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The Logical Animal

It was Bernard Shaw who said that we use our reason only to support our prejudices. This is what psychologists call rationalizing: finding logical reasons for doing what we want to do, or are going to do anyway. Shaw's epigram draws blood, but fortunately for the human race it is not true, at least not universally. All of us rationalize part of the time, but when we stretch it to *all* the time, the moment has arrived to call in a good psychiatrist.

Sane people have their objective intervals, when they manage to deal directly with the world around them and to use that extraordinary instrument the human brain to discover what is actually going on out there. One name for this effort is common sense, another, the objective view, and another more recent name, the scientific attitude. It consists of putting two and two together regardless of one's desires and prejudices. Personal goals and drives do not have to be pursued all the time.

The two-and-two exercise employs reason or logic. Here are the facts, and here are the logical conclusions to be drawn from them. Here is the gun with a left thumbprint on the barrel; here is the left thumbprint of Mr. X, identical thereto. It is highly probable that the murderer has been found. Again, a skilled paleontologist may be able to deduce from a jawbone the sex, height, and physical characteristics of an individual who expired ten thousand years ago. A garage mechanic can often tell what is wrong from the sound of your engine; electricians

and plumbers constantly solve problems in logic which baffle the average householder — though the householder might learn to solve them if he had the time. Most of us, however, would not find it easy to learn the logic demanded in "taping" the program of an electronic computer.

Ever since Homo sapiens came down from trees he has been using logic to avoid extinction. Often it has failed him most dismally, but success has been more frequent than failure, or we should not be here to speculate about it. "If man," says F. C. S. Schiller, "had not succeeded in devising forms of thought which were applicable to reality he would either have perished, or have adjusted himself in other ways than by the use of intelligence."

One of our Stone Age ancestors comes to an abrupt halt in the forest. He looks again and says to his companion: "That footprint in the mud beside the trail looks like a bear's! It is fresh. It is headed for our water hole. We'd better stay away from the spring, and build a trap just about here!" He has observed three facts — the footprint, its timing, its direction; and he deduces a conclusion of considerable value to his survival. If he were very thirsty he might attempt a rationalization, say that the bear had gone away — but it wouldn't be healthy.

Man, while a relatively large mammal, is singularly unarmored in the matter of teeth, claws, hide, and strength of hug. He cannot run very fast compared to a deer, or hit very hard compared to a gorilla. He has to use his wits. Logic, reason, thinking, using one's wits, are nearly synonymous terms, and widely celebrated as the activity which marks men off from all other creatures. This is expressed normally through language, as it is well established that the higher levels of thought are difficult if not impossible without words. A thought may come from the blue, but in order to think about that thought, or especially to discuss it with one's fellows, words are necessary.

I can condition my cat not to jump on the dining room table, but I cannot explain to him why he shouldn't. Animals lack the machinery to pass knowledge down to the next generation, and the next; they have to begin over with each generation. They have no words to describe what they have learned, no method to accumulate the arts and sciences. A rat may learn to thread a maze for food, but it cannot tell another rat how to do it.

On all levels, logic is very closely related to language, and it is hard to know where one stops and the other begins. "Logos" is Greek for "word," and our "logic" and also the "ologies" of the sciences (arch*eology*, physi*ology*) derive from it.

SOME DEFINITIONS OF LOGIC

Few thinkers have thought about the logical process more intensively than the late Morris R. Cohen. He had the great advantage, furthermore, of familiarity with the logic of modern science and modern mathematics, which were of course unknown in Aristotle's time. His book, Logic and the Scientific Method, written with Ernest Nagel, will be our major guide in matters of theory in the pages to come. He says:

> Logic is correct reasoning. To be logical is to argue reasonably. By means of logic we can find out what follows if we accept a given statement as true.

And again:

> Logic may be said to be concerned with the question of the adequacy of different kinds of evidence. Traditionally, however, it has devoted itself in the main to the study of what constitutes proof, that is, complete or conclusive evidence.

The first definition is the broader. It fits the mental process of our Stone Age ancestor as he spots the spoor of the bear. It is the common or garden logic in use by competent members of

the race for a half million years. We all use it many times a day, in the lucid intervals between our emotional behavior and our rationalizations.

Cohen's second definition is more strict, concerned with the subject "logic" as taught in schools and colleges, beginning with the Lyceum of Aristotle. By and large we shall follow the first definition in this book, the logic of everyday living, of common sense, of getting the facts and figuring out what they mean and how best to deal with them.

