had been sitting in traffic for the hour before the attack. One suggestion was that the emotional stress of driving in snarled traffic was to blame for this linkage. What other factors might a researcher use to explain this finding? Perhaps pollution and poor air quality might be contributing factors.

Since the FBI’s Uniform Crime Reports show that over half of the murders in this country are committed each year by family members and/or acquaintances, should we all feel safer if we were surrounded by groups of strangers? No, since “murderers who know their victims” is a huge category and includes such groups as rival gang members who, of course, are acquainted with each other at some level. In big cities (where most murders take place), gangs shoot each other in turf wars, often over drugs, and in this context the term *family members* takes on a whole new meaning (Lott, 2000).

In one study, researchers compared the number of drivers’ citations issued by the police to the number of persons in the driving population for various demographic characteristics, such as gender (Farrell et al., 2004). They found among other things that males, especially young males, were being stopped, cited, and searched at a rate that was disproportionate to their total numbers. One interpretation of these data was that the police were “profiling” male drivers, or ambushing young males in general rather than any individualized suspicion of the driver’s behavior. Can you think of any other interpretations that might help explain this disparity?

Could it be that driving behavior itself may differ across age and gender groups? Driving patterns may not be the same for a young 21-year-old male and his 60-year-old grandmother. We know from other studies that young males are overrepresented when it comes to risk-taking behavior. In one government study of over 40,000 persons, it was found that males between the ages of 18 and 29 are three times as likely as women *not* to wear seat belts. The study also found lower seat-belt use among lower income groups with low levels of education (Chu, 2005). Also, the police use many exterior cues on automobiles before ordering a stop, such as broken tail lights and missing registration tags. Could it be that young males are also less careful about vehicle repairs than are members of other demographic groups?

In one study of 2300 men, all between the ages of 71 and 93, it was found that those who did light exercising, taking short walks on a regular basis, were much less likely to develop dementia (including Alzheimer’s disease and vascular dementia) than...
those who were sedentary (Abbott et al., 2004). What other variables might account for 
this relationship? Perhaps the men who walked were more apt to be engaged in 
several other activities, such as playing games, working crossword puzzles, or 
volunteering for various organizations. Or, perhaps those with some form of demen-
tia were not interested in walking or doing much of anything.

Be careful when reading some of the dire health-risk warnings in the news. It turns 
out that many are later found to be a function of the changes in the frequency of 
diagnostic testing rather than in any real change in the incidence of the disease itself. 
For example, the alleged melanoma (skin cancer) epidemic has been found to be far 
less dramatic than was first reported. One study found that there was actually no 
increase in the death rate for melanoma over the past 20 years, but during that same 
time period, biopsies had risen by a robust 250% (Welch, Woloshin, & Schwartz, 2005). 
Hence, it appears that the epidemic may be in the screening, not in the disease.

To discover if education could be established as a factor in predicting a healthy 
heart, health records of almost 7000 adults ages 25–74 were examined and grouped 
on the basis of whether the person had died of a heart attack or of something else. 
(Fiscella & Franks, 2004). The following factors were also measured: smoking, 
cholesterol levels, systolic blood pressure, and years of education. It was found that 
years of education, based on whether the person graduated from high school, was 
as important a predictor as smoking, cholesterol level, and blood pressure in 
whether a person had died of a heart attack. What other factors might help explain 
this result?

In one study it was found that married men earn significantly more money than 
do single men (Antonovics & Town, 2004). Using a data set that tracked all twins born 
between 1936 and 1955, the researchers selected a sample of 136 monozygotic (identi-
cal twin) males and compared the incomes of those who were married with those who 
had remained single. They found that the married twin was earning 26% more than 
his unmarried sibling. Can it be concluded that married men are paid more because 
they are married or might other factors contribute to the difference?

Despite the genetic similarity, it may be that the married twin is in some ways 
different from his sibling, a difference that attracted a woman and also made him more 
attractive and productive to an employer.

Even the study of literature has succumbed to the lure of quantification. Believing 
that literature can best be understood by an analysis of such variables as publication 
dates, numbers of books sold, ratio of male to female authors, and so on, Professor 
Franco Moretti of Stanford University was quoted as saying that “literature scholars 
could stop reading books and start counting, graphing and mapping them instead” 
(Eakin, 2004). It looks like statistical data are never ending.

And although baseball probably has more accumulated statistics than any other 
sport, football is fast closing the gap. For example, to find the rating of an NFL 
quarterback, you must make a series of calculations. For quarterbacks there are four 
categories of performance to measure: completion percentage, passing yardage, 
touchdowns, and interceptions. At the outset there is a total of 2.375 points per 
category. A perfect rating would be 2.375 times the four categories, or 9.5, divided by 
the constant 6 and then multiplied by 100, which results in a final rating of 158.3
(Sandomir, 2004). On this basis, the all-time highest season-long rating goes to Steve Young, followed by Joe Montana, with Milton Plum in third place. A gunslinger, like Joe Namath, has too many interceptions to rate among the elite.

One former NFL quarterback wrote a statistical computer program designed to assess the probabilities of scoring given an array of assumptions, such as the kind of defense used, the succession of plays run in a row, the quarterback’s passing percentage, the running back’s yards gained in a variety of situations and downs, and much more. The only statistically significant conclusion: the closer a team is to the goal line, the higher the probability of scoring.

