In 100 years, almost every single English speaking person now on earth will have died, yet English will still exist. Every mathematician now alive will be dead, yet mathematics will go on; every physicist, every musician, every painter, every postal worker will have passed on, yet there will still be physics, music, painting, and the mail will still go through.

Now society is a very complicated thing. Societies must grow and distribute food, carry away wastes, provide housing and health care, entertainment and other services, establish and maintain transportation and communication, raise children, and provide all the things that are needed to sustain life. And the collection of all the people in a society at any time knows how to do all these things. But, in each generation, everyone

who knows how to do all these things dies, and so the vast collection of information about how society works must be communicated to the next generation with considerable success or human history will stop. This communication of everything a society knows from one generation to the next is the largest communication process we undertake. How society communicates its own structure from one generation to the next has been the object of a great deal of scientific observation and theorizing.

One important aspect of society that every society we know of has is a system of stratification. People have positions or statuses in society, and, in every society yet studied, these statuses are ranked, so that some are considered higher than others. This stratification system is an important part of every society, and is communicated from one generation to the next, for the most part, without great change except under very unusual circumstances, such as revolutions.

Each individual person is born into a position which has the prestige accorded to his or her family, if he or she has a family. After that, he or she will occupy a number of different positions or statuses while moving through life; the prestige level of those positions may be plotted on a graph, and the resulting curve or trajectory will represent the lifetime history of prestige for that person. The set of all these curves for all people in society gives a good picture of the overall prestige system for the whole society. But just what controls the trajectory of each person as he or she moves through life? In other words, just how does society *communicate* its prestige hierarchy from previous generations to each individual member of the next generation?

Scientists at the University of Wisconsin studied this process carefully. The "pattern matching" theory discussed in the last chapter predicted that individuals would try to choose a level of education and an occupation that "best fit" the kind of person they thought

they were. And other hypotheses from the same theory predicted that individuals would learn what kind of person they thought they were mainly from two sources: 1) their own direct observations about themselves, or what is called "self-reflexive activity," and 2) the opinions other persons ("significant others") communicated to them.

More specifically, this theory hypothesized that the opinions of an individual's "significant others" about how much education that individual ought to get would prove very close to the individual's own opinion of how much education he or she ought to get. Similarly, the theory hypothesized that the opinions of the individual's significant others about how prestigious a job that individual ought to choose would prove very close to the individual's own opinion of how prestigious a job he or she ought to seek. Although we've simplified this theory a great deal here, the complete theory of status attainment developed by the Wisconsin group was

usually called "The Wisconsin Model."

Individual people see stratification differently, depending on their point of view or frame of reference. Some favor the existence of stratification, and strive to maintain their own status; others favor stratification but try to raise their own level, while a few actually deliberately lower theirs by giving away their possessions and living a life of poverty. On the other hand, some oppose stratification, and some work actively to eliminate stratification from society, so that every position and person is equal. Which, if any, of these positions you take is a private matter.

But sociologists and anthropologists have studied stratification carefully, with the goal of producing a public understanding of what it is and how it works. Over a period of several generations, scientists have developed public methods for observing stratification. Among these are several scales or indexes that assign a numerical score to most occupations in

society that represents the degree of prestige members of the society accord to those occupations. These numerical scores represent the averages of thousands of observations collected from thousands of members of society all over the world. Thus an occupation like "university professor" has a score of 90 or higher on most such indexes, indicating that it is a very high prestige occupation, while "truck driver" has a score about thirty points lower, indicating people believe it has less prestige.[1] Many scientists have worked many generations to develop these scales, and many continue to work to update and improve them.

Because these public observations of the status of occupations existed, it was possible for the Wisconsin scientists to measure the level of prestige of the occupations individuals sought. It was easy (and public)

[1] You may prefer truck drivers to college professors, or vice versa. But the public scales are meant to give the average beliefs of society as a whole, rather than the individual beliefs of each person.

enough to measure educational level simply in terms of how far the individuals planned to continue their education. But no one had yet invented ways to observe who were "significant others," or to observe the levels of educational and occupational expectations they held for the individuals they were suspected to influence. These concepts were still "private," because no public, agreed upon methods of observation as yet existed. It was necessary for the Wisconsin group to develop such observational methods and make them public.

The development of these observational instruments (The Wisconsin Significant Other Battery) required the work of many researchers over a two year period. Only a small part of that time was required to make the instruments themselves, but a much larger amount of effort was required to measure the relationships between observations made with these devices and observations made with a large series of other scales and devices. This is because the

requirement for scientific observations to be public means that the way the observations are related to already known observations must be discovered. All the findings from this research were published and made available to other scientists who could check them.

The results of the Wisconsin study showed that the educational and occupational plans of high school students were indeed close to the average or mean expectations of their significant others. The predictions were not perfectly accurate, to be sure, but they were *more accurate than those made by any other theory of status attainment available at that time.* These findings were important, because they suggested that it was possible to estimate people's educational and occupational aspirations fairly well simply by knowing the information communicated to them. Of course, if the information provided to an individual did have an influence on what that individual's attitude would be, it might be possible for guidance counsellors, parents and

others to calculate just what they should say to any student to help adjust their aspirations.[2]

Shortly thereafter, the Wisconsin research was repeated almost exactly by scientists at Ohio State University and at the University of Illinois. Because the results at these two universities agreed closely with the Wisconsin results, confidence in the usefulness of the new measurement devices and the theory was strengthened. When a second group of researchers repeats the same study done by one group and finds the same results, the study is said to have been *replicated.* Replication is essential to science. In fact, a common

[2] The Wisconsin theory was interesting in part because it could be expressed mathematically. If it were true that a person's attitude was the mean or average of the expectations that person had received, then one could compute what that person's attitude would become if he or she received new expectations. Or, if you wanted to change a person's attitude to a particular value, you could use the theory to calculate exactly what expectations you needed to communicate to him or her. Even though the theory was not perfectly accurate, making the appropriate calculations would almost certainly give you a better guess than you could make in any other way, and that is why the theory is valuable.

saying in science is "if it hasn't been seen twice, it hasn't been seen." While essential to science, however, the concept of replication is foreign to most other areas of knowledge. If an artist or orchestra were to perform the same work exactly the same way each time it was played, most artists and critics would (rightfully) be somewhat disappointed.

