Java Report

What You Will Be Learning

Java Report

Making sense of the latest buzz in health-related news

In 1981, a study in the *New England Journal of Medicine* made headlines when it reported that drinking two cups of coffee a day doubled a person's risk of getting pancreatic cancer; five or more cups a day supposedly tripled the risk. "Study Links Coffee Use to Pancreas Cancer," trumpeted the *New York Times*. "Is there cancer in the cup?" asked *Time* magazine. The lead author of the study, Dr. Brian MacMahon of the Harvard School of Public Health, appeared on the *Today* show to warn of the dangers of coffee. "I will tell you that I myself have stopped drinking coffee," said MacMahon, who had previously drunk three cups a day.

Just five years later, MacMahon's research group was back in the news reporting in the same journal that a second study had found *no* link between coffee and pancreatic cancer. Subsequent studies, by other authors, also failed to reproduce the original findings.

A sometime health villain, coffee's reputation seems to be on the rise. Recent studies have suggested that, far from causing disease, the beverage may actually help *prevent* a number of conditions—everything from Parkinson disease and diabetes to cancer and tooth decay. A 2010 CBS News headline announced, "Java Junkies Less Likely to Get Tumors," and a blog proclaimed, "Morning Joe Fights Prostate Cancer." The September 2010 issue of *Prevention* magazine ran an article titled "Four Ways Coffee Cures."

Not everyone is buying the coffee cure, however. Public health officials are increasingly alarmed by our love affair with—some might say, addiction to—caffeine. Emergency rooms are reporting more caffeine-related admissions, and poison control centers are receiving more calls related to caffeine "overdoses." In response, the state of California is even considering forcing manufacturers to put warning

labels on energy drinks. Nevertheless, caffeine's "energizing" effect is advertised on nearly every street corner, where, increasingly, you're also likely to find a coffee shop; as of 2010, there were 222 Starbucks within a five-mile radius of a Manhattan zip code according to Foodio54.com; nationally, the average within the same radius is 10.

Consumers are flooded with a firehose of health information every day.
—Gary Schwitzer

Conflicting messages like these are all too common in the news. From the latest cancer therapies to the ecological effects of global warming, a steady but often contradictory stream of scientific information vies for our increasingly Twitter-size attention spans.

Why the mixed messages? Are researchers making mistakes? Are journalists getting their facts wrong? While both of these possibilities may be true at times, the bigger problem is widespread confusion over the nature of science and the meaning of scientific evidence.

"Consumers are flooded with a firehose of health information every day from various media sources," says Gary Schwitzer, publisher of the consumer watchdog blog HealthNewsReview.org and former director of health journalism at the University of Minnesota. "It can be—and often is—an ugly picture: a bazaar of disinformation." Too often, he says, the results of studies are reported in incomplete or misleading ways.

Consider the grande cup of coffee or the Red Bull you may have had with breakfast this morning. Why might consuming coffee or caffeine be

The national average number of Starbucks within a five-mile radius of a single zip code is 10.

associated with such dramatically different results? The risks or benefits of a caffeinated beverage may depend on the amount a person drinks—one cup versus a whole pot. Or maybe it matters *who* is drinking the beverage. The *New England Journal of Medicine* study, for example, looked at hospitalized patients only. Would the same results have been seen in people who weren't already sick? Sometimes, to properly evaluate a scientific claim, we need to look more closely at how the science was done **(Infographic 1.1)**.

Science Is a Process

Science is less a body of established facts than a way of knowing—a method of seeking answers to questions on the basis of observation and experiment. Scientists draw conclusions from the best evidence they have at any one time, but the process is not always easy or straightforward. Conclusions based on today's evidence may be modified in the future as other scientists ask different—and sometimes better—questions. Moreover, with improved technology, researchers may uncover better data; new information can cast old conclusions in a new light. Science is a never-ending process.

Science is less a body of established facts than a way of knowing.

Let's say you want to investigate the "energizing" effects of coffee scientifically—how might you go about it? A logical place to start would be your own personal experience. You may notice that you feel more awake when you drink coffee. It seems to help you concentrate as you pull an all-nighter to finish a paper. Such informal, personal observations are called **anecdotal evidence.** It's a type of evidence that may be interesting but is often unreliable, since it wasn't based on systematic study. You could perhaps poll your classmates to find out if they experience coffee in the same way.

SCIENCE
The process of using observations and experiments to draw evidence-based conclusions.

ANECDOTAL EVIDENCE
An informal observation that has not been systematically tested.

PEER REVIEW
A process in which independent scientific experts read scientific studies before their publication to ensure that the authors have appropriately designed and interpreted their study.

HYPOTHESIS
A testable and falsifiable explanation for a scientific observation or question.

INFOGRAPHIC 1.1

Conflicting Conclusions

A variety of studies published in peer-reviewed scientific journals report different conclusions about the risks and benefits of coffee. In order for the public to understand and use these outcomes to its advantage, a closer look at the scientific process and the factors that surround coffee drinking is necessary.

Scientific studies report that drinking coffee...

- May cause pancreatic cancer
- Is linked to infertility and low infant birth weight
- Lowers the risk of Parkinson disease
- Does not cause pancreatic cancer
- Reduces risk of ovarian cancer

So, is it really the coffee?
Or other factors associated with drinking coffee?

- Chemicals naturally present in coffee, including caffeine
- The climate and soil in which different coffee plants are grown (which in turn influences the chemicals in coffee)
- How the beans are roasted and processed
- How much coffee a person drinks
- The gender, age, and general health of a coffee drinker
- Other social factors, such as whether coffee is consumed with a meal or with a cigarette, or with other foods and beverages that may interact in some way with coffee
- Other unknown factors that just happen to correlate with coffee drinking

TESTABLE
A hypothesis is testable if it can be supported or rejected by carefully designed experiments or nonexperimental studies.

FALSIFIABLE
Describes a hypothesis that can be ruled out by data that show that the hypothesis does not explain the observation.

EXPERIMENT
A carefully designed test, the results of which will either support or rule out a hypothesis.