And numbers have even been applied to categories that don’t lend themselves to the traditional sports pages. Researchers who have been evaluating street prostitution report that prostitutes work in shifts averaging eight hours a day, six days a week and typically service at least five clients per shift. When the service is performed out of doors, it typically averages only 10 minutes, whereas indoors the mean is closer to 30 minutes (Petrocelli, 2009). There was no report indicating the value of the deviations (standardized or unstandardized).

In a study of the enforcement of custody rules and disciplinary problems in prison, it was found that strict enforcement of the rules resulted in more, not fewer, disciplinary problems than in prisons where conditions are more lax. Two fairly equivalent prison populations were selected, one in which the rules and regulations were strictly enforced and another in which the rules were less invasive and enforcement was more casual. Each prison’s records were examined to find out if there was also a difference in the number of inmates who had committed infractions and therefore were disciplined. Also, all inmates were asked before being released whether they thought they would be likely to reoffend. The results showed a significant difference between the groups in favor of the less restrictive prison. That is, there were more reported infractions in the strict prison than in the lax prison, and the inmates in the strict prison indicated that they were more likely to reoffend upon release. The results were interpreted as showing that increased discipline and strict enforcement cause more disciplinary problems than they solve and may even add an increased risk of recidivism (Stevens, 1997).

Perhaps the increased number of infractions in the strict prison was partly a function of the increased number of rules that could be broken—that is, the more rules there are, the greater the opportunity for infractions to occur. Also, in the lax prison, even those rules that were in place appear to be enforced in a more random fashion (casually enforced). It might be important to find out if the groups were truly equivalent at the outset. Perhaps those with the more serious felonies were sent to the strict prison. Finally, an inmate’s opinion about recidivism isn’t the bottom line. The comparison should be made on the basis of who actually later recidivated. It may be that the lesson to be learned is that management should consider adopting reasonable rules that are strictly enforced.

In another example, Parade magazine headlined the story that “Americans are happier in marriage than their parents were.” This news was based on a survey of young married couples, 70% of whom described themselves as “happily married,” while only 51% could say the same about their parents. The question of course is,
“Compared to whom?” Had the parents participated in the survey, which they didn’t, it might be important to find out how they described their own marital satisfaction, and, more important, the marital success of their offspring. With those data, a meaningful comparison could at least be attempted (Parade, April 28, 1985).

Also, New York City released figures showing that the uniformed police made only 30% of the subway arrests, while the plainclothes police hit the 70% arrest figure. Does this mean that the plainclothes police work that much harder, or could it possibly be that the uniform is indeed a deterrent?

Or a paint company runs a TV ad showing a house that originally sold for $175,000. The new owner then repaints the house with the brand being advertised and later sells the house for $190,000. The implicit message, of course, is that the new paint job increased the value of the house by $15,000. However, in the absence of a definite time frame, there is no way to factor out the obvious effects of inflation. The house may easily have sold for $190,000, or more, given enough time—with or without its reglossed exterior.

Or in the movie version of John Irving’s The World According to Garp, Robin Williams knows that the probability of his home being destroyed by a plane crashing into it is extremely small, but not small enough for our cautious hero. So he deliberately buys a rebuilt house that has already been hit by a plane, convincing himself that the probability of being hit by two planes would be infinitesimally small.

Or consider this one. A researcher with an obvious antifeminist bias concludes that virtually all of America’s problems can be traced directly to the women’s liberation movement. Statistics are paraded before us to prove that as women left the kitchen and entered the fields of psychiatry, criminal justice, politics, real estate, and law, for example, the prison population tripled. The increase in the number of women entering business coincides directly with the number of small business failures. Finally, the increasing number of women’s individual bank accounts correlates with the increasing number of felonies. This is the kind of misuse of statistics that causes honest, competent statisticians to blanch and also casts a pall of suspicion over the whole field. If people accept such artful juxtaposing of statistics as proof of a causal relationship, then, indeed, statistics can be used to prove anything. The point, of course, is that just because two events occur simultaneously is no reason at all to conclude that one of these events has in any way caused the other. As we shall see later, the only way we can ferret out a cause-and-effect relationship is through the use of the controlled experiment.

Also, you must be aware of the size of the sample group from which the statistical inference is being made. Recently, a well-known company reported the results of a comparative study on the effects of using its brand of toothpaste. “The study was conducted over a period of six months, and millions of brushings later,” the company concluded that the other popular fluoride toothpaste was “no better than ours.” This is interesting in that the company isn’t even claiming victory but is apparently proud to have merely achieved a tie. Even more interesting, however, is that we are never told how many subjects participated in this study. Millions of brushings later could mean four people brushing every minute of every day for the full six months. If so, no wonder they don’t have any cavities—they probably haven’t any teeth left.
Chapter 1  Introduction to Statistics

Two researchers, in an attempt to minimize the positive influence of birth fathers in the household, have cited evidence to indicate that among child abusers the absolute number of birth parents surpasses parent substitutes (Silverstein & Auerbach, 1999). Among other things, they found that genetic fathers outnumber (although only slightly) stepfathers as perpetrators of fatal baby beatings in Canada, the United Kingdom, Australia, and the United States. This, of course, fails to take percentages into account. Birth parents vastly outnumber parent substitutes (including step-parents) in the countries listed. Also, as pointed out by Daly and Wilson (2000), the younger a child the less likely he or she is going to be raised by stepparents since very few babies have stepfathers. Thus, on a percentage basis, parent substitutes far exceed the rates of child abuse by genetic parents.