Once an important scientific finding has been replicated enough times so that the scientific community has developed some confidence it may be right, the next step is to try to *generalize* the result to other areas. The original Wisconsin Model, as well as the Illinois and Ohio State replications, applied only to individual's attitudes toward their educational and occupational plans. Now, other researchers began studying how well the same theory could explain other attitudes. The Illinois group extended the study to observe attitudes toward marijuana use, while a joint US-Canadian team studied the effects of information on attitudes toward

separatism in Quebec. In these and other studies, the mean or average of information received by individuals proved a good, but not perfect, predictor of the attitudes of those individuals. When this generalized theory seemed to work about as well for attitudes and beliefs as the Wisconsin Model did for educational and occupational aspirations, it would be appropriate to say the Wisconsin Model was replaced by the newer theory, sometimes called the "Linear Force Aggregation Theory." This, of course, is not because the Wisconsin Model was shown to be false, but simply because it could be shown to be a special case of the more general Linear Force Aggregation theory.

The purpose of the Wisconsin theory was to explain, predict, and, to some extent to make it possible to deliberately change, individual attitudes. But, as we've said before, science is not particularly good at the prediction or explanation of specific individual things. While the Linear Force Aggregation Theory might

predict the attitudes of some individuals quite accurately, it might be far off the mark for others. There are two ways to explain this inaccuracy in dealing with specific individuals. The first of these explanations is that human individuals are inherently unpredictable. By "inherently," we mean that there is something fundamentally "free" about human beings, so that they are not completely controlled by the forces of nature, and can whimsically decide to act contrary to all prior influences. This is a commonly accepted position among some communication scholars as well as many people in general.

A second explanation is that, although individual behavior may be completely governed by natural forces, the influences over any single individual at any time are so numerous and so complicated that it is simply beyond our competence to observe them all with enough precision to predict the outcome. This is the same reasoning which explains why scientists can't

predict where a leaf falling from a tree will land: they believe that the leaf is completely governed by the forces of nature, but that the actual influences are so numerous and complicated that it is impossible in practice to observe them all with enough accuracy to predict how the leaf will fall.[3]

Although this is a deep philosophical question which has roused the best minds to intellectual combat for thousands of years, surprisingly, it may not be particularly important from a scientific standpoint to decide which side is right, because both the "free will" theory and the "too complicated" theory predict exactly the same outcome in any case.

It's easy to see that both the free will theory

[3] In the last two decades, a branch of science, called "chaos theory", has been developed specifically to deal with these very complex processes. One of the major hypotheses of chaos theory is that many, perhaps most, processes in nature, even those completely governed by natural forces, are nevertheless so complicated that it is impossible to predict their future states.

and the too complicated theory predict that individual behavior will not be completely predictable. But it is a little harder to understand that *both theories also predict that, even though single, individual behaviors might be unpredictable, the overall average behavior of a great many individuals might be virtually perfectly predictable.*

To understand how this can be true, imagine a tree with an inexhaustible supply of leaves of all different shapes, sizes, and weights, and imagine that the leaves begin falling. Because the leaves are of different sizes, shapes, and weights, they will flutter in different ways as they fall. If we also assume that small puffs of breeze randomly strike the leaves, you can easily imagine that it will be all but impossible to predict in advance where any one of them will land. Some will fall straight down, others will fall to the left or right, or forward or back. But, as many fall, they will begin to produce a pile of leaves. If the wind is blowing completely at random, the center of the pile will be

directly under the tree. As more and more leaves fall, the pile will take on a definite shape, quite like a shape of a bell. While scientists won't be able to predict where any single leaf has fallen, they will indeed be able to predict with great accuracy where the center of the pile will be, how wide the pile will be, and *how many leaves will lie within any given distance from the center of the pile.* They will even be able to say in advance how likely their predictions are to be accurate to within any given amount of leaves.

Now imagine if you will, the same tree, with the same leaves, all falling generally downward, but imagine that the leaves are completely unaffected by any natural forces at all. Instead, assume that the leaves arbitrarily and capriciously "decide" to jump this way and that as they fall downward. If they do behave completely capriciously and jump randomly about, you will be able to understand that they will, on the average, be equally likely to jump one way or the other, and *the effect will*

be the same as the effect of the random forces in the first example: the leaves will fall into a pile shaped roughly like a bell; the center of the pile will be directly under the tree, and scientists will be able to predict in advance the location of the center of the pile, and the number of leaves in the pile within any distance from the center of the pile. They will also be able to tell how likely their estimates are to be within a certain range.

In this particular way, human individuals are like falling leaves. Each person receives information not only from significant others, but from random strangers, mass media, passersby, and their own observations of the world around them. This stream of incoming information is far too complicated to be observed in its entirety, so no scientists really believe it possible to predict the attitudes, beliefs, and behaviors of a single individual with much precision. But it becomes easier and easier to predict the average attitudes, beliefs, and behaviors of larger and larger numbers of people.

Although this idea may at first seem strange, it is really quite simple. Whenever differences crop up *at random* (as is the case if objects behave freely or if they are influenced by random forces from nature), the differences are equally likely to show up in any possible direction. When you take the average of all the differences, because they are in every possible direction, they average to (approximately) zero, and so don't show up in the final average at all.

A scientist at the University of Michigan applied this reasoning to the Wisconsin model. He measured the major political attitudes of students and their parents, and found that the attitudes of the parents of any single child often were quite different from the attitudes of that child. But the attitudes of all the parents taken together were very similar to the attitudes of all the children taken together. This finding indicates that the political attitudes of each generation are very strongly influenced by the political attitudes of the

previous generation through communication from one generation to the next ("intergenerational communication"), even though the attitudes of any single child may be influenced by many factors other than his or her own parents attitudes.

The Michigan study showed that the Wisconsin theory, which predicted individual attitudes reasonably well, could be used to predict *collective* attitudes extremely well, at least in this case. This theory was useful in a number of ways. First, it was able to explain an important phenomenon -- how information influences attitudes and beliefs -- with relatively good precision. Secondly, it was quite a simple theory, and, other factors equal, scientists always prefer a simple theory to a complicated one. Third, the theory could be expressed mathematically, which is always a great advantage when it turns out to be possible, because the deductive and inferential power of mathematics becomes available. In fact, the mathematical equation that describes the

theory in its simplest form is quite well known:

$$A = \sum_{i}^{n} (I_i/n) \qquad (1)$$

where A = the attitude formed,

I_i = the value of the $_i$th bit of information received, and

n = the number of bits of information received from direct observations and from other persons.

This equation means, in words, that the attitude of a person will be the sum of the values of all the incoming messages he or she receives, whether from the environment directly or from other persons, divided by the number of messages received.

