CHAPTER 32

EVALUATING POPULATION MEASUREMENTS:
BELL CURVES, STATISTICS,
AND PROBABILITY

We discussed the bell curve in Chapter 9, where we indicated that it described a normal distribution of a variable in a population. The bell curve describes a trait that can be measured but which varies continuously in a population, such as weight or height. It does not describe variables that are essentially discrete or discontinuous. For instance, there is no continuous distribution along a gradient between "female-like" and "male-like". Almost all individuals are clustered in one or two categories. On a more complex level, because of the historically late meeting of various groups of humans, in some societies skin color might be discontinuous while in other societies, such as in Brazil or Hawaii, it might tend towards a continuous distribution. It is important to realize that bell curves do not describe all situations, and that the crudest versions of statistical calculations may not apply. This is the most mathematical of restrictions that we encounter. Others are more fundamental, and they relate to the most common misuses of scientific reasoning, testimonials and false associations of logic. You can find examples of these nearly every day, and indeed a study problem at the end of the chapter is to find and analyze them.

TESTIMONIALS

The testimonial is the single example, most commonly in first person: "I followed Dr. J's diet plan, and I lost 50 pounds!" It is important to remember that the function of such a testimonial is to give a single example to entice the listener to generalize from that example to a general rule, from which the listener can deduce the effect on himself or herself: Testimonial-giver X lost 50 pounds→all people who follow Dr. J's plan lose 50 lbs→if I follow Dr. J's plan, I will lose 50 pounds. This is the logic of a false syllogism. A true syllogism allows one to deduce an individual truth from a general truth: If all girls are pretty, and if all children named Mary are girls, then Mary is pretty. A syllogism, basically an issue of logic, works only in this fashion, and reaches only one conclusion. It does not work backwards: If a flower is pretty, it does not follow that a flower is a girl. In other words, the logical flow does not of itself establish the "if and only if" structure of a true scientific experiment.

First, the assumption may be false. The statement "if all girls are pretty" may be false in fact even if the structure is acceptable. If the answer to "if all girls are pretty" is "no," then it is not necessary that Mary be pretty. She might be, but if some girls are not pretty, then Mary might be one of those girls.

The problem with a testimonial is that it attempts to create the syllogism where none exists. In large populations, many things are possible, with or without cause. Someone will win the lottery, but the fact that this person chose the numerical version of his son's birthday as numbers does not create the prediction that choosing birthdays will win again. Likewise, a certain number of people will be involved in traffic accidents. Many of these will have proximate causes, but the fact that you were driving on the priority road when someone pulled out from a stop sign without seeing you does not necessarily make you a less worthy driver. You may or may not have been less attentive than you should have been. Likewise, the dieter giving the testimonial may have been enormously motivated by any of several social or financial consequences of his obesity, or a serious medical problem. In this circumstance almost any effort to lose weight would probably have worked. The causal relationship between Dr. J's diet and his weight loss is not proven, and it will not necessarily work for you or anyone else. Other examples include non-prescription medicines for conditions that spontaneously resolve themselves. The old joke is that this treatment will cure a cold in seven days. Without treatment, the cold can last a week!

STATISTICAL MEASUREMENTS

The only valid predictor is the statistical measurement, done with suitable controls. If 1000 people follow Dr. J's diet and are compared to 1000 people who make no effort to lose weight and 1000 people who try another procedure (exercise or another diet) and, for instance, 200 of those on Dr. J's diet lose 10 or more pounds, compared to 20 who lose weight while doing nothing and 30 who lose weight doing something else, then one can conclude that the diet has some benefit. Note, however, that there is still a catch: 800 people who followed Dr. J's diet nevertheless did not lose weight. It will not work for everyone. In more dismal terms, if 90% of patients survive a difficult operation, the loss of 10% does not necessarily indicate failure or malpractice on the part of the surgeon.