Be extremely skeptical when reading reported corporate profits, especially huge percentage increases. A company can truthfully report a 100% increase in profits and still be having a very poor year. Suppose in the previous year the company earned 1 cent for each dollar spent—a very modest return on capital. This year it earns 2 cents for each dollar. That is a bona fide 100% increase in profits, but it’s hardly enough to keep a prudent stockholder happy or the company long in existence.

The National Safety Council is always telling us how dangerous it is to drive our cars near our own homes. We are warned that over 85% of all auto accidents occur within 10 miles of the driver’s home. It is alleged that one person became so frightened after hearing about this high percentage of accidents occurring close to home that he moved! The other side to the story is, of course, that more than 95% of all driving is done within 10 miles of home. Where does the danger really lie? It lies in not being alert to statistical misdirection. While statistics do have an aura of precision about them, the interpretations are often anything but precise.

**The Tyranny of Numbers**

The authority of numbers, especially computer-generated numbers, promotes their unthinking acceptance as fact. Because the audience is more likely to believe the story, speakers like to waive computer tearsheets as they announce alleged statistics. Hopefully, after reading about all these statistical traps that lie in wait, you won’t simply give up and become disillusioned (after all, you can’t be disillusioned unless you are already illusioned).

**The Dirty Analogy.** As we have seen, statistical thinking is logical thinking, both deductive and inductive. You must beware of the dirty analogy, the seemingly valid deductive proof that changes direction in midstream. An example is the argument that starts off “If we can put a man on the moon, then” and then fills in the rest of the sentence from a long list of non sequiturs, such as “We can end racism,” or “We can put an end to the AIDS epidemic,” or “We can solve the problem of the homeless.” Notice how the conclusions suddenly have nothing to do with the premise. A successful space launch does, of course, take engineering skill and plenty of money, but, unlike AIDS, it doesn’t require any change in attitudes or behavior. Other premises to beware of are “In a country as rich as ours, we ought to be able to,” or “Since
it’s cheaper to send a student to Harvard than to keep a person in prison, then. . . .”
(Should that final conclusion be, “Therefore low-income, law-abiding citizens should be taught to commit felonies in order to get a free college education”?)

**The Only Way to Travel?**

Calculations trumpeting the safest way to travel have long been a favorite target of special-interest groups and a rich mother lode for unscrupulous statisticians. Perhaps the major interpretative misunderstanding has come because of the confusion between miles traveled and the number of trips involved. For example, on the miles-traveled scale, one of the safest ways to travel is to be launched into orbit aboard a space shuttle, but on a per-trip basis this is an extremely high-risk endeavor. As of 1994, the chance of being killed in a space shuttle was 1 for every 78 trips, which unless you had a death wish was a very scary prospect. Imagine if the probability of getting killed in the family sedan were 1 for every 78 times it was taken out of the garage. On that basis, most of us would think long and hard before revving up the old V6. But on a per-mile basis, the space shuttle is amazingly safe. The average NASA trip takes eight days and covers 3.36 million miles, making the risk per mile an infinitesimal 1 in 262 million. Compare that with the risk per mile of 1 in 50 million for the automobile. Incidentally, the risk of injury while driving your car varies tremendously depending on other conditions. For example, you are three times as likely to get killed driving at night, two and one-half times as likely when driving on a country road as opposed to the downtown area of a large city, and three times as likely when driving on the weekend (Berger, 1994). So, if you want to play the probabilities, drive your car on a Wednesday at high noon, dodging taxis on Manhattan’s Fifth Avenue, and be sure to buckle up (which reduces your fatality risk by about another one-third). And be wary of the warnings about holiday driving. It could be that the holiday death rate *per car* is lower, since with so many cars on the road, people necessarily might have to drive at a slower speed, which itself might reduce the seriousness of accidents, if not the frequency.

One author thinks the best way to compare the safety of autos with that of planes is on the basis of the per-hour death rate. Even though the number of deaths in auto accidents (about 40,000 per year) far exceeds the number of deaths in plane crashes (about 1000 per year), we all spend far more time in cars than we do in planes. On a per-hour basis the death rate for the two modes of transportation is just about equal. Consider another safety comparison: allowing children to visit friends whose parents keep a gun in the house or visiting friends whose parents have a swimming pool. In fact, a child is 100 times more likely to die in a swimming mishap than in a firearms accident (Leavitt & Dubner, 2005).