Nevertheless, this anecdotal evidence might lead you to formulate a question: Does coffee improve mental performance? To get a sense of what information currently exists on the subject, you could read relevant coffee studies that have already been conducted, available in online databases of journal articles or in university libraries. Generally, you can trust the information in scientific journals because it has been subject to **peer review,** meaning that independent and unbiased experts have critiqued the soundness of a study before it was published. The aim of peer review is to weed out sloppy research, as well as overstated claims, and thus to ensure the integrity of the journal and its scientific findings. To further reduce the chance of bias, authors must declare any possible conflicts of interest and name all funding sources (for example, pharmaceutical or biotechnology companies). With this information, reviewers and readers can view the study with a more critical eye.

Based on what you learn from reading journal articles, you could formulate a **hypothesis** to explain how coffee improves mental performance. A hypothesis is a narrowly focused statement that is **testable** and **falsifiable,** that is, it can be proved wrong. A hypothesis represents one possible answer to the question under investigation. One hypothesis to explain coffee's effects, for example, is that drinking coffee improves memory. Another might be: high levels of caffeine increase concentration. Not all explanations will be *scientific* hypotheses, though. Statements of opinion, and hypotheses that use supernatural or mystical explanations that cannot be tested or refuted, fall outside the realm of scientific explanation. (Some call such explanations "pseudoscience"; astrology is a good example.)

With a clear scientific hypothesis in hand—"coffee improves memory"—the next step is to test it, generating evidence for or against the idea. If a hypothesis is shown to be false—"coffee does not improve memory"—it can be rejected and removed from the list of possible answers to the original question. On the other hand, if data support the hypothesis, then it will be accepted, at least until further testing and data show otherwise. Because it is impossible to test whether a hypothesis is true in every possible situation, a hypothesis can never be proved true once and for all. The best we can do is support the hypothesis with an exhaustive amount of evidence **(Infographic 1.2)**.

There are multiple ways to test a hypothesis. One is to design a controlled **experiment** in which you measure the effects of coffee drinking on a group of subjects. In 2002, Lee Ryan, a psychologist at the University of Arizona, decided to do just that. Ryan noticed that memory is often optimal early in the morning in adults over age 65 but tends to decline as the day goes on. She also noticed that many adults report feeling more alert after drinking caffeinated coffee. She therefore hypothesized that drinking coffee might prevent this decline in memory, and devised an experiment to test her hypothesis.

First she collected a group of participants–40 men and women over age 65, who were active, healthy, and who reported consuming some form of caffeine daily. She then randomly divided these people into two groups: one that would get caffeinated coffee, and one that would receive decaf. The caffeine group is known as the **experimental group,** since caffeine is what's being tested in the experiment. The decaf group is known as the **control group**–it serves as the basis of comparison. Both groups were given memory tests at 8 A.M. and again at 4 P.M. on two nonconsecutive days. The experimental group received a 12-ounce cup of regular coffee containing approximately 220-270 mg of caffeine 30 minutes before each test. The control group received a **placebo:** a 12-ounce cup of decaffeinated coffee containing no more than 5 to 10 mg of caffeine per serving.

By administering a placebo, Ryan could ensure that any change observed in the experimental group was a result of consuming caffeine and not just any hot beverage. Moreover, participants did not know whether they were drinking regular or decaf, so a **placebo effect** was also ruled out. In addition, all participants were forbidden to eat or drink any other caffeine-containing foods or drinks–like chocolate, soda, or coffee–for at least four hours before

EXPERIMENTAL GROUP
The group in an experiment that experiences the experimental intervention or manipulation.

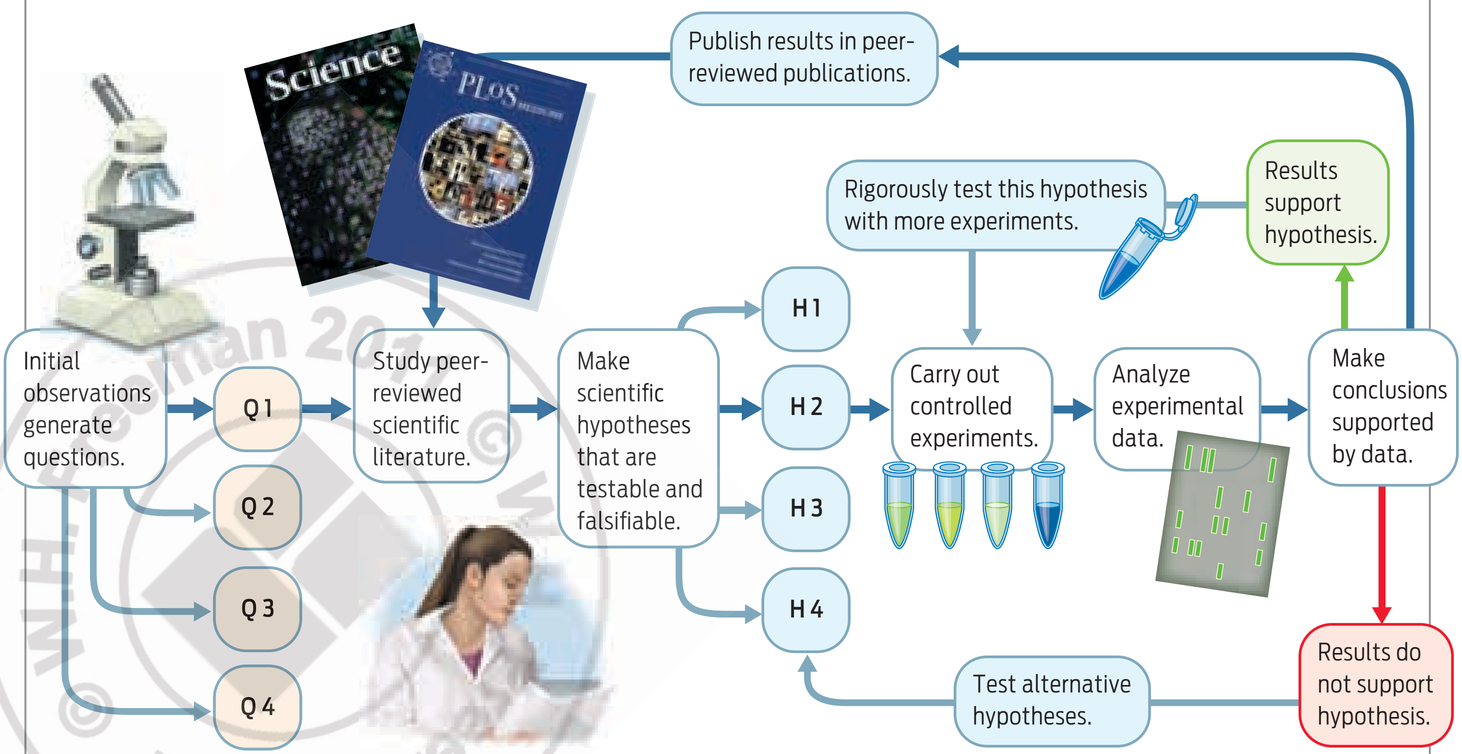
CONTROL GROUP
The group in an experiment that experiences no experimental intervention or manipulation.