Thus the testimonial relates one instance to one other instance. It does not establish any greater causality than my winning the lottery by choosing numbers based on the license plate of a car stopped ahead of me at a red light. In addition to the issue of bell curves discussed in Chapter 9, there is the other extremely difficult problem when dealing with large populations: since we cannot truly control the situation, there are huge numbers of variables that potentially can affect results. Suppose we tried to compare rates of heart disease among Mexican-Americans in Los Angeles and among people of Swedish descent in Minnesota. Using your hands and feet, you can readily count off the numerous likely differences in genetic background, diet, probability of smoking, exposure to sunlight, exposure to

childhood diseases, exposure to airborne carcinogens, amount of exercise, level of education, probability that they have lived in the same location all their lives—and we have not begun to consider the age and sex of the subjects. If there is any social component, for instance if the data are gathered by interview, there may be other differences. It is well known that different ethnic groups give different responses depending on circumstances such as the race of the interviewer. Even if one relies on more solid data, such as hospital admissions, some groups are more likely than others to present themselves to formal medicine at an early stage of a disease. Thus, as was discussed in Chapter 9, correlation is NOT causality.

IMPLICATIONS OF CONFUSING CORRELATION AND CAUSALITY

The reason that this discussion is important to us is that it is precisely this type of misuse of data that is so often used to argue against the theory of evolution or, at a more destructive level, to justify a particularly heinous or cruel attitude toward fellow human beings. One can readily argue that there is a direct line from Darwin to Hitler, and that most of the cruelest political activities of the 20th C were based on somewhat innocent to intentional distortions of the meaning of evolutionary theory. To avoid any potential confusion or misinterpretation of the intent of this chapter, we will state the following as the basis of our current belief:

- The modern human species evolved once in biological history and consists of a group highly variable in phenotype but genetically extremely close, much closer than the range in many other species.
- Although there are geographic differences among humans, the designation of race is far more political or social than biological. For instance, it might be of medical interest to know that a person carries genes derived from Africa or the Middle East (in which case the person might carry the sickle-cell gene (Chapter 15, pp 247–255) but for other purposes, though designated for census and even self-designated as Afro-American, the person might well have much less than 50% of his or her genes derived from African populations.
- The range of variability within a group such as what we describe as a race is much greater than the difference between races.
- In tests such as those described below, purporting to measure intelligence, many aspects of the social situation substantially affect the results, and in any event it is not obvious that the tests measure a vital biological characteristic.
- In any event, in a democratic society one judges individuals, and we do not allow any informed or uninformed opinion of a group to influence the manner in which we interact with an individual. If there were a statistical argument that children born in [choose the month of your birth] were, on average, of slightly lower intelligence than children born in [choose the month six months later], would you feel that it was fair that people discriminate against you?