**It’s All in the Question**

When the great poet Gertrude Stein was near death, one of her friends asked her, “Gertrude, what is the answer?” and Ms. Stein whispered back, “It depends on the question.” Taking Ms. Stein’s advice, you must therefore be especially careful when
reviewing the results of all the polling data that constantly bombard us. In the first place, the questions themselves may be loaded—phrased in such a way as to favor a specific answer. For example, a question such as “Do you prefer socialized medicine as practiced in England or free-enterprise medicine as practiced in the United States?” is obviously slanted. Patriotic respondents might opt for the American variety simply because it is American. Also the terms socialized and free-enterprise might bias the result, since some respondents might be negatively disposed to anything socialist without always realizing what it means in context. When a New York Times–CBS poll asked respondents their opinion on a constitutional amendment “prohibiting abortions,” the majority (67%) opposed it. But when the question was reworded, the majority (51%) favored “protecting the life of the unborn child.” Also, when asked, “Are we spending too much, too little, or about the right amount on welfare?” the results seemed to paint Americans as greedy and noncaring, with only 22% saying “too little.” However, when the same question was rephrased as “Are we spending too much, too little, or about the right amount on assistance to the poor?” the results cast Americans in an entirely different light. To that question, the vast majority, 61%, said “too little” (National Opinion Research Center of the University of Chicago). The Gallup Poll asked Americans if they were for or against a “waiting period and background check before guns can be sold.” The results? An impressive 91% said they were for it. However, when the Wirthin poll asked a similar question, “Are you for or against a national gun registration program costing about 20% of all dollars now spent on crime control?” the results were virtually reversed, with 61% disagreeing. A poll conducted by Reader’s Digest in conjunction with the Roper Center for Public Opinion Research (at the University of Connecticut) asked respondents if they would be disappointed if Congress cut funding for public TV. The majority said they would be disappointed if the cuts were made. But when the same respondents were later asked whether cuts in funding for public TV were justified as part of an overall effort to cut federal spending, the results went in the opposite direction, with the majority now agreeing that the cuts should be made (Barnes, 1995). In another rather famous (infamous?) New York Times–CBS poll, people were asked if they agreed or disagreed with the statement that the “federal government ought to help people get medical care at low cost.” The results indicated that three-quarters of those polled agreed, appearing to lend strong support for a government-run national health plan. But when the poll was repeated, asking exactly the same question but substituting “private enterprise” for “federal government,” it was discovered that, again, three-quarters of those asked voiced their agreement. At least the respondents were consistent in one way: they want low-cost medical care—whether it be by the federal government or free enterprise seems not to be of concern. Then again, perhaps there are long lists of other things and activities that people want at low cost. Even the order of questions may influence the responses. The same question presented at the beginning of the survey may get a very different answer when presented near the end (Schwarz, 1999).

Finally, poll data may even be reported in such a way as to belie the questions that were actually asked. A sample of Americans was asked, “Would you be concerned if the family unit were to disintegrate?” Of those polled, 87% said yes. The headlined conclusion in the newspaper was that “87% of Americans are concerned over the
disintegration of the family unit.” One might just as well ask, “Would you be concerned if the sun were to explode?” The conclusion would then be, “100% of Americans are concerned that the sun will explode.”

The Numbers Game

Even the numbers themselves are sometimes only guesses, and often wild guesses at that. But after the numbers have been used for a while and have become part of the public record, they often take on a life of their own and may continue to be reported long after their shadowy origins have been exposed. Several years ago a distraught father began a campaign for finding missing children after his own son had been abducted. He announced that 50,000 children were being abducted each year, and newspapers trumpeted that figure throughout the country. The faces of missing children began appearing on milk cartons, and alarmed parents, hoping to protect their offspring, formed missing children’s organizations. However, during the late 1980s the FBI announced that the number of yearly confirmed abductions was somewhat lower, a total of 57 in fact for the previous year. Also, the widely cited figure of 626,000 kidnappings committed each year by parents in custody battles may also be a tad on the high side. Since the census data for the 1990s told us that there were 6.1 million children of divorce in this country, at the rate of 600,000 per year, every one of them would have to have been kidnapped over the span of the last 10 years. Then there is Mitch Snyder, advocate for the homeless, who announced that there are 2.2 million homeless persons in the United States and that soon there would be 3 million. When confronted with scientific studies that place the number of homeless at about 250,000, Snyder told a congressional committee that his numbers were in fact “meaningless and were created to satisfy your gnawing curiosity for a number because we are Americans with Western little minds that have to quantify everything in sight, whether we can or not” (U.S. News & World Report, July 1986, p. 107). The trouble with inflated numbers, aside from the lie factor, is that they are so often used to guide public policy. For example, we are told that the United States has only 5% of the world’s oil reserves, but we are not told how much oil that amounts to. Maybe 5% could last for the next hundred years, or perhaps just until later next week. We must constantly remind ourselves that what ought to be is not always what is. Advocacy groups typically tend to inflate the numbers, since the most accurate numbers are not always the most satisfying numbers. This can often then lead to real social problems being misdiagnosed. It is too often the case that a numerical lie gets jetted halfway across the country before the truth has had a chance to taxi out onto the runway.

Profiling and the FBI

Unfortunately, the term profiling has recently taken on a racist connotation, but in fact it has proven to be an extremely valuable statistical tool, a tool that has saved many lives. The FBI’s Behavioral Analysis Department in Stafford, Virginia (near Quantico), is divided into three units; internal terrorist threats, crimes against adults, and crimes against children. Since human beings, good and bad, are largely creatures of habit,
behavioral analysts look for certain, often unique, patterns of behavior. As any of you TV viewers know who watch shows like CSI (crime scene investigations), criminals are usually betrayed by their characteristic actions, not their words. Profilers analyze enormous data files and attempt to match aspects of a certain crime with their statistical computer data. By correlating evidence at the crime scene with the information in the data bank, profilers can narrow the search, and in some cases narrow it to the point of such uncanny accuracy as to seem almost clairvoyant (Kessler, 2008).

**Beer, Taxes, and Gonorrhea**

**If You Drink Don’t Park: Accidents Cause People.** A study released on April 27, 2000, by the U.S. Centers for Disease Control (CDC) suggested that increasing taxes on beer could lower sexually transmitted disease (STD) rates, especially gonorrhea. Although about 3 million teenagers are infected with sexually transmitted diseases each year, the CDC found that there were reductions in gonorrhea rates following tax increases by the various states during the period 1981–1995. The conclusion: a 20-cent increase per six-pack leads to a 9% drop in gonorrhea. It was suggested that the increased beer price puts it over the price range for many teenagers. Without the beer’s influence on impulse control, the teenager is less likely to be sexually active.