IT BEGINS EARLY

It is fascinating to observe the logical process developing in young children. Not long ago I was playing chess with my grandson when his sister Anne, aged seven, came over to watch us. She was curious about the pieces, and I stopped a moment to tell her their names.

"The castle is much smaller than the king, but it ought to be bigger," she said.

"Why?" I asked in some perplexity.

"Because the way it is now the king couldn't get into it."

This, I submit, is not the bright saying of a moppet to be laughed at indulgently; it is the human mind beginning to work on a problem of relationships.

A simple statement of fact is not logical or illogical by itself, though it can be true or false or in between. *Only when we draw a conclusion from the statement does logic technically enter*. It is a fact that the castle on a chess board is smaller than the king. It is a fact that kings, in storybooks at least, live in castles. Therefore castles must be larger than kings. Anne put those two facts together to draw a reasonable conclusion.

"The moon is made of green cheese," is a highly improbable statement — though nobody has yet been to the moon to check

it. Let us assume it to be true. If you then say: "When our space ship lands we can replenish our food supply," the logic is sound and the conclusion is valid. But if, from the same premise, you say: "When our space ship lands we'll find plenty of carbon monoxide," the conclusion does not follow. There is no connection between green cheese and carbon monoxide in this frame of reference.

The point here is of the first importance, and it is often misunderstood. Let me restate it.

Logic is the process of drawing a conclusion from one or more statements or propositions, called premises.

If the premises are assumed to be true — whether they are or not — the logic can be technically correct.

Even if the premises are demonstrably true, the logic can be bad. If you say: "There is practically no air on the moon," you are stating a scientific fact.[1] But if you continue: "Therefore the moon is drawing closer to the earth," the conclusion has no relation to the fact, and is illogical.

"Your religion is different from mine." A fact.

"Therefore you are no good." An illogical conclusion — but one held, alas, by untold millions.

"If people live in Connecticut they live in the U.S.A." A fact.

"Therefore if they do not live in the U.S.A. they cannot live in Connecticut." A logical conclusion depending on relationship, like Anne's kings and castles.

Logical as it is to conclude that *if* the moon is made of green cheese we can use it as a grocery store, it makes most of us uneasy — the premise is so wildly improbable. Straight thinking requires more than a logical inference; the facts must also make some sense. If we are going to argue about the moon, we should follow what scientists have discovered about its struc-

[1] Estimated at one million millionth of earth's air at sea level.

ture. Green cheese is definitely out, while lack of an atmosphere is definitely in.

"BECAUSE"

When you hear the word *because*, you can be fairly sure that an exercise in logic is about to take place. The logic may be good, bad, or indifferent, but the person saying "This is so, *because*" is going through the motions of the logical animal. "Castles should be bigger than kings because kings have to live in them." In one sense, the study of logic is nothing but an analysis of *becauses*. Logical fallacies occur when the *because* does not follow, does not make sense. Sound logic occurs when it does — though sometimes, as in the fallacy of "arguing in circles" (Chapter 14), it takes quite a bit of triangulation to locate the nonsense. Here is a statement supported by four *becauses*, all wrong:

The earth is flat. Why?
Because it looks flat.
Because people would fall off the underside if it were a ball.
Because the gods say it is.
Because my father told me so.

Morris Cohen gives us a more sophisticated example: "The number of inhabitants in New York City is greater than the number of hairs on the head of any inhabitant."

How come?

Because tests show that there are never more than five thousand human hairs to a square centimeter. No human head has more than a thousand square centimeters of hair. The limit on any head is thus five million hairs. There are eight million people in New York City. Therefore, there are more people than hairs on any one head. We can also deduce from the above facts that at least two individuals in New York City have precisely the same number of hairs on their heads.

I have bathroom scales and I have a cat. I want to weigh the cat. My mind goes to work imagining various complicated basketry constructs to hold the cat on the platform. I try some of them, with a lamentable lack of success; a cat seems to get out of anything at the speed of light. Then the solution comes — a solution which the alert reader doubtless glimpsed at once. I take the cat in my arms and weigh us both. I drop the cat and weigh myself, and subtract the second reading from the first . . . . This illustrates what is meant by everyday logic, the homely problems constantly demanding a solution on a level above trial and error.

HERODOTUS AND THE NILE

The great historian Herodotus was curious about the Nile. Why did it overflow its banks every summer? The facts were clear. Beginning in mid-June, the river flooded back to as much as two days' journey inland, for a period of about three months. "I made every inquiry," said Herodotus, "from priest and peasant, but nobody knew why." He then considers three theories which had been advanced.

