or music contains materials that could be processed by superposing comparison by any receiving organism with a few seconds of memory.

Is it possible that this worldwide artistic, poetical, and musical phenomenon is somehow related to moiré? If so, then the individual mind is surely deeply organized in ways which a consideration of moiré phenomena will help us to understand. In terms of the definition of “explanation” proposed in section 9, we shall say that the formal mathematics or “logic” of moiré may provide an appropriate tautology onto which these aesthetic phenomena could be mapped.

9. THE CASE OF “DESCRIPTION,” “TAUTOLOGY,” AND “EXPLANATION”

Among human beings, description and explanation are both highly valued, but this example of doubled information differs from most of the other cases offered in this chapter in that explanation contains no new information different from what was present in the description. Indeed, a great deal of the information that was present in description is commonly thrown away, and only a rather small part of what was to be explained is, in fact, explained. But explanation is certainly of enormous importance and certainly seems to give a bonus of insight over and above what was contained in description. Is the bonus of insight which explanation gives somehow related to what we got from combining two languages in section 6, above?

To examine this case, it is necessary first briefly to indicate definitions for the three words: description, tautology, and explanation.

A pure description would include all the facts (i.e., all the effective differences) immanent in the phenomena to be described but would indicate no kind of connection among these phenomena that might make them more understandable. For example, a film with sound and perhaps recordings of smell and other sense data might constitute a complete or sufficient description of what happened in front of a battery of cameras at a certain time. But that film will do little to connect the events shown on the screen one with another and will not by itself furnish any explanation. On the other hand, an explanation can be total without being descriptive. “God made everything there is” is totally explanatory but does not tell you anything about any of the things or their relations.

In science, these two types of organization of data (description and explanation) are connected by what is technically called tautology. Examples of tautology range from the simplest case, the assertion that “If P is true, then P is true,” to such elaborate structures as the geometry of Euclid, where “If the axioms and postulates are true, then Pythagoras’ theorem is true.” Another example would be the axioms, definitions, postulates, and theorems of Von Neumann’s Theory of Games. In such an aggregate of postulates and axioms and theorems, it is of course not claimed that any of the axioms or theorems is in any sense “true” independently or true in the outside world.

Indeed, Von Neumann, in his famous book,* expressly points out the differences between his tautological world and the more complex world of human relations. All that is claimed is that if the axioms be such and such and the postulates such and such, then the theorems will be so and so. In other words, all that the tautology affords is connections between propositions. The creator of the tautology stakes his reputation on the validity of these connections.

Tautology contains no information whatsoever, and explanation (the mapping of description onto tautology) contains only the information that was present in the description. The “mapping” asserts implicitly that the links which hold the tautology together correspond to relations which obtain in the description. Description, on the other hand, contains information but no logic and no explanation. For some reason, human beings enormously value this combining of ways of organizing information or material.

To illustrate how description, tautology, and explanation fit together, let me cite an assignment which I have given several times to classes. I am indebted to the astronomer Jeff Scargle for this problem, but I am responsible for the solution. The problem is:

A man is shaving with his razor in his right hand. He looks into his mirror and in the mirror sees his image shaving with its left hand. He says, "Oh, there's been a reversal of right and left. Why is there no reversal of top and bottom?"

The problem was presented to the students in this form, and they were asked to unravel the muddle in which the man evidently is and to discuss the nature of explanation after they have accomplished this.

There are at least two twists in the problem as set. One gimmick distracts the student to focus on right and left. In fact, what has been reversed is front and back, not right and left. But there is a more subtle trouble behind that, namely, that the words right and left are not in the same language as the words top and bottom. Right and left are words of an inner language; whereas top and bottom are parts of an external language. If the man is looking south and his image is looking north, the top is upward in himself and it is upward in his image. His east side is on the east side in the image, and his west side is on the west side in the image. East and west are in the same language as top and bottom, whereas right and left are in a different language. There is thus a logical trap in the problem as set.

It is necessary to understand that right and left cannot be defined and that you will meet with a lot of trouble if you try to define such words. If you go to the Oxford English Dictionary, you will find that left is defined as "distinctive epithet of the hand which is normally the weaker." The dictionary maker openly shows his embarrassment. If you go to Webster, you will find a more useful definition, but the author cheats. One of the rules of writing a dictionary is that you may not rely on ostensive communication for your main definition. So the problem is to define left without pointing to an asymmetrical object. Webster (1959) says, "that side of one's body which is toward the west when one faces north, usually the side of the less-used hand." This is using the asymmetry of the spinning earth.

In truth, the definition cannot be done without cheating. Asymmetry is easy to define, but there are no verbal means—and there can—be none—for indicating which of two (mirror-image) halves is intended.

An explanation has to provide something more than a description provides and, in the end, an explanation appeals to a tautology, which, as I have defined it, is a body of propositions so linked together that the links between the propositions are necessarily valid.

The simplest tautology is "If P is true, then P is true."

A more complex tautology would be "If Q follows from P, then Q follows from P." From there, you can build up into whatever complexity you like. But you are still within the domain of the if clause provided, not by data, but by you. That is a tautology.

Now, an explanation is a mapping of the pieces of a description onto a tautology, and an explanation becomes acceptable to the degree that you are willing and able to accept the links of the tautology. If the links are "self-evident" (i.e., if they seem undoubtable to the self that is you), then the explanation built on that tautology is satisfactory to you. That is all. It is always a matter of natural history, a matter of the faith, imagination, trust, rigidity, and so on of the organism, that is of you or me.