The data did not show that teenagers were buying less beer, or having less sex. This was simply assumed. Perhaps the reduction in STD rates was a result of other factors, such as the states using the increased revenue to augment sex education programs in the schools, or more TV and radio spots extolling the virtues of “safe sex.” It might have been instructive had there been some indication of whether STD rates had declined in the state’s older populations, a group that would probably not be dissuaded by a few cents being added to the beer tax. We might also wish to know if consumption of other alcoholic beverages had increased as a result of the beer tax, beverages that might be more influential regarding impulse control. Also, there was no evidence put forth to indicate that the teens in those states were actually less sexually active, only that there was a small decline in STDs. Perhaps the beer influences the teen’s readiness to use condoms, rather than general sexual readiness.

**September 11, 2001**

In 2001, almost 83% of all the homicides in New York City were committed by foreigners. Of course, almost 3000 of the total of roughly 3600 were committed on one day, September 11. Newspapers tend to meter out homicide rates evenly on a per-day or per-hour basis, such as someone gets killed every X minutes (as though homicides really occur on a regularly timed basis). Using that logic, in 2001 someone in New York got murdered every two hours. A person reading that number might check his watch and decide not to leave his hotel room for a few minutes to avoid that two-hour mark. Incidentally, if you take out September 11, the rate drops dramatically to fewer than two per 24 hours.
Can You Spot the Volvo?  Some of you may remember the ad for Volvo that showed a lineup of cars being crushed by a giant pickup truck called the big “Bear Foot.” Big Bear Foot, with its huge tires, was shown running over the tops of the row of automobiles. The Volvo withstands the pounding while the competition’s cars are flattened. The ad is titled, “Can You Spot the Volvo?” Well, you could if you were told ahead of time that the Volvo had been reinforced with extra steel columns to withstand Bear Foot’s assault and that the structural pillars of all the other cars had been severed. In fact, USA TODAY (October 5, 1994) named this Volvo ad as the most effective television promotion for the entire 1991 model year. After the deception was uncovered, however, Volvo quietly dropped the ad.

A BRIEF LOOK AT THE HISTORY OF STATISTICS

The general field of statistics is of fairly recent origin, and its birth and growth were spurred on by some very practical considerations. Although some form of both mathematics and gambling has existed since the earliest days of recorded history, it wasn’t until about 300 years ago that any attempt was made to bring the two together.

It is rather curious that it took the human race such a long time to gain any real understanding of the probability concept. Primitive persons used numbers, had a counting system, and were not averse to gambling. In fact, well-formed dice (which must have played true since even now they show almost no bias whatsoever) have been found dating at least as far back as 3000 BC. Perhaps early humans were afraid to think about probability, believing that it was the sole province of the gods. Perhaps it was felt that to deny the gods’ control over events would be an invitation to personal disaster, either at the hands of the gods or at the hands of the religious authorities. It was probably easier and a good deal safer to speak fatalistically in terms like the wheel of fortune and the throw of the dice rather than to dare penetrate the mysteries of the deities and thereby bring on a charge of heresy.

In Book I of De Divinatione, Cicero wrote 50 years before the birth of Christ, “They are entirely fortuitous you say? Come! Come! Do you really mean that? When the four dice produce the venus-throw you may talk of accident; but suppose you made a hundred casts and the venus-throw appeared a hundred times; could you call that accidental?” (David, 1962, p. 24). Implicit in his statement, of course, is that the gods must intervene to cause the occurrence of so improbable an event. In this passage, Cicero is voicing the popular view of his day, but in later writings he indicates his own mistrust of this opinion.

Even today, many people prefer not to calculate probabilities but instead to trust blind luck. All of us have met bold adventurers who grandly dismiss the dangers inherent in their newest sport. “After all, you can get killed in your own driveway,” they intone, not caring to be bothered with the blatant probability differences between getting hurt by falling on the driveway and getting hurt while hang gliding off the top of Mount Everest.
Gertrude Cox was born in the small town of Dayton, Iowa, on January 13, 1900, and graduated from Perry High School in Perry, Iowa, in 1918. Her early years were filled with a strong sense of ethics and religious faith. In fact, her earliest goal was to become a Methodist minister, not a typical career choice for a young girl growing up in the Midwest in the early 1900s. After attending Iowa State College in Ames for a year, however, she changed her career path and instead chose to major in mathematics, again an atypical major for a woman at that time. Like Pascal, Cox was searching for answers in both faith and probability theory, and both became strong guides throughout her remarkable life. She graduated from Iowa in 1929 with a B.S. degree in mathematics, and then entered Iowa’s graduate school, receiving her master’s degree in statistics in 1931 (which was the first master’s in statistics ever awarded at Iowa State). She also met and exchanged ideas with the great English statistician R. A. Fisher, who spent the summer of 1931 at Iowa State. In 1933, she became the assistant director of Iowa’s newly formed Statistical Laboratory. But then in 1940 she answered a call from North Carolina State’s president, Frank Graham, to organize, set up, and head a new department in experimental statistics, the first of its kind in the country. This was also the first time that North Carolina State had ever named a woman as a full professor (and a department head as well). By 1944, the university established what was called the “Institute of Statistics,” and chose Cox as its first director. For the next several years she worked on a series of methodological and design problems, that culminated in 1950, along with her coauthor William Cochran, with the publication of her first book, *Experimental Designs*. In this book, which became a bible to statisticians for many years to come, she proved to be far ahead of her time, creating tables for determining effect sizes and sample sizes for given alpha levels. She also addressed some of the thorny problems involved in setting up within-subjects designs, especially issues resulting from the residual or carryover effect from one trial to the next. She insisted that since within-subjects designs are more precise than between-subjects designs, her control techniques make ferreting out the pure effects of the IV (independent variable) more defensible. In 1949, she established the Department of Biostatistics at the University of North Carolina at Chapel Hill, and in the early 1950s, she worked on putting together the Research Triangle Institute (RTI). Then, in 1960, she took over the directorship of RTI’s Statistics Research Division (Monroe & McVay, 1980). Dr. Cox was recognized around the world for her creative and profound work in statistical methods. Her contributions to our field are far too numerous to mention here, but among them are the following: the first editor of the *Biometrics Journal* of the American Statistical Association, a post she held from 1945 until 1956; the first woman elected to the International Statistical Institute in 1949; and
During the seventeenth century, the birth of statistics finally took place. It happened one night in France. The scene was the gaming tables, and the main character was the Chevalier de Mère, a noted gambler of his time. He had been having a disastrous run of losing throws. To find out whether his losses were indeed the product of bad luck or simply of unrealistic expectations, he sought the advice of the great French mathematician and philosopher Blaise Pascal (1623–1662; see page 124). Pascal worked out the probabilities for the various dice throws, and the Chevalier de Mère discovered that he had been making some very bad bets indeed. Thus, the father of probability theory was Pascal. His motive was to help a friend become a winner at the dice table. Although Pascal’s motive may seem not to have been overly idealistic, it was extremely practical as far as the Chevalier de Mère was concerned.