PLACEBO
A fake treatment given to control groups to mimic the experience of the experimental groups.

INFOGRAPHIC 1.2

Science Is a Process: Narrowing Down the Possibilities

Multiple scientists doing multiple experiments narrow down the pool of possible hypotheses. Those that are rigorously tested and supported by other experiments emerge with greatest confidence.



The studies in scientific journals are reviewed by experts before publication to ensure accuracy.

each test. Thus, the control group was identical to the experimental group in every way except for the consumption of caffeine.

In this experiment, caffeine consumption was the **independent variable**—the factor that is being changed in a deliberate way. The tests of memory are the **dependent variable**—the outcome that may "depend" on caffeine consumption.

Ryan found that people who drank decaffeinated coffee did worse on tests of memory function in the afternoon compared to the morning. By contrast, the experimental group who drank caffeinated coffee performed equally well on morning and afternoon memory tests. The results, which were reported in the journal *Psychological Science*, support the hypothesis that caffeine, delivered in the form of coffee, improves memory—at least in certain people **(Infographic 1.3)**.

Because other factors might, in theory, explain the link between coffee and mental performance (perhaps coffee drinkers are more active, and their physical activity rather than their coffee consumption explains their mental performance), it's too soon to see these results as proof of coffee's memory-boosting powers. To win our confidence, the experiment must be repeated by other scientists and, if possible, the methodology refined.

PLACEBO EFFECT
The effect observed when members of a control group display a measurable response to a placebo because they think that they are receiving a "real" treatment.

INDEPENDENT VARIABLE
The variable, or factor, being deliberately changed in the experimental group.

DEPENDENT VARIABLE
The measured result of an experiment, analyzed in both the experimental and control groups

SAMPLE SIZE
The number of experimental subjects or the number of times an experiment is repeated. In human studies, sample size is the number of subjects.

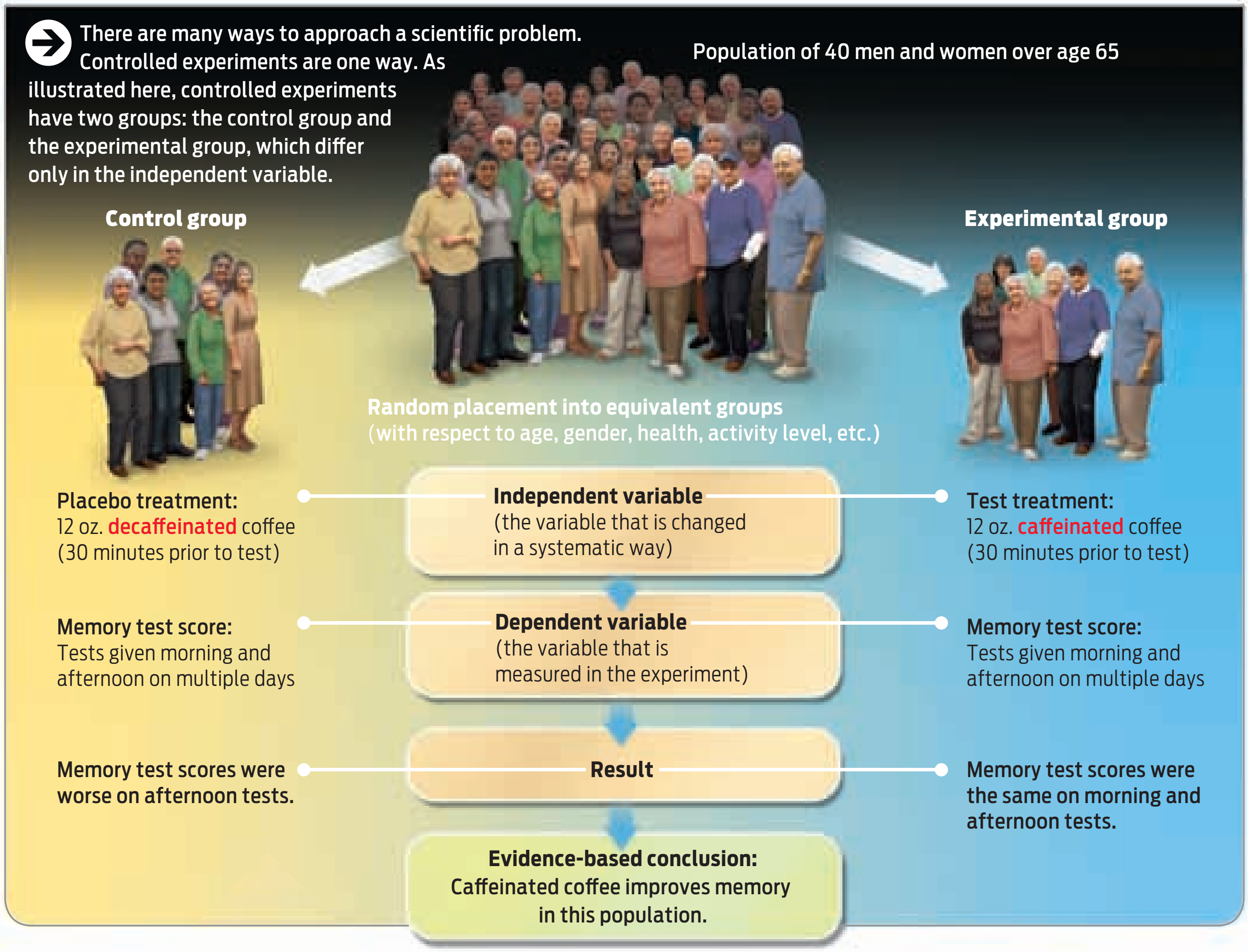
Size Matters

Consider the size of Ryan's experiment—40 people, tested on two different days. That's not a very big study. Could the results have simply been due to chance? What if the 20 people who drank caffeinated coffee just happened to have better memory?