First, northwest winds from the Mediterranean backed the river up. This he dismisses because other rivers subjected to the same winds do not back up.

Second, the Nile is an exceptional river and flows from the ocean upstream. Not tenable, says Herodotus; rivers always flow downhill.

Third, melting snows cause the overflow. This sounds plausible, observes Herodotus, but it can't be true. Why? Because the Nile flows north from a region hotter than Egypt, where birds fly to spend the winter. Can one find snow in such a torrid country?

Herodotus dismissed all three hypotheses. His logic was keen; no man of his time could have reasoned better. The

trouble was that no traveler had yet visited the sources of the Nile to report the great snowfields in Ethiopia, or Mt. Ruwenzori, which lies close to the equator. The third theory was the right one, but Herodotus' world lacked the knowledge to support it.

This story forcefully illustrates a serious limitation of logic. One of the most profound thinkers of his time, exercising his mind to the utmost, was unable to reach the right conclusion by logic alone. Heavy thinkers down the ages have believed that if they only sat still and thought hard enough, the right answer would come. Sometimes it did and often it didn't. Now we know that unless we heave out of our armchairs and do the essential leg work or laboratory work, new knowledge seldom comes.

First, nail down your facts, get your premises in line with current knowledge. Second, exercise logic upon them. Then you are likely to have a conclusion worth battling for.

The fly-and-bicycle story is a good exercise in simple logic. You probably remember it. Two cyclists began to pedal toward each other at the same moment. They are thirty miles apart and their rates are equal, fifteen miles per hour. Simultaneously a fly takes off from A's handlebar to B's handlebar, and back to A's, in an ever-decreasing round trip. The fly's rate is forty miles an hour — with no allowance for stops and starts. When the cyclists meet, the hard-working fly is crushed between the handlebars. How far has the fly flown?

On first hearing this story some engineers are said to whip out their slide rules, some mathematicians to exercise their calculus. Most laymen demand pencil and paper and time to figure. Others get the answer at once, by eliminating the nonessential facts. How long before A and B meet? One hour, of course. Therefore, the fly has flown nonstop for an hour. Therefore, at forty miles per hour, it has flown forty miles. Q.E.D. Observe that this problem could not be stated, let alone be

solved, without words or other symbols, and that the brightest chimpanzee could make nothing of it, although bright chimpanzees can ride bicycles.

LEVELS OF LOGIC

Up to a century ago or so, people who did not pay their debts were thrown into prison. The logic on one level was inescapable.

People who don't pay their debts must be punished.
Jones won't pay his debts. (Usually Jones couldn't.)
Therefore he must be punished.
How do we punish civil offenders?
By putting them in jail.

All very neat and tidy. But on another level the logic was so bad that the whole process had to be abandoned. Poor debtors in prison had no way to work off their debts, and were a burden to taxpayers as well. Nowadays we let them go through bankruptcy proceedings, which wipes out the debt and may hurt their self-respect. Sometimes the bankrupt goes to work and pays off his debt as a matter of honor. This marked improvement in logic, observe, comes from considering more facts about the total situation.

On a cold winter day in the depths of the Great Depression, bulldozers descended on a shanty colony of unemployed men in New York, to clear the area for a new building. The poor starvelings were driven from their tar-paper shacks. It was sad, even cruel, but obviously nothing could be done about it. To give them a dole, in the logic of the year 1931, would have established a dangerous precedent. Said Thurman Arnold, who tells the story: "The eviction of these unfortunates was a symbol of a faith that economic competence can only be developed by refusing to protect incompetence." A lesson, however, painful, had to be taught.

As the work proceeded, two men were discovered unconscious under one of the huts. Instantly the old logic went by the board and a happier one took its place. It was no longer wrong to protect citizens from their own incompetence. Twenty thousand dollars' worth of ambulances, stretchers, pulmotors, drugs, accompanied by a squad of internes and nurses, rushed to the scene. The starving men were taken to a hospital and given treatment which a millionaire could not have afforded fifty years earlier. "Thus a practical and humanitarian attitude develops techniques and not logical arguments." Or, to put it another way, it raises the level of logic.

RATIONALIZING

D. S. Robinson quotes the "philosophy of an airman" as a lively example of rationalizing.[2] Rationalizing, as noted earlier, is logic employed to bolster one's hopes, desires or prejudices. A flier really has nothing to worry about, for look:

If you fly well there is nothing to worry about.