Another famous French mathematician, Abraham de Moivre, delighted in the macabre and is alleged to have used an algebraic equation for predicting the very day of his own death, November 27, 1754. De Moivre was considered to be a really fun guy at a party. He published his findings in a book titled “The Doctrine of Chances.” As an aside, there was a Texas logician who predicted the exact day of death for four of his wives. The first three died from eating bad mushrooms, and the last one died from being hit on the head with a frying pan. She wouldn’t eat the mushrooms. There are those among us who love math. In fact one couple, who hadn’t seen each other for almost 10 years, ever since the halcyon days of their ninth grade algebra course, suddenly spotted each other across a busy intersection in downtown Manhattan. The two star-crossed lovers then raced toward each other like two freight trains, one which left Boston at 8AM traveling at 55 miles per hour and the other which left Springfield at 9AM, traveling at 62 miles per hour.
Another milestone for statistics occurred in the early 1900s in Ireland at the famous Guinness brewery, now known worldwide for the record books of the same name. In 1906, to produce the best beverage possible, the Guinness Company decided to select a sample of people from Dublin to do a little beer tasting. Since there turned out to be no shortage of individuals willing to participate in this taste test, the question of just how large a sample would be required became financially crucial to the brewery. They turned the problem over to mathematician William Sealy Gossett (see page 258). In 1908, under the pen name “Student,” Gossett produced the formula for the standard error of the mean (which specified how large a sample must be, for a given degree of precision, to extrapolate accurately its results to the entire beer-drinking population).

So that’s the history—craps and beer—hardly likely to strike terror in the hearts of students new to the field. The point is that the hallmark of statistics is the very practicality that gave rise to its existence in the first place. This field is not an area of mysticism or sterile speculations. It is a no-nonsense area of here-and-now pragmatism. You will not be led upstairs to a dark and dingy garret, with a taper and a crust of bread, to contemplate heavy philosophical issues. Instead, you will, with your trusty calculator in your hand or computer at your side, be brought into the well-lit arena of practicality.

**BENEFITS OF A COURSE IN STATISTICS**

If, as the Bible says, “the truth shall set you free,” then learning to understand statistical techniques will go a long way toward providing you with intellectual freedom. Choosing to remain ignorant of statistical concepts may doom you to a life sentence of half-truths. Essentially, the benefits of a course like this are twofold. You will learn to read and understand research reports, and you will learn to produce your own research. As an intelligent research consumer, you’ll be able to evaluate statistical reports read at professional conventions or printed in your field’s journals. Also, as a student of the social sciences, you will probably be called on at some time to do original research work. This prospect will not seem so overwhelming after you’ve mastered the tools available in this book. More basic than that, you’ll have a far better chance of understanding research items in newspapers or magazines, or on TV. Who should take statistics? Virtually anyone who wishes to be informed.

In fact, the argument has been made that learning the lessons of statistical methods increases a person’s reasoning ability, so the rules taught in statistics courses can be generalized to situations encountered in everyday life (Lehman, Lempert, & Nisbett, 1988). In fact, Lehman found that large gains in the application of scientific rules of evidence to everyday life situations occurred among graduate psychology majors (who had taken research methods courses), but not among graduate students in other areas. In another study, the reasoning powers of students who had just completed an introduction to psychology course (where research methodology
had been stressed) were compared with students who had had an introductory philosophy course. The reasoning power and level of critical thinking for the psychology students increased dramatically from the first to the last day of the course, whereas the philosophy students showed no such improvement on the final test (Leshowitz, 1989).

GENERAL FIELD OF STATISTICS

Statistics as a general field consists of two subdivisions: descriptive statistics and inferential, or predictive, statistics.

Descriptive Statistics

Descriptive statistics involves techniques for describing data in abbreviated, symbolic fashion. It’s a sort of shorthand, a series of precise symbols for the description of what could be great quantities of data.