One thing that can strengthen our confidence in the results of a scientific study is **sample size.** Sample size is the number of individuals participating in a study, or the number of times an experiment or set of observations is

INFOGRAPHIC 1.3

Anatomy of an Experiment



repeated. The larger the sample size, the more likely the results will have **statistical significance**—that is, they will not be due to random chance **(Infographic 1.4)**.

News reports are full of statistics. On any given day, you might hear that 75% of the American public opposes a piece of legislation. Or that 15% of a group of people taking a medication experienced a certain unpleasant side effect—like nausea or suicidal thoughts—compared to, say, 8% of people taking a placebo. Are these differences significant or important? Whenever you hear such numbers being cited, it's important to keep in mind the total sample size. In the case of the side effects, was this a group of 20 patients (15% of 20 patients is 3 people), or was it 2,000? Only with a large enough sample size can we be confident that the results of a given study are statistically significant and represent something more than chance. Moreover, it's important to consider the population being studied. For example, do the people reporting their views on a piece of legislation represent a broad cross section of the public, or are most of them watchers of the same television network, whose views lie at one extreme? Likewise, in Ryan's study, are the 65-year-old self-described "morning people"

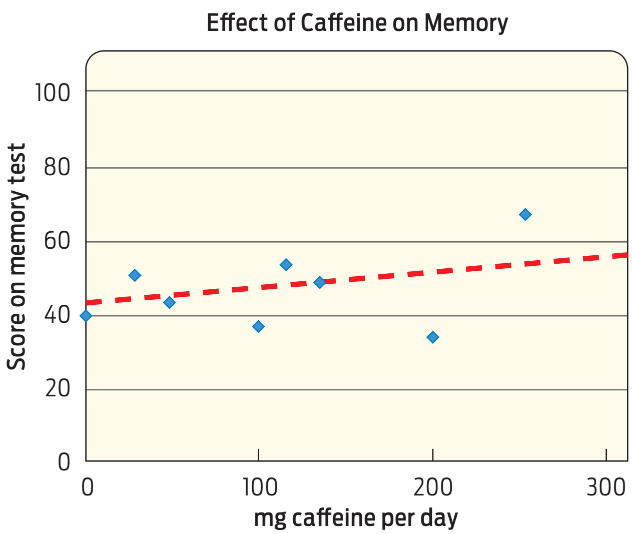
STATISTICAL SIGNIFICANCE
A measure of confidence that the results obtained are "real," rather than due to random chance.

INFOGRAPHIC 1.4

Sample Size Matters

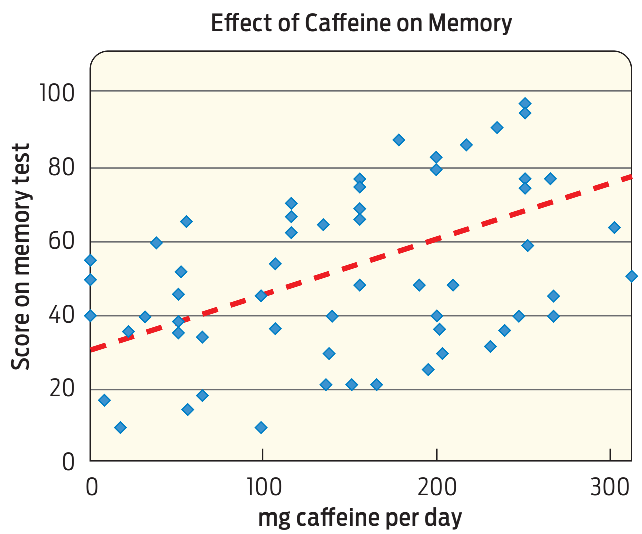
The more data collected in an experiment, the more you can trust the conclusions.

Data from only eight participants:



Conclusions drawn from these data might suggest that caffeine has only a slight positive influence on memory, a 15% average increase, but could easily be inconclusive, because of the small sample size.

Data from dozens of participants:



These data show a more convincing positive effect of caffeine on memory, a 45% average increase, because it is supported by more data. A statistical analysis would show that this positive influence is significant — in other words, it is not due to chance.

SCIENTIFIC THEORY A hypothesis that is supported by many years of rigorous testing and thousands of experiments.

who regularly consume coffee representative of the wider population?

If you search for "caffeine and memory" on PubMed.gov (a database of medical research papers), you'll see that the memory-enhancing properties of caffeine is a well-researched topic. Many studies have been conducted, at least some of which tend to support Ryan's results. Generally, the more experiments that support a hypothesis, the more confident we can be that it is true. A hypothesis that continues to hold up after many years of rigorous testing may eventually be considered a **scientific theory.** Note that the word "theory" in science means something very different from its colloquial meaning. In everyday life we may say something is "just a theory," meaning it isn't proved. But in science, a theory is an explanation that is supported by a large body of evidence compiled over time by numerous researchers, and which remains the best explanation we have for an observed phenomenon **(Infographic 1.5)**.

In science, a theory is the best explanation we have for an observed phenomenon.

This Is Your Brain on Caffeine

Caffeine is a stimulant. It is in the same class of psychoactive drugs as cocaine, amphetamines, and heroin (although less potent than these, and acting through different chemical pathways). Caffeine boosts not just memory and mental activity but physical activity as well. One study, in 2004, found that 33% of 193 track and field

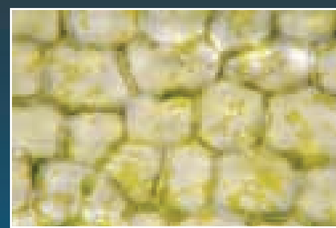
INFOGRAPHIC 1.5

Everyday Theory vs. Scientific Theory

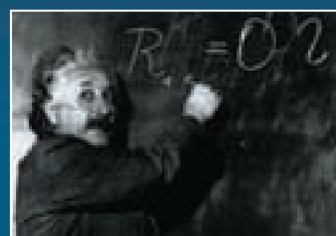
In everyday life, people use the word "theory" to refer to an idea that they would like to follow up.
In science, a theory is a hypothesis that has never been disproved, even after many years of rigorous testing.