We have to deal with the issue that humans tend not to display the most noble instincts when encountering each other. Most ancestral histories, whether Biblical, Greek, Asian, African, or other, recount mostly long episodes of war, and the history
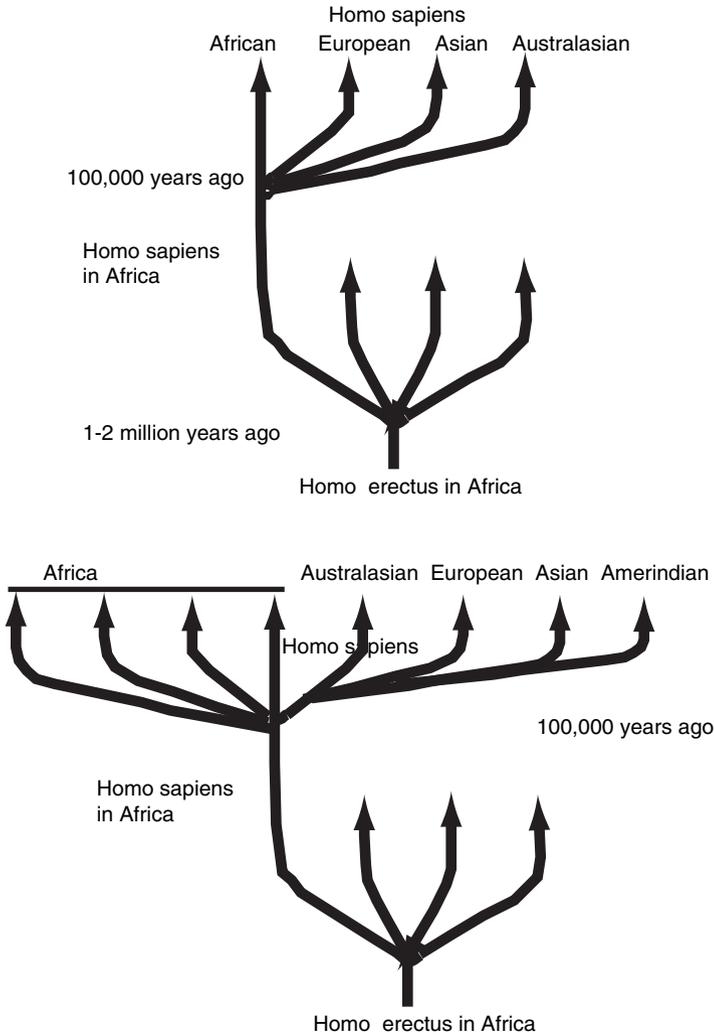
Figure 32.1. Even modern textbooks tend to drift into subtle implications. The figure above, taken from a textbook printed in 2002, manages to suggest that the African lineage is the most direct line from (and therefore closest to) the ancestral lineage. The lower figure gives a more accurate picture, in that the *Homo sapiens* lineage appeared in Africa about 100,000 years ago and generated many branches, most of which remained in Africa. About 50,000 years ago one branch left Africa and gave rise to the Australasian (Melanesians and Australian Aborigines) and European branches. The European branch gave rise to the Asian branch, which gave rise to the Amerindian branch. (The 2006 edition of the book has a more representative figure.) Credits: Redrawn from textbook figures

of exploration of the world, the development of nations, and the development of empires, relates far more to opportunities for plunder than to any more noble or innocent cause. Similarly, humans have not in general viewed with pleasure the encounter with other humans who were noticeably different. In fact, it is not unreasonable to comment that, when two humans find a difference between themselves and a third human, they are likely to use the difference as a basis for discrimination. This discrimination has little memory. Many individuals encountered the prejudice of the currently reigning population in spite of proud, even magnificent, achievements of their cultures. For instance, Mayans, Aztecs, and Incas had very sophisticated, impressive civilizations; most of the Middle East, including Egypt, Syria, Iraq, Persia, Israel, and Greece were elegant when Europe was barbarian; and the same is true for China and some parts of Africa.

Because of the human proclivity to fear and demean strangers, the first understanding of the rudiments of evolutionary theory led almost immediately to a grouping and hierarchical ranking of presumed human groups. There were many efforts to place different groups of humans along this scale, and the scale was almost always linear rather than branched. (Fig. 32.1) Most of this effort took place in Europe and North America, where evolutionary theory had created a stir, and, needless to say, the hierarchical rankings always placed Europeans and, especially,

Figure 32.2. Chimpanzee. Note that, contrary to popular impression, the skin color of our closest relatives is not necessarily dark. The color of the skin, as opposed to the hair, varies quite a bit. Credits: http://en.wikipedia.org/wiki/Image:South_Djoum_Chimp.jpg

Table 32.1.

Characteristic	Bonobo	Human
Skin color	Variable	Variable
Hair color	Black	Black, Brown, Red, blond
Length of legs	Short	Long
Length of arms	Long	Short
Brow ridge	Pronounced	Very slight (out of Africa) to absent (Africa)
Hair Style	Straight	Straight, wavy, curly, tight curls
Male Beard	None	All races; variable
Hirsuteness	Very hirsute	Moderate to almost none
Lips	None	Pronounced
Light color palms and soles	No	Yes (all races)
Nose	No nose projection	Modest to pronounced

northwestern Europeans, at the very top of the scale. These rankings were unapologetically prejudiced.