For example, when we are told that the average score on the verbal section of the Scholastic Assessment Test (SAT) is 500, we are being provided with a description of one characteristic of hundreds of thousands of college-bound high school students. The descriptive tool used in this case is the arithmetic average, or the mean. To arrive at this value, the SAT verbal scores of all the high school students taking the test throughout the country were added together, and then the total was divided by the number of students involved. The resulting mean value of 500 describes one characteristic of this huge group of high school students.

Perhaps we would also like to know how wide the range of SAT scores was. To arrive at this value, the difference between the highest and lowest scores is calculated. In the case of the SAT distribution, where the highest score is 800 and the lowest 200, the range is found to be 600.

Knowing this value, our description of the group gains additional refinement. Other important descriptive statistics are the median, the mode, the standard deviation, and the variance. Chapters 2 and 3 will introduce these descriptive techniques.

Inferential Statistics involves making predictions of values that are not really known. Suppose we wished to estimate the height of the average American male. Since it would be impossible to line up all the men in the country and actually measure them, we would instead select a small number of men, measure their heights, and then predict the average height for the entire group. In this way, inferential statistics makes use of a small number of observations to predict, or infer the characteristics of, an entire group.

This process of inference is obviously risky. The small group of observations from which the inference will be made must be representative of the entire group. If not, the predictions are likely to be way off target. A person who takes a small amount of blood for analysis knows that the sample is fairly representative of all the blood in the entire
circulatory system. But when a researcher takes a sample of adult males, no one can be absolutely sure that true representation has been achieved. Also, the researcher seldom, if ever, gets the chance to verify the prediction against the real measure of the entire group. One exception, however, is in political forecasting. After pollsters like Gallup, Harris, Zogby, and Yankelovich make their predictions as to how the population of voters will respond, the actual results are made compellingly (and sometimes embarrassingly) clear on the first Tuesday in November.

John Kenneth Galbraith, the world-famous economist, once said that the only function of statistical-economic forecasting was to make astrology look respectable. Cynics have since said that comparing statistics to astrology was an insult to astrology. And Justin Fox asks the Wall Street number gurus, “If you’re so smart, why aren’t you rich,” or for those who through luck pick out a winning stock, “If you’re so rich why aren’t you smart” (Fox, 2009). However, in defense of the numbers used in both criminal justice and psychology, studies have consistently found that the numbers generated by standardized test scores are more accurate than clinical judgment in the prediction of behavior.

Despite the riskiness of the endeavor, statisticians do make predictions with better than chance (actually, far better than chance) accuracy about the characteristics of an entire group, even though only a small portion of the group is actually measured. Inferential statistics is not an infallible method. It does not offer eternal truth or immutable reality carved in stone. As one statistician said, “There is no such thing as eternal truth until the last fact is in on Judgment Day.” It does offer a probability model wherein predictions are made and the limits of their accuracy are known. As we will see, that really isn’t bad.

**Statistics and Fallacies**

Many statistical fallacies are a result of wishful thinking. As has been sarcastically stated, statisticians are only satisfied with results that confirm something they already believe to be true. Also, many fallacies are based on a lack of understanding of independent events. Soldiers often dive into a shell hole on the assumption that a shell will never hit in exactly the same place twice. During World War II, the English chess champion P.S. Millner-Barry decided to refurbish and not leave his London apartment after it was bombed. Sadly, it was bombed again.

Sir Francis Galton (1822–1911) is long remembered as the father of intelligence testing and the person most responsible for developing the methods we use even today for quantifying the data of the behavioral sciences. Galton once said,

> Some people even hate the name of statistics, but I find them full of beauty and interest. Whenever they are not brutalized, but delicately handled by the higher methods, and are warily interpreted, their power of dealing with complicated phenomena is extraordinary. They are the only tools by which an opening can be cut through the formidable thicket of difficulties that bars the path of those who pursue the Science of Man. (Galton, 1899)
Let us hope that throughout the semester, we will not be accused of brutalizing statistics but will try and follow Galton’s advice and handle them delicately. As many have said, “statistics can be mind-numbing and seductive and can be used to make any point,” but, as you will soon see, only to the uninitiated.

### SUMMARY

It has often been said that one can prove anything with statistics. However, this is only true if the audience is naïve about statistical procedures and terms. The terms used by statisticians are exact and their definitions are important, since they are designed to facilitate very precise communication.

The field of statistics is of fairly recent origin. The laws of probability were not formulated systematically until the seventeenth century. Blaise Pascal is popularly credited with these first formulations. Not until the beginning of the twentieth century were the strategies devised (by W. S. Gossett in 1906) for measuring samples and then using those data to infer population characteristics.

The general field of statistics includes two subdivisions, descriptive statistics and inferential statistics.

*Descriptive statistics:* Those techniques used for describing data in abbreviated, symbolic form.
*Inferential statistics:* Those techniques used for measuring a sample (subgroup) and then generalizing these measures to the population (the entire group).

### Key Terms and Names

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<th>descriptive statistics</th>
<th>inferential statistics</th>
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<td>Gossett, William Sealy</td>
<td>Pascal, Blaise</td>
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### PROBLEMS

1. During the crisis in Iraq, the number of Americans who died there was lower (for the same time period) than the number of Americans who died in the United States. Therefore, one can conclude that it is safer to participate in a war than to remain at home. Criticize this conclusion based on what you know of the two population sizes—Americans who go to war versus those who do not.