Everyday theory:
Great idea based on a person's experience and knowledge

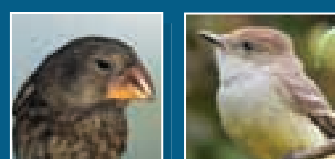
Scientific theory:
Important hypotheses supported by thousands of scientific experiments



Cell Theory:
All living things are made of cells.



Theory of General Relativity:
Gravity influences time and space.



Theory of Evolution by Natural Selection:
Populations of organisms change over time, adapting to their environment.

athletes and 60% of 287 cyclists said they consumed caffeine to enhance their performance. Recognizing caffeine's reputation as a performance-enhancing drug, the International Olympic Committee prohibited athletes from using it until 2004 (when it decided to allow it, presumably because it had become too common a substance to regulate).

While the exact mechanisms are not fully understood, scientists think that caffeine exerts its energizing effect by counteracting the actions of a chemical in the brain called adenosine. Adenosine is the body's natural sleeping pill–its concentration increases in the brain while you are awake and by the end of the day promotes drowsiness. Caffeine blocks the effect of adenosine in the brain and keeps us from falling asleep.

Some researchers contend that coffee's mind-boosting effects are an indirect result of the cycle of dependency.

Though our understanding of the chemistry is relatively new, humans have enjoyed coffee's kick for more than a thousand years. It's said that an Ethiopian goatherd found his goats acting unusually frisky one afternoon after munching the leaves of a small bush. Chewing a few of the shrub's berries himself, he got a caffeine buzz, and the rest was history. Today, caffeine is the most wildly used stimulant on the planet (**Table 1.1**).

In fact, consumption of caffeinated beverages has skyrocketed in the past 25 years; for example, young people now drink far more soda than milk. A 2009 study in the journal *Pediatrics*

INFOGRAPHIC 1.6

Caffeine Side Effects

found that teenagers consume up to 1,458 mg of caffeine a day—nearly five times the recommended maximum adult dose of 300 mg. Caffeine can cause anxiety, jitters, heart palpitations, trouble sleeping, dehydration, and more serious symptoms—especially in people who are sensitive to it. In 2007, two high school students in Colorado Springs, Colorado, were hospitalized with stomach pain, nausea, and vomiting after drinking one 8-ounce can of Spike Shooter, a potent beverage that packs a walloping 300 mg of caffeine—the equivalent of almost four Red Bulls **(Infographic 1.6)**.

For regular coffee drinkers who crave their morning buzz, such symptoms are unlikely to convince them to kick the habit. This may be because, like many other psychoactive substances, caffeine is addictive. Those who drink a significant amount of coffee every day may notice that they don't feel quite right if they skip a day; they may be cranky or get a headache. These are symptoms of withdrawal. In fact, some researchers contend that coffee's mind-boosting effects are an indirect result of the cycle of dependency. Improvement in mood or performance following a cup of coffee, they say, may simply represent relief from withdrawal symptoms rather than any specific beneficial property of coffee.

To test this dependency hypothesis, scientists could conduct an experiment. They could compare the effects of drinking coffee in two groups: one group of regular coffee drinkers who had abstained from coffee for a short period, and another group of non–coffee drinkers. Does coffee give both groups a boost, or only the regular coffee drinkers looking for their fix?

In fact, this very experiment was done in 2010 by a group of researchers at the University of Bristol in England. Their study, published in the journal *Neuropsychopharmacology*, looked at caffeine's effect on alertness. Researchers gave caffeine or a placebo to 379 participants and asked them to take a test that rated their level of alertness. The study found that caffeine did not boost alertness in non–coffee drinkers compared to those drinking a placebo (although it did boost their level of anxiety and headache). Heavy coffee drinkers, on the other hand, experienced a steep drop in alertness when given the placebo.

"What this study does is provide very strong evidence for the idea that we don't gain a benefit in alertness from consuming caffeine," the study author, Peter Rogers, said. "Although we feel alert, that's just caffeine bringing us back to our normal state of alertness." Of course, this doesn't really explain why people get hooked on coffee in the first place.

Finding Patterns

Performing controlled laboratory experiments like those discussed above is one way that scientists try to answer questions. Another approach is to make careful observations or comparisons

of phenomena that exist in nature. This is the approach taken by scientists who study **epidemiology**—the incidence of disease in populations—or some other area, like the movement of stars or the nature of prehistoric life, that cannot be directly manipulated.

For example, if an epidemiologist wanted to learn about the relationship between cigarette smoking and lung cancer, he could compare the rates of lung cancer in smokers and nonsmokers, but he could not actually perform an experiment in which he made people smoke cigarettes and waited to see whether or not they got cancer. Such an experiment would be highly unethical.

Although epidemiological studies do not provide the immediate gratification of a laboratory experiment, they do have certain advantages. For one thing, they can be relatively inexpensive to conduct, since often the only procedure involved is a participant questionnaire. And you can study factors that are considered harmful, such as excess alcohol or smoking, that you would be unable to test experimentally. Finally, epidemiological studies have the power of numbers and time. The Framingham Heart Study, for example, is a famous epidemiological study that has tracked rates of cardiovascular disease in a group of people and their descendants in Framingham, Massachusetts, in order to identify common risk factors. Begun in 1948, the study has been going on for decades and has provided mountains of data for researchers in many fields, from cardiology to neuroscience.

Most of the health studies featured in the news are epidemiological studies. Consider a study on coffee and Parkinson disease published in the *Journal of the American Medical Association (JAMA)* in 2000. Researchers examined the relationship between coffee drinking and the incidence of Parkinson disease, a condition that afflicts more than 1 million people in the United States, including men and women of all ethnic groups. There is no known cure, only palliative treatments to help lessen symptoms, which include trembling limbs and difficulty coordinating speech and movement.

EPIDEMIOLOGY
The study of patterns of disease in populations, including risk factors.

TABLE 1.1

How Much Caffeine Is in Our Beverages?

