

of a historical series or uninterrupted lineage. Because there are structural differences, there is the possibility of historical variations in the lineages. But, more precisely, how is it that certain lineages are produced or established and others are not? How is it that, when we look around, fish seem to us so naturally aquatic and horses so naturally adapted to the plains? To answer these questions, we must look more closely and explicitly at how interactions occur between living beings and their environment.

### Structural Determination and Coupling

Ontogeny is the history of structural changes in a particular living being. In this history each living being begins with an initial structure. This structure conditions the course of its interactions and restricts the structural changes that the interactions may trigger in it. At the same time, it is born in a particular place, in a medium that constitutes the ambience in which it emerges and in which it interacts. This ambience appears to have a structural dynamics of its own, *operationally distinct* from the living being. This is a crucial point. As observers, we have distinguished the living system as a unity from its background and have characterized it as a definite organization. We have thus distinguished two structures that are going to be considered operationally independent of each other: living being and environment. Between them there is a necessary structural congruence (or the unity disappears). In the interactions between the living being and the environment within this structural congruence, the perturbations of the environment do not determine what happens to the living being; rather, it is the struc-

ture of the living being that determines what change occurs in it. This interaction is not instructive, for it does not determine what its effects are going to be. Therefore, we have used the expression "to trigger" an effect. In this way we refer to the fact that the changes that result from the interaction between the living being and its environment are brought about by the disturbing agent but *determined by the structure of the disturbed system*. The same holds true for the environment: the living being is a source of perturbations and not of instructions.

Now, at this point the reader may be thinking that all this sounds too complicated and that it is unique to living beings. To be exact, as in the case of reproduction, this is not a phenomenon unique to living beings. It takes place in all interactions. And if we do not see it in all its generality, it becomes a source of confusion. Hence, let us dwell a moment further on examining what happens each time we distinguish a unity and an environment in which it interacts.

The key to understanding all this is indeed simple: as scientists, we can deal only with unities that are *structurally determined*. That is, we can deal only with systems in which all their changes are determined by their structure, whatever it may be, and in which those structural changes are a result of their own dynamics or triggered by their interactions. In our daily lives, in fact, we behave as though all things we encounter are structurally determined unities. An automobile, a tape recorder, a sewing machine, and a computer are all systems we treat as though they were determined by their structure. Otherwise, how could we explain that when we find a breakdown we try to change the structure and not something

else? If we step on the gas pedal of our car and the car doesn't move, it will never occur to us that there is something wrong with our pressing foot. We assume that the problem lies in the connection between the gas pedal and the injection system, that is, in the structure of the car. Thus, breakdowns in man-made machines reveal more about their effective operation than our descriptions of them when they operate normally. In the absence of failure, we sum up our description by saying that we "instruct" the computer to give us the balance of our bank account.

This everyday attitude (which becomes more systematic and explicit only in science, by rigorous application of the criterion of validation of scientific statements) is not only adequate for artificial systems but also for living beings and social systems. Otherwise we would never go to a doctor when we felt sick or replace a manager in a company when his performance does not meet expectations. We may choose not to explain many phenomena of our human experience; however, if we wish to explain them scientifically, we must treat the subject phenomena as being structurally determined.

All this becomes explicit when we distinguish four domains (classes) that the structure of a unity specifies:

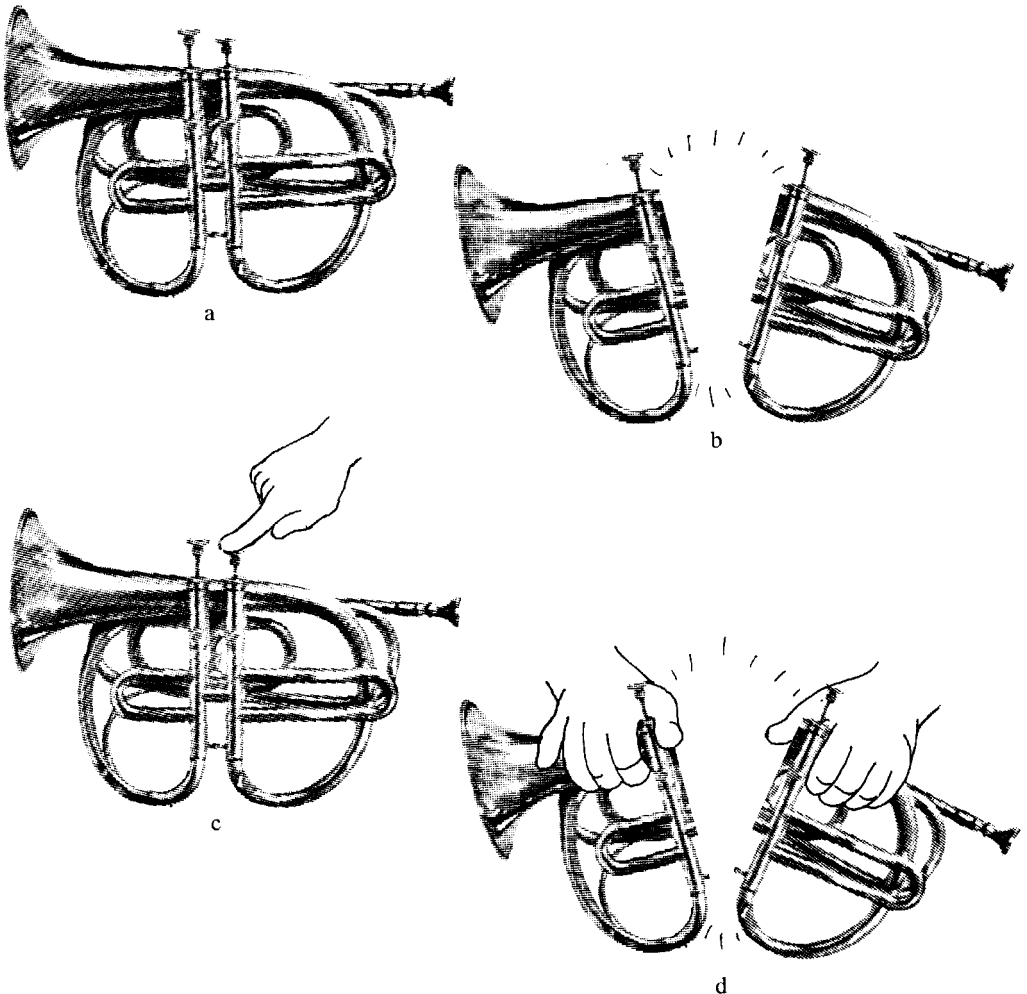
- a. *Domain of changes of state: viz., all those structural changes that a unity can undergo without a change in its organization, i.e., with conservation of class identity*
- b. *Domain of destructive changes: all those structural changes that a unity can undergo with loss of organization and therefore with loss of class identity*

c. *Domain of perturbations*: all those interactions that trigger changes of state

d. *Domain of destructive interactions*: all those perturbations that result in a destructive change

Thus, we all reasonably suppose that lead bullets fired at someone at point-blank range trigger in the victim destructive changes specified by the

Fig. 25. The trumpet, like every unity, has its four domains: (a) of changes of state, (b) of destructive changes, (c) of perturbations, and (d) of destructive interactions.



structure of that person. As we well know, however, those same bullets are a mere perturbation for the structure of a vampire. He requires a wooden stake in his heart before he undergoes a destructive change. Moreover, it is obvious that a compact car crashing into a tree may undergo a destructive interaction, but this would be a mere perturbation for a tank (Fig. 25).

Note that in a dynamic system structurally determined, since the structure is in ongoing change, its structural domains will also change, although they will be specified at every moment by their present structure. This ongoing change in its structural domains is what is proper of the ontogeny of each dynamic unity, whether it is a cassette player or a leopard.

As long as a unity does not enter into a destructive interaction with its environment, we as observers will necessarily see between the structure of the environment and that of the unity a compatibility or congruence. As long as this compatibility exists, environment and unity act as mutual sources of perturbation, triggering changes of state. We have called this ongoing process "structural coupling." Thus, for example, in the history of structural coupling between the lineages of automobiles and cities there are dramatic changes on both sides, which have taken place in each one as an expression of its own structural dynamics under selective interactions with the other.

## Ontogeny and Selection

Everything said before is valid for any system; therefore, it is valid also for living beings. Living beings are not unique in their determination nor in their structural coupling. What is proper to