Nevertheless, the theory at that time was still

quite limited because it could only be applied to those attitudes which could be expressed quantitatively, such as how many years of school an individual planned to attain, or how much occupational prestige a person wished to achieve, or how many times you voted for a Separatist political candidate. The theory could not be applied to attitudes that were not quantitative, for a very simple reason: If, for example, your mother wants you to finish college, a total of sixteen years of school, and your father wants you to finish high school, a total of twelve years of school, it is easy to see that the average or mean is (16+12)/2 = 14 years. But if your mother wants you to be a doctor and your father wants you to be a journalist, just what *is* the average of doctor and journalist? The equation x = (doctor + journalist)/2 makes no sense. The theory is undefined in cases of discrete choice, and hence useless for anything other than quantitative attitudes.

Theorists at the University of Illinois studied

this problem from a mathematical point of view. They reasoned that even discrete, non-quantitative things like occupations differed from each other and from other things *by some amount*. One could say not only that Doctor and Journalist were *different,* but that they differed *by a certain amount*. Much in the same way as the Wisconsin group developed the Wisconsin Significant Other Battery, they developed a measurement system that obtained *quantitative estimates* of how much each occupation differed from each other occupation. They then developed mathematical methods for plotting these differences on a graph. Although the mathematical procedures for making these graphs are beyond the scope of an introductory account, the graphs themselves and the way they are used are easy to understand.

Figure 1 shows a graph of the differences among a set of occupations. You can notice that Plumber and Carpenter are much closer together than

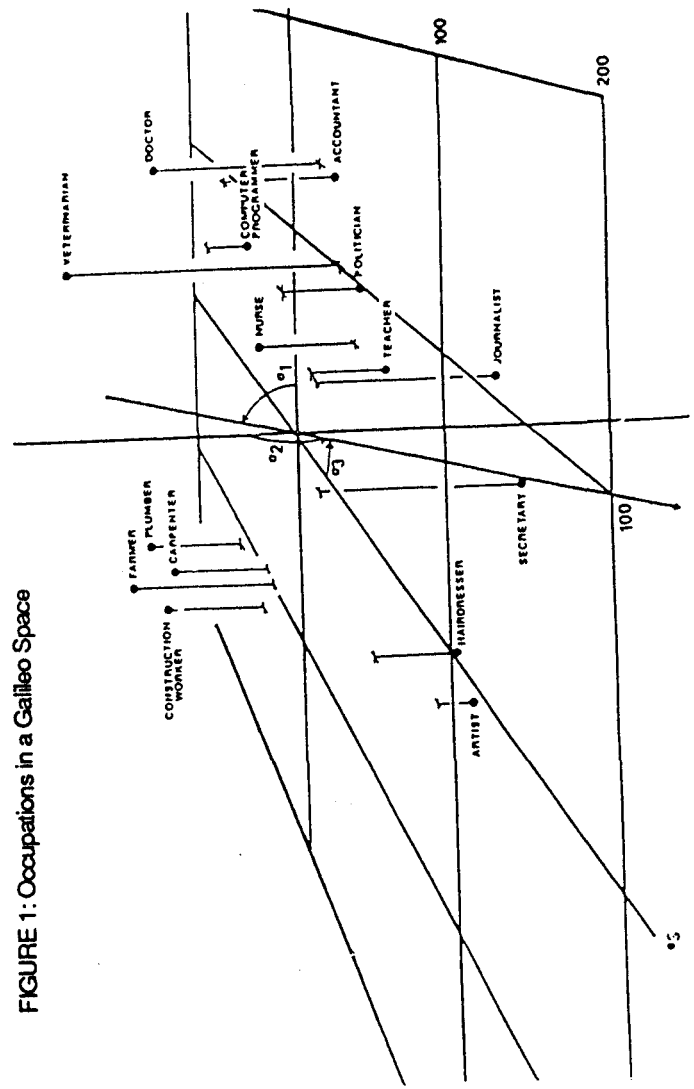


FIGURE 1: Occupations in a Galileo Space

Doctor and Journalist, which means that people perceive Plumbers and Carpenters to be more similar than Doctors and Journalists. The locations of each of these occupations in the graph is established by their *coordinates*. Each occupation has two coordinates in this graph, one along the horizontal axis (the "x" axis), and another along the vertical axis (the "y" axis). The distances between any two occupations are related to their coordinates by the pythagorean theorem. You can notice that, if lines are dropped from each of two occupations perpendicular to the x and y axes, they will form a right triangle. You may recall that the hypotenuse of a right triangle is equal to the square root of the sum of the squares of the two remaining sides; in this way you can prove to yourself that the *distance between any two occupations is equal to the square root of the sum of the squares of the differences between their coordinates,* or

$$s_{ij}=\sqrt{(x_i-x_j)^2+(y_i-y_j)^2} \qquad (2)$$

where s_{ij} = the distance between the *i*th and *j*th occupation

x_i = the coordinate of the *i*th occupation on the x axis,

x_j = the coordinate of the *j*th occupation on the x axis,

y_i = the coordinate of the *i*th occupation on the y axis, and

y_j = the coordinate of the *j*th occupation on the y axis.

The great significance of this graph is that it makes it possible to treat non quantitative concepts in a quantitative way. For example, it is now possible to calculate the *average* of Doctor and Journalist; this average is given by simply taking the average of the coordinates of Doctor and Journalist on each axis; the

result is an average coordinate on each axis. Plotting the point which corresponds to these coordinates on the graph gives the location of the average of Doctor and Journalist.

Based on this new technology, the original theory can now make a prediction about what the attitude of an individual ought to be if his or her significant others expected him or her to be a journalist and a doctor; the theory now predicts that the individual ought to choose an occupation which is close to this average spot.

A researcher at Montana State University, using a version of the Wisconsin Significant Other Battery modified to gather the observations needed by this more general version of the theory, compared the occupational choices of high school students in Montana with the observations predicted by the modified theory. He found that the actual observations coincided very well (although not perfectly) with the observations

predicted by the theory. This new theory is called the Galileo Theory, and, just as the Linear Force Aggregation Theory replaced the Wisconsin Model, the Galileo Theory claims to be a replacement for the Linear Force Aggregation theory. Once again, you should understand that this is not because the Linear Force Aggregation theory was shown to be false, but rather because it is a special case of the more general Galileo Theory.