The FDA Recommends No More than 65 mg of Caffeine in 12 oz.

BEVERAGE	SERVING SIZE	QUANTITY OF CAFFEINE
Coffee	8 oz	95 mg and up
Red Bull	8.3 oz (1 can)	76 mg
Rockstar	8 oz (half can)	80 mg
Amp	8.4 oz (1 can)	74 mg
Coke Classic	12 oz (1 can)	35 mg
Mountain Dew	12 oz (1 can)	54 mg
Barq's Root Beer	12 oz (1 can)	23 mg
Sprite	12 oz (1 can)	0 mg

Source: Mayo Clinic

For more than 30 years, researchers at the Veterans Affairs Medical Center in Honolulu followed more than 8,000 Japanese-American men, gathering all sorts of information about them: their age, diet, health, smoking habits, and other characteristics. Of these men, 102 developed Parkinson disease. What did these 102 men have in common? Epidemiologists found that none of them drank caffeinated beverages—no coffee, soda, or caffeinated tea.

By contrast, coffee drinkers had a lower incidence of Parkinson disease. In fact, those who drank the most coffee were the least likely to get the disease. Men who drank more than two 12-ounce cups of coffee each day had one-fifth the risk of getting the disease compared to non–coffee drinkers.

So does coffee prevent Parkinson disease? The occurrence and progression of many diseases are affected by a complex range of factors, including include age, sex, diet, genetics, and exposure to bacteria and environmental chemicals, as well as lifestyle factors like drinking, smoking, and exercise. Although the study discussed here suggests a link—or **correlation**—between caffeine and lower incidence of Parkinson disease, it does not necessarily show that caffeine prevents the disease. In other words, correlation is not causation. Perhaps the people who like to drink coffee have different brain chemistry, and it's this different brain chemistry that explains the differing incidence of Parkinson disease among coffee drinkers **(Infographic 1.7)**.

Indeed, other studies have found that cigarette smoking also correlates with a lower risk of Parkinson disease. Both coffee drinking and smoking could be considered types of thrill seeking, behavior observed in people who enjoy the "high" they get from stimulants such as caffeine or nicotine. The lower risk of Parkinson disease among coffee drinkers might therefore result from thrill-seeking brain chemistry that also happens to resist disease—rather than being caused by either smoking or drinking coffee per se.

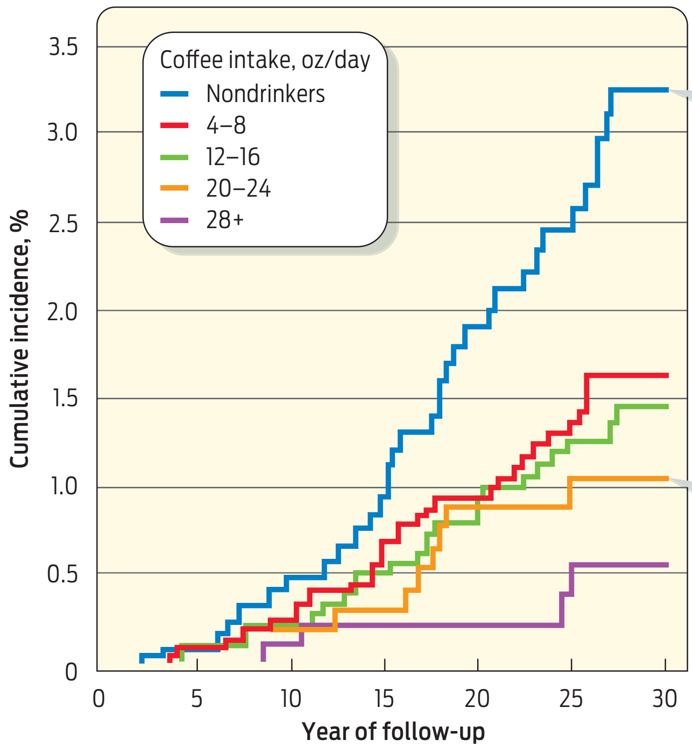
Moreover, the study followed Japanese-American men. Would the same relationship of caffeine and Parkinson disease be seen in other ethnic groups or in women? Several

CORRELATION
A consistent relationship between two variables.

INFOGRAPHIC 1.7

Correlation Does Not Equal Causation

While the data shown below show a convincing **correlation** between reduced caffeine intake and an increased risk of Parkinson disease, it is impossible to state that less coffee **causes** Parkinson disease. Other factors that were not tested or controlled for could be causing the reduced risk.



Less coffee correlates with higher incidence of Parkinson disease.

More coffee correlates with lower incidence of Parkinson disease.

Possible explanations for these results:

- Drinking coffee reduces risk of developing Parkinson disease.
- People who are at risk for developing Parkinson disease are less likely to drink coffee.
- Drinking coffee masks the symptoms of Parkinson disease, thereby reducing the rate of diagnosis of Parkinson disease in coffee consumers.

Pitfalls for making decisions from a single epidemiologic study:

- Complexity of a disease makes it unlikely that every variable can be controlled for.
- Small sample sizes can influence accuracy of results.
- The specific population in the study may not be representative of the general population.

SOURCE: ROSS ET AL., JAMA 2000; 283:2671–2679

other epidemiological studies have found a correlation between caffeine consumption and a lower incidence of Parkinson disease in men of other ethnicities. But in women the results have been inconclusive. All in all, there's still no direct evidence that caffeine actually prevents the disease in either men or women.