2. A certain Swedish auto manufacturer claims that 90% of the cars it has built during the past 15 years are still being driven today. This is true, so say the ads, despite the fact that the roads in Sweden are rougher than are those in the United States. What important piece of information must you have before you can evaluate the truth of this auto-longevity claim?
3. A recent TV ad tried to show the risks involved in not taking a certain antacid tablet daily. The actor, wearing the obligatory white coat and stethoscope, poured a beaker of "stomach acid" onto a napkin, immediately creating a large hole. The actor then menacingly intoned, "If acid can do that to a napkin, think what it can do to your stomach." On the basis of the "evidence" included in the commercial, what can the acid do to your stomach?

4. An oil company grandly proclaims that its profits for the fourth quarter increased by 150% over those in the same period a year ago. On the basis of this statement, and assuming that you have the money, should you immediately rush out and buy the company's stock?

5. A toothpaste company says that a large sample of individuals tested after using its brand of toothpaste had 27% fewer dental caries. Criticize the assumption that using the company's toothpaste reduces the incidence of caries.

6. A statewide analysis of speeding tickets found that state troopers in unmarked cars were giving out 37% more tickets over holiday weekends than were troopers working from cruisers that were clearly visible as police cars. Criticize the suggestion that troopers assigned to unmarked cars were obviously more vigilant and more vigorous in their pursuit of highway justice.

7. A marketing research study reported that a certain brand of dishwashing detergent was found by a test sample to be 35% more effective. What else should the consumer find out before buying the product?

8. Two major automakers, one in the United States and the other in Japan, proudly announce from Detroit that they will jointly produce a new car. The announcement further states (patriotically) that 75% of the parts for this car will be produced in the United States. Is this necessarily good news for U.S. workers?

9. A research study reported a linkage between learning disabilities and crime. Data from the Brooklyn Family Court (1988) indicated that 40% of the juveniles who appeared in court were learning disabled. The report further suggested that these data show that juveniles with learning disabilities are likely to engage in antisocial behavior for the following reasons: (1) they are unskilled, (2) they suffer from low self-esteem, and (3) they are easily swayed by others. Criticize these conclusions on the basis of the data being offered.

10. Two separate research studies conducted in 1994 came up with the same finding, that men in the corporate world who had working wives earn less money than the men whose wives stayed home to care for the children (as reported in Newsweek, October 14, 1994, page 44). In both studies the causal inference was drawn that the reason these men earned less was because their wives were in the workforce. It was suggested that men with working wives are therefore subject to some of the same social inequalities as are working women. Thus, when it comes to salary increases and promotions, men with working wives are treated with the same bias and disdain as are the working wives themselves. What alternative explanations might you suggest that are still consistent with these data?

11. It was reported that at a certain university in the United States, only 50% of the student athletes in the major sports programs (Division 1 football and basketball) were graduating within the standard four-year period. The announcement was greeted with great howls of anguish by both the local press and many of the university's alumni and faculty.
A chorus of voices moaned that this just goes to prove that the “dumb jock” image is indeed still alive and well. Before the hand-wringing gets too out of control, what might you as a fledgling researcher point out with regard to the value of comparison groups?

12. With a nice four-day holiday weekend ahead, you’re cruising down the highway and listening to your favorite music station when suddenly you hear the National Safety Council’s warning that over 600 persons will die on the highways this weekend. What other information should you know before you pull off the road and hide out in a motel for the entire holiday weekend?

13. In 2006, it was said that senior citizens were spending twice as much on prescription drugs as they did eight years earlier. Does this mean that big, greedy drug companies were charging twice as much for their drugs?

14. The heights of 2,848 students, ages 5–13, were recorded and it was found that at every grade level, the oldest students in the class were the shortest (Wake, Coghlan, & Hesketh, 2000). The conclusion was that these students were being held back because of faulty teacher perceptions. That is, the teachers perceived the lack of height as a sign of immaturity and a lack of readiness for promotion. This was found to be especially true for boys. What other reasons might you suggest to explain this result?

15. The opening of a new Broadway musical in April of 2001, “The Producers,” led news accounts to rave that box-office advance sales set an all-time popularity record, with almost $3 million worth of tickets sold the first day. What other information must we get before concluding that this actually reflected a record popularity for the new show?

16. In a study of over 14,000 high school students, reported in September 2000, it was found that teens, both boys and girls, who were members of sports teams were less apt to engage in a number of unhealthy activities. For example, the athletes were less likely to (a) use drugs, (b) smoke, (c) carry weapons, (d) have unhealthy eating habits, and (e) have sex. The authors implied that the image of the clean-cut jock may be more than just a Hollywood stereotype. They concluded that because of the positive relationship between sports participation and positive health behaviors, physicians should actively encourage young people to take advantage of the opportunity to join sports teams (Pate et al., 2000). Comment on the implied causal relationship between athletics and healthy behaviors.

17. Studies have shown that whereas armed citizens shoot the wrong person 2% of the time, police officers do so 11% of the time (Poe, 2001). Does this mean that police officers are more careless and less vigilant than armed citizens?

18. Bullying is the repeated physical or psychological mistreatment by a peer who is physically or psychologically stronger than the victim. Dan Olweus cites evidence showing that the victims of bullying are more likely to attempt suicide than are children in general (and far more likely than are the bullies themselves). This appears to be the dramatic statistic that has encouraged schools to show more interest in providing programs aimed at reducing bullying. Does this mean that being bullied causes suicide attempts? What other explanations are possible?

19. Fatalities per million miles of driving are 5.1 for men and 5.9 for women. Be careful not to assume that this proves that men are better and safer drivers than are women. What else must be known to interpret this result?