Other offshoots of these presumptions included the often-illustrated interpretation that dark-skinned people were more closely related to apes than the lighter-skinned people, though by most skeletal and other criteria African populations are more differentiated from apes than are the lighter-skinned peoples, and our closest relatives among the apes have light, not dark, skins (Fig. 32.2; Table 32.1).

The Eugenics Society contributed other misconceptions. Based on a misunderstanding of the manner in which genes spread in a society, the members worried about the capacity of "unfit" people to breed. The misunderstanding was the assumption that a harmful gene will spread throughout a population. It will not. Genes will spread only if they are selected for—that is, if the carrier is more successful in leaving children to the next generation.

THE RISE OF NAZISM

By far the greatest excess of the 20th C was the rise of Nazism. Based on the Malthusian argument of struggle among competing groups, the Nietzschian concept of the superior being, and Darwinian selection, the theory of Nazi racial policy was that the best humans should be selectively bred and those who were not beneficial to the gene pool should be prevented from breeding by confinement, sterilization, and execution. The undesirables included Jews, Blacks, homosexuals, Gypsies (members of an itinerant population coming from the area of northern India—the name "Gypsy" refers to the erroneous Medieval assumption that they were from Egypt), non-representational artists, and several others deemed by Hitler and his staff to undercut what they perceived to be their highest culture. Although

there have been many other massacres in history, this one derived its primary philosophy on the most brutal (and inaccurate) interpretation of Darwinian Theory.

BIAS IN SCIENCE

It is easy to blame society and leaders for misinterpreting and misusing the findings of a politically neutral science, but the explanation is not that easy. First, science is never totally politically neutral. As certain facts make no sense until we have a logic to explain them, scientists are humans and operate within the assumptions of the society. Thus early primatologists, who were all male, observed among apes the structure of male social hierarchy and interpreted the behavior of the females as totally dependent on the social ranking of their male partners. It was not until women primatologists, notably Diane Fossey and Jane Goodall, joined the research that the social structure of the females was noted and recognized to be important. Similarly, Konrad Lorenz, who was a brilliant observer of behavior but also someone who was willing to help draft Nazi policy, promulgated the concept of the "alpha male," the one who is the natural leader and dominant member of the troop. Field observations, combined with a more questioning or at least different political viewpoint, revealed that, while one male might be dominant (or, depending on your viewpoint, a bully) in a zoo setting, in the field one male might be the alpha defender against attack, another the alpha fruit-seeker, another the alpha chooser of the nesting site, etc. In the case of the immigration issues and the Eugenics Society, although ultimately science proved the interpretations wrong, well-meaning, intelligent scientists sometimes led the way. It is the responsibility of scientists to assess the social implications of what they do and say, and to consider the possibility that expertise in the laboratory is not expertise in social policy. Similarly, it is the responsibility of those who are not doing the science to remember the social imperatives and to be sufficiently aware of the fallibility of science to resist making or asking for bad law in the name of science.

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STUDY GUIDE

1. Note a testimonial advertisement on television or in a newspaper, or a political endorsement based on a personal experience. To what extent does it meet or fail the requirements of a valid syllogism?

2. Identify any medical report in a newspaper or on television that notes the results of a study in which the sample size is described ("small," "very large," or an actual number. Locate the original article and read the description of how one population was compared to another. Were all possible sources of bias eliminated?

3. How many instances can you identify in which something is accepted as scientific truth, but the opinion reflects the beliefs of the time? Hint: All historical times are valid, not just the modern period.

4. Observe the behavior of any domestic or caged (zoo) animal toward others of its species. Can you identify any aspect of the behavior that is likely to be a result of current situation, rather than its status in the wild? How do you know?

5. Domesticated animals are frequently highly selected for characteristics such as docility and tolerance of crowding.
   a. What does this sentence mean?
   b. How might this selection affect what we interpret to be their natural behavior?