If you go into a spin, then one of two things can happen: Either you crash or you don't.

If you don't crash, there is nothing to worry about.

If you do crash, one of two things can happen: Either you are hurt or you are not hurt.

If you are not hurt, there is nothing to worry about.

If you are badly hurt, one of two things can happen: Either you recover or you don't.

If you recover there is nothing to worry about.

If you don't recover you can't worry!

One hates to spoil a good story, but if you do recover and are crippled for life, there is plenty to worry about. Rationalization usually has a catch in it.

[2] In his *Principles of Reasoning.*

SEVEN FIELDS OF LOGIC

Reason enters every human activity, with seven kinds particularly noticeable. Often the logic is faulty but the attempt is there.

1. *Common sense*.

This workaday logic has been practiced constantly by every sane person ever since time out of mind. He may be alone as he reasons, or in a group. He may or may not use words. The logic, such as it is, is applied to his acts, to his evaluation of himself, his neighbors, and his world.

2. *Formal logic.*

This is a scholarly discipline introduced by Aristotle. At one time wise men believed that through formal logic we could find all the laws governing human thought. Now we know that this task belongs in great part to the social sciences, especially psychology. Aristotle's logic operates through a device called the syllogism, which has its merits; but if followed too rigorously, it can get the straight thinker into trouble. The syllogism was used by the Greeks and the Schoolmen of the Middle Ages to "prove" the most improbable things — for instance, that Achilles could not overtake the tortoise in a race. Nowadays, however, a new streamlined formal logic, also highly technical, goes far beyond the syllogism.

3. *Mathematics.*

Mathematics is chiefly systematized logic. Pure mathematics, hitched to no specific fact — no tons of freight, or years, or temperatures — is incapable of discovering new knowledge. Applied to the physical universe, it can be immensely valuable, aiding the mind when it grows dizzy trying to understand too

many events at once. A super-mind might see the relationships at a glance and not need the help of mathematics, but such minds lie far in the biological future. Even Einstein had to use mathematics to help him think.

4. *The logic of modern science.*

Scientists today use not only mathematics but many other logical techniques as well. The techniques include: the verification of hypotheses, continual check between logical inferences and relevant facts, thinking in terms of probability, of processes, of relationships. Scientists employ techniques of modern symbolic logic, including multi-valued systems.

5. *Legal procedure.*

A courtroom is a kind of laboratory of logic, to determine what is evidence and what is not, and whether the defendant is guilty as charged. Smart attorneys try to twist the logic to the advantage of their clients, while the judge tries to keep the argument undistorted. We recall the attorney who said to the jury after summing up his case: "These, gentlemen, are the conclusions upon which I base my facts" — which is the logical process upside down!

6. *Winning arguments, votes, and customers.*

In this area logic is stretched to throw advantage to a special side or interest, but the audience is forewarned. A college debate bristles with *becauses*, but few take it as the serious pursuit of truth; one side is out to win, as in a football game. The debater who argues for the affirmative may switch to the negative in a later contest, and so exercise his mental muscles.

Few sophisticated voters expect the logic of a political campaign to have much connection with reality. When a candidate named Adlai Stevenson tried to make the connection, pro-

fessionals were alarmed. Wendell Willkie, caught in an inconsistency in the 1940 presidential campaign, dismissed it as "just campaign oratory."

Advertising companies are on a still lower level. Sometimes they give us useful information about new products, but mostly they are a verbal stew of half truths, reiteration, snob appeal, and *non-sequiturs*, reinforced with bathing beauties and jingles from the folklore.

7. *All-out propaganda.*

In this final area the distortion of logic goes beyond that normally found in number 6, often to the point of treachery and crime. The reasoning process is twisted, slanted, adulterated, as a matter of course, by demagogues, dictators, and fanatical ideologists. The bigger the misrepresentation one can get away with, the greater the triumph. Logical fallacies are deliberately manipulated, and new mantraps are added, such as the "scapegoat" technique. The logic is always two-valued: We are absolutely right and you are absolutely wrong, and anybody in the middle is wrong too. The issue has already been decided by the propagandist; there is no common search for truth.

My classification above, rough as it is, suggests how the exercise of reason pervades human affairs. This book will try to promote the use especially of number 4, scientific reasoning, and to give the reader some defense against numbers 6 and 7 — campaign oratory, competitive advertising, and all-out propaganda.

Let us now observe briefly how the study of logic began, some twenty-five hundred years ago.