Just as with the simpler, less general Linear Force Aggregation theory, this more general Galileo theory made it possible to predict the actual career choices of high school students with good accuracy by simply knowing what careers their significant others expected of them. And equally important, they theory could be used to predict how a student's career choice might change if he or she received new expectations. Similarly, if one wished to influence a student toward a particular career, the theory could be used to determine

just what kind of expectations could be communicated to him or her to change his or her career choice toward the desired outcome.

No other group has yet attempted to replicate the Montana State findings, but other research groups have attempted to generalize the theory to include other discrete, qualitative choices besides occupations, and to more areas than simply occupational choice. Researchers at the University at Albany, The University of Hawaii, The East West Center and Michigan State University, for example, generalized the equations of the theory to predict not only beliefs and attitudes toward occupations, but *changes* in those beliefs and attitudes.

Because the theory takes a mathematical form, it is possible to use mathematical reasoning to make predictions. Because the theory predicts that the beliefs and attitudes people have about occupations are the average of what they have heard in the past, it is possible to write an equation for what the new beliefs

and attitudes will be expected to be if new information is received.

$$B_{new}=(N_{old}B_{old}+N_I I)/(N_{old}+N_i) \quad (3)$$

This equation says that, when an individual or group receives a new batch of information, their new belief (B_{new}) will be equal to the sum of the old belief (B_{old}) multiplied by the number of messages from which the old belief was formed (N_{old}) plus the number of messages in the new information (N_i) multiplied by the value of the incoming information (I), which sum is divided by the sum of the number of messages in the old belief and the number of messages in the incoming information. This new equation is simply derived by algebra from equation (1), and is the same equation you would use to calculate how your grade point average will change after you add this semester's grades into

your existing average, or what a hitter's batting average will be after you add his average for today's game into his season average up to today.

The equation works regardless of whether the values entered into it represent a quantitative attitude, such as how many years of education you plan to attain, or represent the coordinates of discrete, qualitative objects in space.

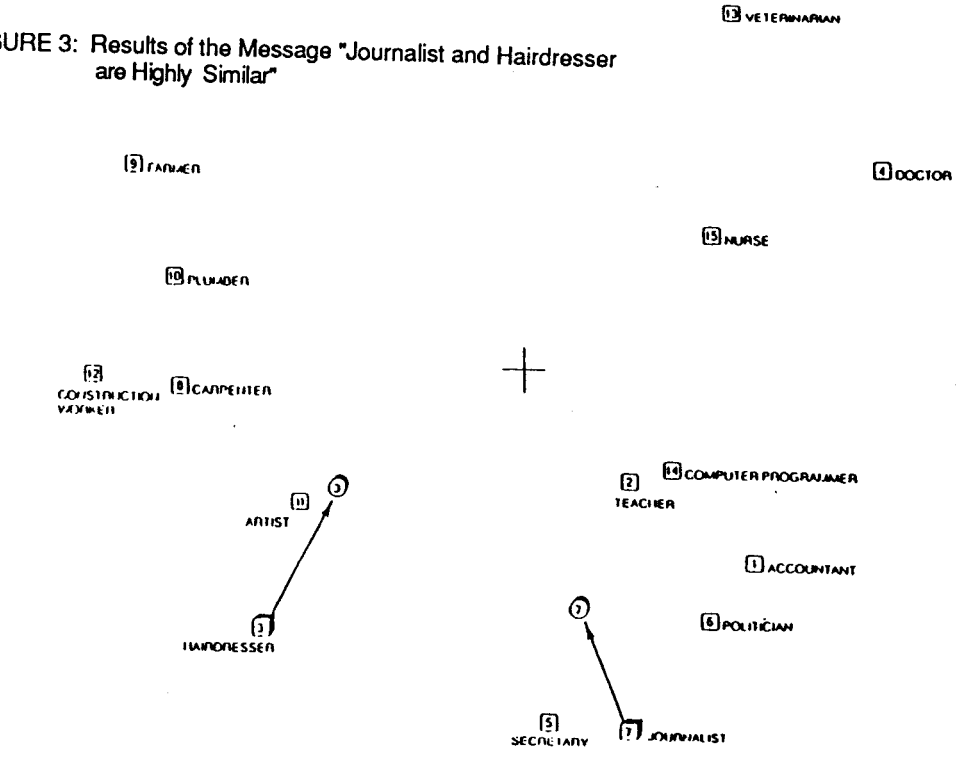
The Hawaiian, Michigan and New York team used the Galileo methods to measure the beliefs of over a thousand students about 15 occupations selected from the Montana study. In one group (what is called a "control" group) they simply measured these beliefs; in four other "treatment" or "experimental" groups, they provided the students with information that said some of the occupations were similar to each other before measuring the students' beliefs. The researchers used a somewhat more general form of equation 3 to predict what the coordinates of the occupations should be after

the students received the new information about them, then compared the actual observed positions of the occupations with the observations the equations from the theory predicted should be seen.

In this experiment, the theory predicted that the occupations which were said to be similar should move closer to each other. In all the cases, this happened. But in every case, some more than others, the experimental or manipulated occupations were also shifted toward the center of the graph, which the theory did not predict. Figure 2 shows a case in which the occupations moved almost exactly as the theory predicted, while Figure 3 shows a case in which the unexpected shift toward the center is quite noticeable.

On one hand, the results of the experiment tend to support the theory, because they show that the theory makes fairly accurate predictions about how beliefs change in response to new information. On the other hand, if the unexpected displacement is confirmed by

FIGURE 3: Results of the Message "Journalist and Hairdresser are Highly Similar"