Let us consider what sort of tautology will serve as a foundation for our description of mirror images and their asymmetry.

Your right hand is an asymmetrical, three-dimensional object, and to define it, you require information that will link at least three polarities. To make it different from a left hand, three binary descriptive clauses must be fixed. Direction toward the palm must be distinguished from direction toward the back of the hand; direction toward the elbow must be distinguished from direction toward the fingertips; direction toward
which is in the end never totally satisfactory because nobody knows what will be discovered later.

If explanation is as I have described it, we may well wonder what bonus human beings get from achieving such a cumbersome and indeed seemingly unprofitable truism. This is a question of natural history, and I believe that the problem is at least partly solved when we observe that human beings are very careless in their construction of the tautologies on which to base their explanations. In such a case, one would suppose that the bonus would be negative; but this seems not to be so judging by the popularity of explanations which are so informal as to be misleading. A common form of empty explanation is the appeal to what I have called "dormitive principles," borrowing the word dormitive from Molière. There is a coda in dog Latin to Molière's Le Malade Imaginaire, and in this coda, we see on the stage a medieval oral doctoral examination. The examiners ask the candidate why opium puts people to sleep. The candidate triumphantly answers, "Because, learned doctors, it contains a dormitive principle."

We can imagine the candidate spending the rest of his life fractionating opium in a biochemistry lab and successively identifying in which fraction the so-called dormitive principle remained.

A better answer to the doctors' question would involve, not the opium alone, but a relationship between the opium and the people. In other words, the dormitive explanation actually falsifies the true facts of the case but what is, I believe, important is that dormitive explanations still permit abduction. Having enunciated a generality that opium contains a dormitive principle, it is then possible to use this type of phrasing for a very large number of other phenomena. We can say, for example, that adrenalin contains an enlivening principle and reserpine a tranquilizing principle. This will give us, albeit inaccurately and epistemologically unacceptably, handle with which to grab at a very large number of phenomena that appear to be formally comparable.

And, indeed, they are formally comparable to this extent, that invoking a principle inside one component...
is in fact the error that is made in every one of these cases.

The fact remains that as a matter of natural history—and we are as interested in natural history as we are in strict epistemology—abduction is a great comfort to people, and formal explanation is often a bore. "Man thinks in two kinds of terms: one, the natural terms, shared with beasts; the other, the conventional terms (the logicals) enjoyed by man alone."*

This chapter has examined various ways in which the combining of information of different sorts or from different sources results in something more than addition. The aggregate is greater than the sum of its parts because the combining of the parts is not a simple adding but is of the nature of a multiplication or a fractionation, or the creation of a logical product. A momentary gleam of enlightenment.

So to complete this chapter and before attempting even a listing of the criteria of mental process, it is appropriate to look briefly at this structure in a much more personal and more universal way.

I have consistently held my language to an "intellectual" or "objective" mode, and this mode is convenient for many purposes (only to be avoided when used to avoid recognition of the observer's bias and stance).

To put away the quasi objective, at least in part, is not difficult, and such a change in mode is proposed by such questions as: What is this book about? What is its personal meaning to me? What am I trying to say or to discover?

The question "What am I trying to discover?" is not as unanswerable as mystics would have us believe. From the manner of the search, we can read what sort of discovery the searcher may thereby reach; and knowing this, we may suspect that such a discovery is what the searcher secretly and unconsciously desires.

* This chapter has defined and exemplified a manner of search, and therefore this is the moment to raise two questions: For what am I searching? To what questions have fifty years of science led me?

The manner of the search is plain to me and might be called the method of double or multiple comparison.

Consider the case of binocular vision. I compared what could be seen with one eye with what could be seen with two eyes and noted that in this comparison the two-eyed method of seeing disclosed an extra dimension called depth. But the two-eyed way of seeing is itself an act of comparison. In other words, the chapter has been a series of comparative studies of the comparative method. The section on binocular vision (section 2) was such a comparative study of one method of comparison, and the section on catching Plato (section 3) was another comparative study of the comparative method. Thus the whole chapter, in which such instances are placed side by side, became a display inviting the reader to achieve insight by comparing the instances one with another.

Finally, all that comparing of comparisons was built up to prepare author and reader for thought about problems of Natural Mind. There, too, we shall encounter creative comparison. It is the Platonic thesis of the book that epistemology is an indivisible, integrated meta-science whose subject matter is the world of evolution, thought, adaptation, embryology, and genetics—the science of mind in the widest sense of the word.*

The comparing of these phenomena (comparing thought with evolution and epigenesis with both) is the manner of search of the science called "epistemology."

Or, in the phrasing of this chapter, we may say that epistemology is the bonus from combining insights from all these separate genetic sciences.

* The reader will perhaps notice that consciousness is missing from this list. I prefer to use that word, not as a general term, but specifically for that strange experience whereby we (and perhaps other mammals) are sometimes conscious of the products of our perception and thought but unconscious of the greater part of the processes.

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But epistemology is always and inevitably personal. The point of the probe is always in the heart of the explorer: What is my answer to the question of the nature of knowing? I surrender to the belief that my knowing is a small part of a wider integrated knowing that knits the entire biosphere or creation.