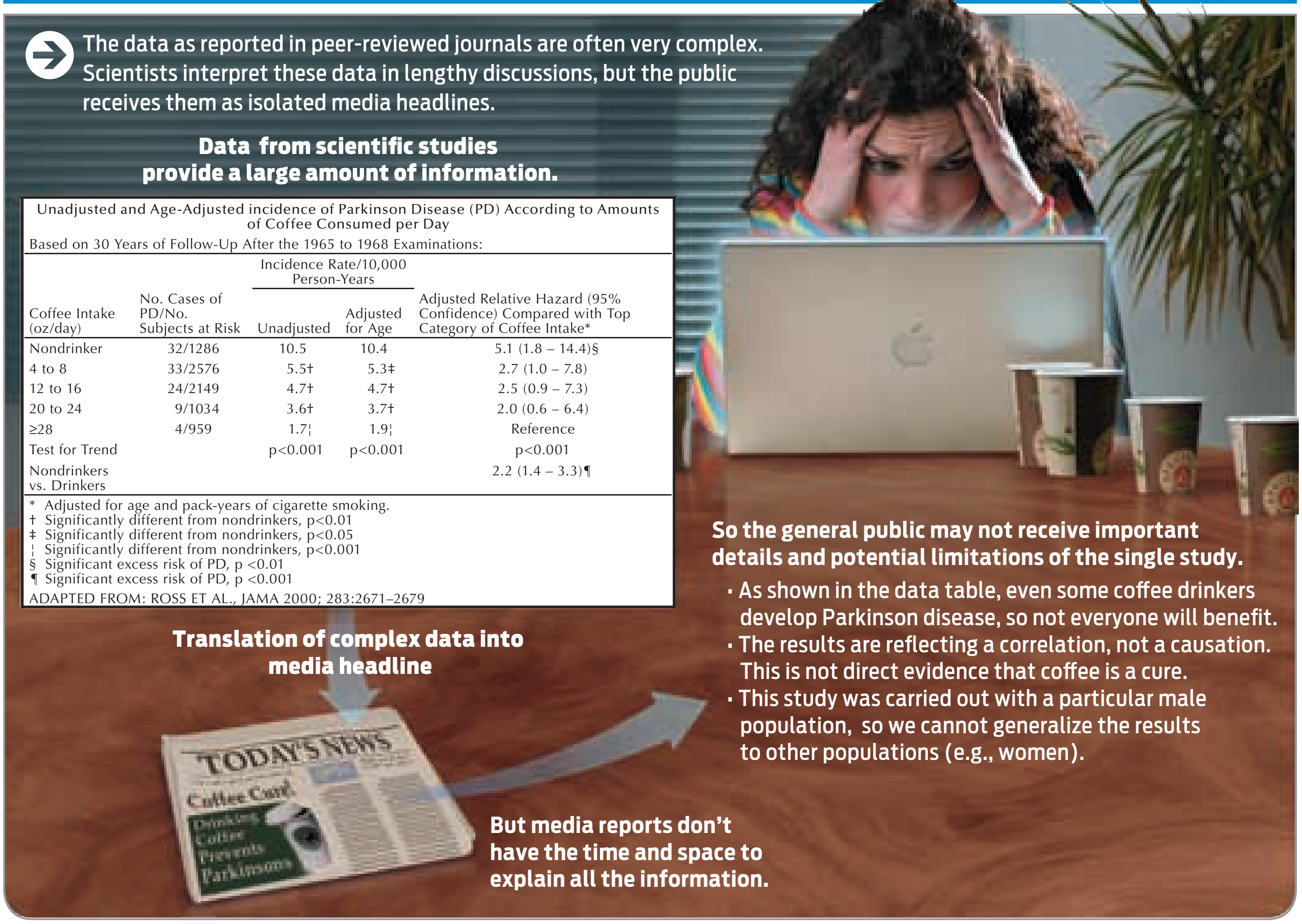
"While our study found a strong correlation between coffee drinkers and low rates of Parkinson's disease," said the study's lead author, G. Webster Ross in a press release issued by the U.S. Department of Veterans Affairs, "we have not identified the exact cause of this effect. I'd like to see these findings used as a basis to help other scientists unravel the mechanisms that underlie Parkinson's onset."

To get a clearer picture of caffeine's role in Parkinson disease, researchers could conduct a type of experiment known as a **randomized clinical trial,** in which the effects of coffee are measured directly under controlled conditions. One could divide a population into two groups, put one group on coffee and the other on decaf, and then follow both groups for a number of years to see which one had the higher incidence of disease. The problem with such a study is that it is often very expensive to conduct, and it can be difficult to get

RANDOMIZED CLINICAL TRIAL
A controlled medical experiment in which subjects are randomly chosen to receive either an experimental treatment or a standard treatment (or placebo).

INFOGRAPHIC 1.8

From the Lab to the Media: Lost in Translation



Unadjusted and Age-Adjusted incidence of Parkinson Disease (PD) According to Amounts of Coffee Consumed per Day

Based on 30 Years of Follow-Up After the 1965 to 1968 Examinations:

Coffee Intake (oz/day)	No. Cases of PD/No. Subjects at Risk	Incidence Rate/10,000 Person-Years: Unadjusted	Incidence Rate/10,000 Person-Years: Adjusted for Age	Adjusted Relative Hazard (95% Confidence) Compared with Top Category of Coffee Intake*
Nondrinker	32/1286	10.5	10.4	5.1 (1.8 – 14.4)§
4 to 8	33/2576	5.5†	5.3‡	2.7 (1.0 – 7.8)
12 to 16	24/2149	4.7†	4.7†	2.5 (0.9 – 7.3)
20 to 24	9/1034	3.6†	3.7†	2.0 (0.6 – 6.4)
≥28	4/959	1.7¦	1.9¦	Reference
Test for Trend		p<0.001	p<0.001	p<0.001
Nondrinkers vs. Drinkers				2.2 (1.4 – 3.3)¶

* Adjusted for age and pack-years of cigarette smoking.
† Significantly different from nondrinkers, p<0.01
‡ Significantly different from nondrinkers, p<0.05
¦ Significantly different from nondrinkers, p<0.001
§ Significant excess risk of PD, p <0.01
¶ Significant excess risk of PD, p <0.001

ADAPTED FROM: ROSS ET AL., JAMA 2000; 283:2671–2679

people to stick to the regimen for the length of the study. (And such studies are unethical if the experimental treatment is likely to cause harm.)

Getting Beyond the Buzz

While a lower risk of Parkinson disease represents a potential boon to coffee drinkers, the news for caffeine addicts isn't all good. Over the years, epidemiological studies have linked caffeine consumption to *higher* rates of various diseases, including osteoporosis, fibrocystic breast disease, and bladder cancer. As with the link to Parkinson disease, however, such correlations do not necessarily prove that caffeine causes any of these diseases. Nevertheless, such studies are often quite influential and newsworthy–like the supposed link between coffee and pancreatic cancer that made headlines in 1981. That study was based on a single epidemiological study, which was later discounted by further research.