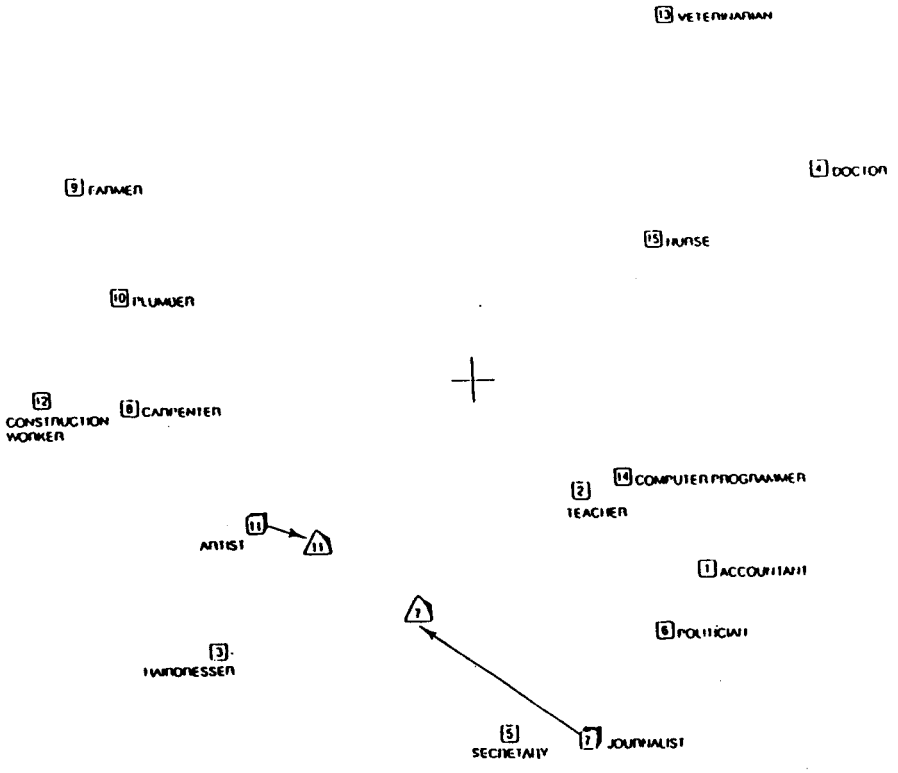


FIGURE 2: Results of the Message "Artist and Journalist Are Highly Similar"

other investigators in other studies, it will be good evidence that the theory is not perfectly accurate and needs to be revised to account for the new observations. Unexpected findings like these are always exciting to scientists, because they signal the possibilities of new developments and deeper understandings.

The theory has been studied and revised many times since then. Many observers, for example, have noted that attitude and belief changes do not take place immediately, but are spread out across intervals of time. Sometimes it appears that beliefs and attitudes change some time after messages have been received; sometimes they change in one direction and then appear to change back in the original direction. Theorists at Michigan State University and The University of Maryland hypothesized that there might be another "force" at work, a restoring or equilibrium force, which acted to hold attitudes and beliefs in place and to restore them to their previous positions if they were

dislodged. If this were true, beliefs and attitudes would behave something like springs, or pendulums, or marbles in the bottom of a bowl. If they were dislodged from their "resting" position at the bottom of the bowl, they would tend to move back. This would mean that beliefs and attitudes would tend to "oscillate" (move back and forth) under some conditions. Observations made by several different investigators seem consistent with this hypothesis, but much more research is needed before a solid understanding is achieved. If further research shows the oscillation model predicts observations better than the Galileo theory's simpler equations, then the Galileo theory will have to be modified. At that time, scientists may rename the theory and call it a "new" theory, or they might just modify the old theory and keep its old name.

Technologies

Several hundred other studies related to this theory have been done, but these few are enough to provide a sketch of how theories and observations are related in science, and how scientists seek to improve and expand theories by making observations and conducting experiments. But once a theory reaches a stage of development where it makes predictions better than are possible without the theory, and enables a degree of control over events that is greater than what is possible without the theory, *applied technologies* begin to develop. *Technologies* are routinized methods of doing something in practice rather than just understanding in theory. Unlike science, whose sole purpose is to understand and explain experience, the purpose of technology is to do something. In the case of the Galileo theory, computer programs that incorporate all the important equations that make up the theory

provide a useful technology, because they make it possible to predict the likely effect of information on the beliefs and attitudes of a large group of people before that information is actually communicated. The Galileo technology also makes it possible to calculate in advance what kind of information needs to be communicated in order to change people's beliefs and attitudes in a specific way. Advertisers, market researchers, product developers, politicians, and others have made extensive use of Galileo technology to develop public information campaigns, advertising and political campaigns, new products, and many other activities.

Neural Networks

The Galileo theory has developed from a very crude model into a fairly general, precise and useful theory relative to other theories of attitude and belief change. Its equations provide reasonably accurate

descriptions of the processes of attitude and belief change observed in experiments. And its applied technology enables technicians to design changes in collective beliefs and attitudes with useful precision. Yet the Galileo theory does not provide any *explanation* for attitude or belief changes. It is, like Newton's theory, simply a description of how certain things appear to act. It is not as precise or general or important as Newton's theory, but it is the same *kind* of theory: Newton's theory provides a set of equations that describes how any objects will move relative to each other under any circumstances; the Galileo theory provides a set of equations that describes how beliefs and attitudes will change under any circumstances. Neither theory "explains" why these things happen as they do.[4] Both

[4] There is a sense in which the relative motions of bodies can be said to be "explained" by Newton's concept of gravity, which is a force by which every body attracts every other body. Newton's great insight was to see that bodies would behave as we know they do if there were a force of mutual attraction acting among them. But just what

theories are really simply mathematical descriptions of motion and change under certain ideal conditions. On the other hand, the myth of the turtle who carries the sun across the sky not only describes how the sun moves, but explains it. (The explanation, of course, has turned out to be false -- careful observation has failed to locate the turtle.)

Recent research, however, has learned a great deal about the physical processes by which the brain works. Fundamentally, the brain appears to be composed of *neurons*, which are like biological "switches". These neurons communicate with some of their neighbor neurons electrochemically. When stimuli activate some neurons beyond a certain *threshold*, they turn on or "fire", which sends electrochemical messages to the other neurons to which they are connected. If these neurons, in turn, are stimulated beyond their

gravity is, or why it is that bodies should attract one another is completely unknown, even today.

thresholds, they also fire. The result is that a pattern of neurons is activated when external stimuli are experienced; as the pattern of external stimuli changes, the pattern of neuron firings also changes. Mathematical analyses too complicated to describe here show that brains built on this model would exhibit properties very similar to those predicted by the Galileo theory. If further research confirms these early and very tentative speculations, Communication theorists would certainly adopt the newer theory, because it would agree with known observations as well as the Galileo theory does, but goes further in providing a mechanism that explains what the Galileo theory only describes.

Before a new theory can be adopted, however, it would have to fit the pattern of observations available at least as well as the old theory. Researchers at the University of Buffalo have developed computer based neural network simulators which appear consistent with Galileo theory, and which can learn to carry out simple

conversations. While a great deal of further research is necessary, this new model appears very promising.

Summary

This chapter has provided a brief description of the development and change of one communication theory, the Galileo theory. Galileo theory began as a simple set of hypotheses about how children developed their educational and occupational aspirations called The Wisconsin Model. In this form, the theory predicted that the educational and occupational aspirations of high school students would tend toward the mean or average of the information they received from self reflexive activity and from the expectations of their significant others. It then was generalized to include the process by which any one-dimensional, quantitative beliefs and attitudes at all were formed, and was then called the Theory of Linear Force Aggregation, which predicted

that the attitudes and beliefs of any person would tend toward the mean or average of all information about those beliefs and attitudes received from direct observation and from other persons. That theory was then generalized again to apply to multidimensional, non-quantitative beliefs and attitudes, at which time it began to be called The Galileo Theory, which predicted that the holistic cognitive structure of people and groups would tend toward the average of the information they received directly from the environment and from communication with other people. At each stage, the theory was modified to make its fit to observations closer. As more and more experience with the theory accumulated scientists began to develop applied technologies that were useful for practical purposes. At present, it appears possible that the entire theory might be replaced by a more general, more explanatory theory based on the structure of the brain.

While the Galileo theory is by no means the

only important theory of communication and its effects, it provides a good example of how science proceeds from a body of observations to form simple hypotheses which in turn grow into theory which is continually corrected, modified, and generalized on the basis of continuous comparison with observations. It also shows how science is a collective process involving an organized community of scientists who share common definitions, common methods of observations, and who communicate their observations to others who must check them.

Chapter IV

VARIATIONS IN COMMUNICATION THEORY AND RESEARCH

Scientists are usually not much interested in science. Of course, typically scientist love science, and study extremely hard to learn how to carry out scientific research, but they are most interested in using scientific theories and methods to discover something interesting about their particular topic. High energy particle physicists, for example, are very interested in the structure of matter; astronomers are deeply interested in learning about the universe and its origins, biologists are concerned about life processes in many ways. But few scientists, particularly physical scientists, are much interested -- except, perhaps, in a recreational way -- in the study of science itself. Many of them consider such study a waste of time, and prefer to get on with doing science instead of talking about it.

This is not so in the social sciences, however.

As we have said, science is a collective, social process, and so it is not only a method that some social scientists use, but also a topic that some social scientists study professionally. This is particularly true for Communication scientists, because science is, first and foremost, a communication process. Communication scientists study science not only to learn how to do it, but to understand it as a type of communication processes. In this chapter, we will try to examine the process by which science works, and understand it as a communication process.

In the last chapter, we discussed the development of one theory (sometimes called the "Galileo" theory) about the effects of communication on people's beliefs and attitudes. This is only one theory, but there are many other theories which Communication researchers use to explain the effects of communication on people's beliefs and attitudes. The Galileo theory states that people's attitudes and beliefs

tend to move toward the average or mean of the information they receive from all sources. While the Galileo theory and most other communication theories generally agree that communication among people has important influences on those people, they disagree about what kinds of influences communication has, and about what is the basis of that influence.

Some theories hold that people may tend to accept information that is consistent with what they believe and reject information that is inconsistent with what they believe. Other theories hold that people are more likely to be influenced by information they receive from people they like than from people they don't like; still other theories believe that people are free to accept or reject information on a completely arbitrary basis, so that attitudes and beliefs are not explainable or predictable by scientific means. There are dozens of other serious theories in use. Moreover, each of these theories has been tested many times, some of them

hundreds of times, by deriving hypotheses and making observations or conducting experiments to see if the predictions of the theories match the observations actually recorded. Why is it that communication scholars haven't come to an agreement about which is the most general, most accurate, and most useful theory?

One possible reason, and a very good reason indeed, may be that none of the theories is particularly good, and that none works much better than the others. Or, it might be that some theories work better in some situations while other theories work better in others, so we need to keep them all. Another possibility might be that the observational methods we use to determine how well they work are not precise enough to discover which, if any, is best. And, another possibility, which some communication scholars believe, is that communication is not fully explainable by any theory at all, so it is impossible to invent a single theory that will work particularly well.

There may be some truth to each of these proposed reasons. There is another possibility, one predicted by the Galileo theory itself. Science, as we have described it, is above all a *communication* process. Remember that Einstein said that, by the aid of language, we are able, to some extent, to communicate about our experiences. Those about which we agree, we call real. Niels Bohr said science is the process by which we make observations and communicate them to others, who must check them. And, as we said earlier, science is a process whereby scientists attempt to develop a common, public understanding of our observations about which we agree. All these definitions of science understand the scientific process to be a communication process, in which many people communicate among themselves, make common definitions of words and form agreements about procedures for making observations in common ways, and try to formulate theories that explain the relationships among those

observations.

All communication theorists, however, do not communicate equally with all others. All societies -- including societies of scholars -- are structured into communication networks. A *communication network* is the pattern of communication that takes place among people.[1] People who share the same living or working space tend to communicate more frequently than those who are widely separated. People who are concerned with the same topic, such as mass media, or debate, or drama, or attitude change or interpersonal communication or critical theory or other topics, tend to communicate more frequently among themselves than with others. People who belong to the same scientific or professional organizations tend to communicate more

[1] In its most general form, a communication network is a pattern of communication among nodes, where a node can be any communicating entity, such as a group, person, organization, neuron, switch, or virtually anything else that can communicate with its environment.

frequently with each other than with non-members, and so forth.

Many theories, including the Galileo theory, predict that people who communicate tend to grow more similar in their beliefs, attitudes and actions. (Because your attitudes are the average of the information you receive, you will grow more similar to your conversation partner, and your partner more similar to you.) This is true of communication scholars as well as everyone else. Because communication researchers tend to cluster together according to their specialties and interests, they tend to develop beliefs, attitudes, and behaviors which are similar within interest groups and dissimilar across groups.

These similar beliefs and attitudes may be thought of as *theories* about the experiences of the members of these groups. Another term often used to describe the shared set of attitudes and beliefs of people who are connected to each other in a communication

network is *cultures*. Thus, each interest group within the field of communication has developed its own unique culture, which may be thought of as its own *theory* of the world in which its members live and work. As we discussed earlier, these cultures or theories represent different *frames of reference* from within which each member of the culture makes observations. To the extent that these cultures are different from group to group, it is difficult or impossible to compare the observations made by members of different groups with any precision. As a result, it is often difficult or impossible to compare the theories produced by one group with the theories held by another group. The field of communication, which consists of many such diverse groups, is very much divided into different cultures which communicate a great deal within each group, but not much across groups, and so common agreements about theories, observation methods, definitions of words, and the like have not progressed very far. It is

fair to say that the field of communication has not developed a common frame of reference, but rather consists of a large number of competing frames of reference. Thus, communication scholars are often able to reach agreements within each group, but have not yet reached general agreements across groups.