Journalists face unique challenges in covering health news, says Gary Schwitzer of HealthNewsReview.org: "They must cover complex topics, do it quickly, creatively, accurately, completely and with balance–and then be sure they don't 'dumb it down' too much for a general news audience. . . . If they can't do it right, they must realize the *harm* they can do by reporting inaccurately, incompletely, and in an imbalanced way" **(Infographic 1.8)**.

Journalists and scientists aren't the only ones who bear the responsibility of determining what information is trustworthy. As consumers and citizens, we can become more knowledgeable about how science is done and which studies deserve to influence our behavior. Whether it's the latest media report linking cell phones to brain tumors or vaccines to autism, the only way to really judge the value of a study is to sift through the evidence ourselves. Of course, to do that, we might first need a cup of coffee. ■

Summary

- Science is an ongoing process in which scientists conduct carefully designed studies to answer questions or test hypotheses.
- Scientific hypotheses are tested in controlled experiments or in nonexperimental studies, the results of which can support or rule out a hypothesis.
- Scientific hypotheses can be supported by experimental data but cannot be proved absolutely, as future experiments or technologies may provide new findings.
- The strength of the conclusions of a scientific study depends on, among other factors, the type of study carried out and the sample size.
- Every experiment should have a control—a group that that is identical in every way to the experimental group except for one factor: the independent variable.
- The independent variable in an experiment is the one being deliberately changed in the experimental group (e.g., coffee intake). The dependent variable is the measured result of the experiment (e.g., effect of coffee on memory).
- Often a control group takes a placebo, a fake treatment that mimics the experience of the experimental group.
- In epidemiological studies, a relationship between an independent variable (such as caffeine intake) and a dependent variable (such as development of Parkinson disease) does not necessarily mean one caused the other; in other words, correlation does not equal causation.
- A randomized clinical trial is one in which test subjects are randomly chosen to receive either a standard treatment (or placebo) or an experimental treatment (e.g., caffeine).
- Scientists rely on peer-reviewed scientific reports to learn about new advances in the field. Peer review helps to ensure that the scientific results are valid as well as accurately and fairly presented.
- Most of the general public relies on media reports for their scientific information. Media reports are not always completely accurate in how they portray the conclusions of the scientific studies.
- Scientific theories are different from everyday theories. A scientific theory has withstood the test of time and extensive testing and is supported by a significant body of evidence.

Chapter 1 Test Your Knowledge

PROCESS OF SCIENCE

Science is a method of seeking answers to questions on the basis of observation and experiment.

HINT See Infographics 1.1. and 1.2.

KNOW IT

1. When scientists carry out an experiment, they are testing a

- **a.** theory.
- **b.** question.
- **c.** hypothesis.
- **d.** control.
- **e.** variable.

2. Of the following, which is the earliest step in the scientific process?

- **a.** generate a hypothesis
- **b.** analyze data
- **c.** conduct an experiment
- **d.** draw a conclusion
- **e.** ask a question about an observation

USE IT

3. When a scientist reads a scientific article in a scientific or medical journal, he or she is confident that the report has been peer reviewed. What does this mean? Why is peer review important?

DESIGNING EXPERIMENTS

Many considerations go into the design and implementation of a scientific experiment.

HINT See Infographics 1.3–1.4.

KNOW IT

4. In a controlled experiment, which group receives the placebo?

- **a.** the experimental group
- **b.** the control group
- **c.** the scientist group
- **d.** the independent group
- **e.** all groups

5. In the studies of coffee and memory discussed, the independent variable was _________ and the dependent variable was ______________.

- **a.** caffeinated coffee; decaffeinated coffee
- **b.** memory; caffeinated coffee
- **c.** caffeine; memory
- **d.** memory; caffeine
- **e.** decaffeinated coffee; caffeinated coffee

USE IT

6. You are working on an experiment to test the effect of a specific drug on reducing the risk of breast cancer in postmenopausal women. Describe your control and experimental groups with respect to age, gender, and breast cancer status.

7. Design a randomized clinical trial to test the effects of caffeinated coffee on brain activity. Design your study so that the results will be as broadly applicable as possible.

EVALUATING EVIDENCE

Many factors can influence the strength of a scientific claim.

HINT See Infographics 1.4–1.8.

KNOW IT

8. From what you have read in this chapter, would you say a 21-year-old Caucasian female can count on caffeinated coffee to reduce her risk of Parkinson disease?

- **a.** yes, because the results of a peer-reviewed study showed that drinking caffeinated beverages reduced the risk of Parkinson disease
- **b.** no, because subjects in that peer-reviewed study were Japanese-American males; it cannot be inferred that the same results would hold for Caucasian females
- **c.** no; she would have to restrict her consumption of coffee to decaffeinated coffee to reduce her risk of Parkinson disease
- **d.** yes; coffee is known to reverse the symptoms of Parkinson disease
- **e.** There is no data on the relationship between drinking caffeinated beverages and Parkinson disease because it would be unethical to conduct such an epidemiological study.

9. In which type of study would you have the most confidence?

- **a.** a randomized clinical trial with 10,000 subjects
- **b.** a randomized clinical trial with 5,000 subjects
- **c.** an epidemiological study with 15,000 subjects
- **d.** an endorsement of a product by a movie star
- **e.** a report on a study presented by a new organization

➔ USE IT

10. Your friend's mother has always been a coffee addict. She recently received a diagnosis of Parkinson disease. Does her experience negate the results of the *JAMA* study described in this chapter? Why or why not?

11. Depending on the television station that you watch, you may have seen advertisements that show beautiful people with clear skin who claim that a specific skin care product is "scientifically proven" to reduce acne. The product reportedly gave these people their glowing, clear skin.

a. Is their testimony itself strong enough evidence for you to act on? Why or why not?

b. What kind of scientific evidence would convince you to spend money on this product? Explain your answer.

SCIENCE AND ETHICS

12. You know that scientific reports are subject to peer review before being published in scientific journals. Do you think that scientists should also review media reports about their studies and work to correct any misleading statements? Why or why not? Who is ultimately responsible for what is reported in the popular press?

13. Your grandmother has told you about the changes she is making to her diet because of stories she has read in the news. Make a checklist of things she should consider before changing her behavior.