To some extent, these subgroupings correspond to topics, so that we have groups interested in interpersonal communication, others in intercultural communication, or journalism, or health communication, or organizational communication. But even within these groups, researchers tend to cluster around approaches to theory and method. As we have seen, the field of communication is large and diverse, and there is no possibility of describing or even listing the huge array of theories and methods in use in the field.

It is possible, however, to discuss several *types* of theory and method that are used in many different ways. There are three general approaches we will talk

about in this chapter: the *intuitionist,* or *qualitative,* approach, the *logical,* or *categorical,* approach, and the *quantitative,* or *comparative,* approach. As we saw earlier, individual researchers sometimes tend to specialize in one or another of these approaches, and this often results in friendly or not-so-friendly rivalries between advocates of each different approach. In the short run, these arguments often appear to make sense, because the splitting up of the scarce resources available to communication students in general often requires one or another group to grow or shrink, and it is natural to speak out for one's own side. In the long run, however, science has always relied on all three approaches taken together, even if any single scientist may specialize in only one or perhaps two. As we shall see, each of the three approaches is incomplete without the others, and arguments as to which should predominate make as little sense as arguing about which of the legs of a stool ought to be the longest.

Chapter V

HUMAN INTUITION AND SCIENTIFIC UNDERSTANDING

In our discussion of scientific method, we said that the scientific process always begins and ends with observations: a collection of observations is gathered, hypotheses about recurring patterns in the observations (how they go together) are made, experiments or observations are conducted, and then verified by further observations, at which time the process begins again. But, like all introductions to a complicated topic, this description is an oversimplification. In particular, it doesn't make clear why observers were gathering observations in the first place, or how they chose what to observe. Nor does it say much about the process by which hypotheses are derived, particularly the first few hypotheses.

When well-formed theory already exists, hypotheses can be derived by logic or mathematical

reasoning. Thus, in extending the Wisconsin theory of status attainment to the area of, say, attitudes toward French Canadian Separatism, it was possible to hypothesize that the attitudes of Canadians ought to be the average of the attitudes communicated to them by their significant others using algebra alone. It is easy to see that one must measure the attitudes communicated to a sample of Canadians, measure the attitudes of the members of the sample, and compare the means of the attitudes communicated to the sample members with the sample members' own attitudes. But in the initial stages of studying a topic, when a well-formed theory does not yet exist, how does one know what to observe? Or what to hypothesize? The beginnings of scientific inquiry may well be the hardest, and certainly take the longest.

If science begins with observation, what shall we observe and how shall we observe it? When a well developed theory about some topic already exists, it is filled with suggestions about what should be observed.

A theory makes many predictions about what kinds of things ought to happen under particular circumstances. The theory of universal gravitation, for example, predicts that every object ought to fall at a rate that is proportional only to the length of time it has been falling. This suggests certain experiments and observations that we ought to make to test the theory. The Galileo theory predicts that, when two groups communicate without any special restrictions, their beliefs and attitudes ought to grow more similar, and this in turn suggests certain experiments and observations that we might make to test the theory and improve it. But what do we do when we are studying a topic for which there is, as yet, no well developed theory? What should we observe and how should we observe it?

The physicist Richard Morris has made this point very well:

A lot of people still have the idea that the description of scientific method that Francis Bacon proposed around the beginning of the seventeenth century was basically correct. I'm sure you know how it goes. Scientific laws are supposed to be generalizations from observed facts. If you want to do science, you accumulate this data, ponder your results, and then deduce a theory from them.

Well, the only trouble with that description is that science doesn't work that way. And it never has. The construction of a scientific theory is an act of creative imagination. The scientist discovers that there are some physical or chemical or biological phenomena that he can't quite figure out. So he looks at them. And looks at them. And feels completely baffled. Then, suddenly, he has a flash of insight, and everything makes sense. A theory comes into being. Only

then do scientists begin to perform experiments to find out whether or not the theory is correct. Theories are not generalizations from experiment. On the contrary, it is the theory that tells the scientist what experiments to perform. (Morris, 1988)

In these stages of scientific inquiry, research tends to be guided by *intuition*, based on the particular interests of the observers. It is fair to say that no one knows precisely what intuition is, but we can discuss some of its main features. First and foremost, intuitive methods are *inductive*. Induction means to discover general ideas from the observation of many specific instances. In an intuitionist model, observations are not sharply focused by hypotheses, but guided by the insights of earlier observers and hunches on the part of the observer. Wide collections of frequently disparate data are gathered and recorded. Methods of observation tend to be non-standard and individual, guided by the

interests and talents of the observer. The observations are usually recorded in ordinary language rather than a special code like mathematics, although, as a body of collective observations grow, specialized codes for describing the observations tend to develop. Methods of observation, recording, and comparing observations tend to be informal rather than formal.

While the observations are being gathered and shared, researchers examine and reexamine the body of data in the hope of detecting useful, recurring patterns. As in any scientific theory, these patterns represent the ways in which observations "go together." The Big Dipper is one way a pattern of stars may be described; Ursa the Bear is another way to represent the same pattern. Patterns may be thought to represent the underlying reality in a confusing, fuzzy realm of experience, or as abstract simplifications of the richness of experience, or as analogies to other areas of observation, or even as simple mnemonics to help us

remember what we have observed. Whatever they may be, however, once identified and widely shared, they tend to become not the realm of observations we experience, but the social reality about which we communicate and agree. Thus, the patterns that result from an intuitionist approach to observing incoherent and private personal experience tend to render it coherent and public. They do so by making some aspects of our experience more salient while obscuring others. Once having learned to see a pattern in a complicated swarm of data, we tend to look past the actual sensory stimuli and perceive the pattern we have learned to associate with those stimuli. When Neanderthals looked at the sky they may have seen the embodiment of the spirit of the Great Bear; runaway slaves saw instead the Drinking Gourd which marked the pathway to freedom via the underground railroad, and a modern astronomer may see pinpoints of thermonuclear hydrogen plasma embedded in a cosmos

of interstellar dust.

Untrained observers are notoriously poor at observing and recalling what is before them. Many artists and teachers of art say that people can draw anything they can see; failure to be able to draw common objects like houses and trees and faces and animals is usually not due to lack of hand control (people who can write beautifully often can't draw at all) but instead to inability to see accurately. A great part of initial instruction in drawing and sketching, then, usually involves teaching students to see the underlying patterns in the objects they are trying to draw. Usually this involves training students to recognize basic geometric shapes, such as lines, circles, squares, rectangles, triangles, ovals and their extensions such as lines, rectangles, balls, cylinders, cones, and ellipsoids. When looking at a human face, the student is taught to see eyes, heads, cheeks, and the like as circles, noses as triangles, and so on. Once students have learned to "see

through" the object to the more basic underlying patterns, they are able to remember what they saw and draw it.

What works for visual patterns works as well for sound patterns. As bad as people are in seeing things, they are frequently as bad or worse at hearing them. Musical training, in its earliest stages, often consists in exactly the same kind of training for the ear as artists provide for the eye: certain simple, recurring pasterns are picked out (abstracted) from the total sound picture and students learn to recognize them. First among these is often the concept of "interval," or distance between pitches. Students learn to divide the octave into eight intervals, and learn to recognize and remember those intervals. The interval between the pitches of "Row, row, row " and "your" is a second; the interval between "Row, row, row" and "boat" is a third. The interval between the first and second "twinkle" in "Twinkle, twinkle, little star" is a fifth, while the interval

between "My" and Bon" in "My Bonnie lies over the Ocean" is a seventh. Once having learned these underlying patterns well, it is possible to listen to a previously incomprehensible piece of music, hear what was played, remember it, and even to write down what was heard.

Teaching these patterns to students requires skill and diligence, and results in vastly improved ability to observe, record, and communicate about what we see and hear. But, great as those skills might be, they are minor compared to the skill and insight required to discover them in the first place. It is the intuitive process that allows persons to explore previously incomprehensible observations and to discover and catalog the underlying simple, recurrent patterns that make it possible to create a public realm of experience.

Not all underlying patterns need to be visual or auditory. In examining the ongoing communication of individuals, for example, some astute observers might

note that, underlying the very different and complicated interactions of everyday life, one can see simple, recurrent patterns that are rather like a stage drama. If this is approximately true, then it is possible to use these "dramaturgical" symbols as a framework on which one can place the observations one has made, thus making it easier to see, record and communicate about what one has seen.

Because these patterns have important consequences, intuitionist researchers debate over alternative patterns. Human experience abounds in patterns, and it is not enough to detect and record any pattern at all, because many, perhaps infinitely many, patterns may be found in any large body of observations. When observing human intercommunication, for example, one observer may see a dramaturgic pattern, with each individual a player on a social stage, with back regions and roles to be enacted for social audiences; another might see individuals

mutually negotiating identities and goals in a constantly changing setting, while a third might see people acting out false consciousness imposed on them by giant economic forces. Freud intuited from the lifetime of observations of his patients a pattern consisting of a tripartite mind; an *Id*, or striving font of sexual energy pressing for gratification, a *Superego*, or internalized representation of parents and social forces restraining the desires of the Id, and an *Ego*, or rational agency which attempted to find ways and means of gratifying the unending desires of the Id without engaging the retribution of the Superego. George Herbert Mead saw instead a pattern of a subjective *I* which existed only in the instant of now, fading instantly into an objective *Me* which represented the objective, historical self of which the *I* was aware. Each of these patterns is a way of representing aspects of our observations that is more or less coherent and which "explains" the activities we observe.

V Intuition

Intuition involves taking in large, unstructured sets of data and finding a best matching pattern for those data. While there is some well-founded suspicion that the process by which intuition proceeds is similar -- if not perhaps identical -- to the way neural networks operate, an important characteristic of intuition is that it is holistic and non-algorithmic. By holistic we mean that intuition takes into account entire patterns of data at once, rather than processing bits of information one at a time, as a common serial computer does. And by non-algorithmic, we mean that no one, not even those who have the intuition, knows how they arrived at the conclusion they did.[1]

[1] The weaker use of the term non-algorithmic simply means that the process by which an intuitive judgment is made is not known by the person making it. The stronger use implies that there is no definable process which could be described even in principle. Whether all human activity is algorithmic in the stronger sense is a subject of debate in cognitive and computer science, but there is little disagreement among experts that few people if any understand how their insights work in practice.

Intuition seems to take place at the beginning of every theory. It is possible, for example, to understand the experiment by which Galileo established his law of falling bodies, but the process by which he came to see pendulums, balls rolling down inclined planes, and free falling objects as the same remains fuzzy. In the same way, the mathematics by which Newton derived the trajectories of the planets from his laws of motion and law of universal gravitation are among the most famous and admired in human history, but how Newton intuited the laws in the first place remains obscure, and we rely on a myth about an apple falling on his head to explain this fundamental insight.

But intuition alone is never sufficient; it was also through intuitive methods that Aristotle derived *his* laws of motion, which are incorrect. In fact, it is

probably fair to say that most intuitions are false. While intuition is an indispensable tool of science, it cannot stand alone. Its strengths as a method are that it allows often spectacular insights into areas that have been without clear form, it is holistic and provides leads and understandings when more formal deductive or quantitative methods are without a clue as to what to do. But it also has drawbacks. First and foremost, it is a highly uncertain method. While it is true that some of the intuitions of the greatest men and women of history have been of breakthrough importance in the development of our understanding of our experience, most intuitions are simply wrong. Even many of the intuitions of the great minds of history have been far off the mark: Galileo's intuition about the tides being a result of the motion of the earth, for example, is not only wrong, but quite inconsistent with a good deal of what Galileo himself knew.

Secondly, because the chain from observation to conclusion in the intuitive process is murky, the language of intuition and the conditions under which intuitions are made are not standardized, it is virtually impossible to compare the intuitions of two or more observers.

The result is that intuition is essential to originating ideas and theories, as well as overthrowing them with new theories. But intuitionist approaches have little value in confirming or rejecting theories. In fact, one important criteria which separates scientists from other scholars is their reluctance to accept any insight, no matter how brilliant or compelling, as anything other than speculation until it has been exposed to exhaustive and repetitive checking against observation by many observers over a long time. To be sure, a scientist may have a strong feeling that a theory is right or wrong which may guide much of his or her research, but must always reserve judgment in the end until painstaking

comparisons with observations have been made.

An artist, a philosopher and a scientist once came upon a flock of sheep in a field.

"Look," said the artist. "Those sheep are all black!"

They *appear* to be black," the philosopher said.

"...on the side we can see," said the scientist.

Chapter VI

CATEGORICAL METHODS: LOGIC AND SCALING