

# Theoretical Biology

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IMPORTANCE OF THE RULES OF FUNCTION  
FOR THE FUNCTION-CIRCLE

It is impossible to understand the relation between mark-organs and action-organs, and the interdependence of their function-rules, unless we first separate from one another the individual function-circles of which these organs form the keystones.

We must note that each circle—for instance, the enemy-circle—is in principle always closed, however simple the indication that gives information of the enemy's presence, and even if it consists merely of a smell, or of a slight movement; the act, whether of flight or of defence, that serves to ward off the enemy, will always be initiated with completeness. Consequently, the two organs may be of very different degrees of development. The indication may be highly complex, and the action may consist of a simple movement; or, conversely, a very elaborate action may follow when the indication is quite simple.

To facilitate a general survey, I give below the simple diagram of a function-circle.

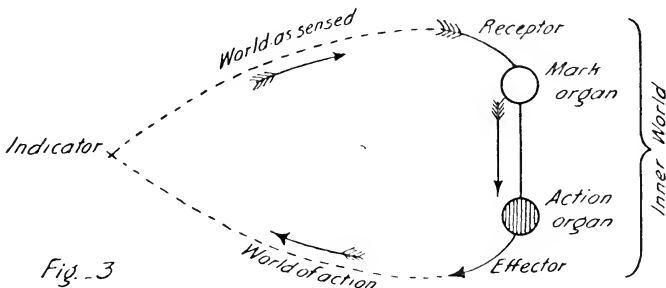


Fig. 3

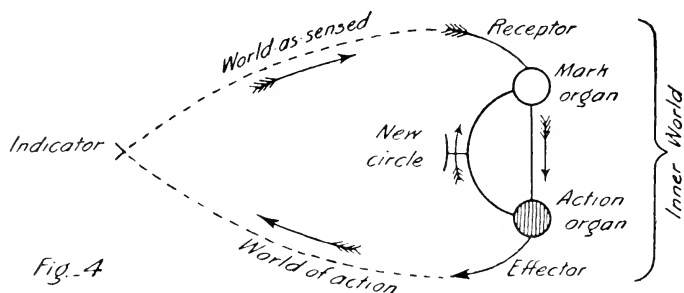
As the diagram shows, the inner world is divided into two parts; one, which receives the impressions, is turned towards the world-as-sensed, and the other, which distributes the effects, is turned towards the world of action. Between

mark-organ and action-organ lies the watershed of the whole function-circle. The mark-organ and the action-organ are each of them controlled by a rule; the one arranges the impressions in the mark-organ, and so creates the indications; the other arranges the effects produced by the action-organ, and so creates the actions. Both rules are focussed accurately on the indication in the external world, the appearance of which is the signal for the indications to arise, and which has then "to be dealt with." The circle forms a unified whole, for, just as in an organism, each part is dependent on the others. The design which connects each part becomes intelligible down to the last detail only when we see the circle as a whole. The receptors are focussed on the typical manifestations of the indicators, whether these be chemical, optical or of some other kind; and, in virtue of their specific structure, the effectors deal with the indicator in the most effective way. The mark-organs and action-organs are just as nicely focussed on the indicator as are the receptors, and their rules embrace it with scrupulous exactness from the sides both of action and of reaction.

The diagram given above serves to illustrate the whole of what is done by an animal's nervous system, in so far as this relates to reflexes, plastic actions, or instinctive actions. In the case of reflexes, however, we must assume that the framework of the action-organ is all ready and prepared beforehand; while with instincts, the rule of the action-organ can still be built up and broken down again. We know a number of cases that are explicable only by super-mechanical regulation, and so prove the intervention of protoplasm. In contradistinction to these, reflex actions, which are usually of a simple kind, unfold, as it were, automatically.

But it is characteristic both for reflex and for instinctive actions, that the action-rule reveals itself only in the actions, and in no way enters into the indications and the rules affect-

ing these. In the highest animals, however, the creature's own action-rule penetrates further and further into the world-as-sensed, and there assumes direction and control.



A new circle is introduced within the animal's own central organ, for the support of the external function-circle, and this connects the action-organ with the mark-organ. In this way, the animal's own action-rule fits in with the indications stimulated from without, and now serves the mark-rule as a skeleton to which it may attach the external indications.

Now for the first time there appear in the world-as-sensed actual implements, possessing a function-rule. The world-as-sensed of the simpler animals contained nothing but objects. When the movements of the animal's own limbs enter the mark-organ, it becomes possible for it to control its own actions. But so long as the action-rule taken over from the mark-organ is not used to form implements, there are nothing but objects in the world-as-sensed.

As we know, even objects are elaborate unities, extended in space and in time. But implements arise in the world-as-sensed only when the subject's own action-rule endows them with a function: this action-rule combines all the properties and capacities in such conformity with plan that they are obliged to obey an inner rule, which we call the function-rule of implements. So we human beings transfer our own

function-rule to implements, just as we transfer to them the indications we ourselves have formed.

These are general laws, depending on the structure of each individual subject. And so it is quite inadmissible to impose on the sensed-world of animals the human function-rules on which, as something taken quite for granted, we base all the implements that fill our sensed-world. We must first get to know the action-rules of animals, before we can proceed to the question of implement-forming in animals. As soon as an observer turns his back on an animal, his human implements disappear, and only these really belonging to the animal continue to surround it.

Moreover, we must learn to regard the function-rule as a real natural factor, and attempt to investigate its effects in all subjects.

Even the "psychoid," introduced by Driesch into natural science, is to be understood in this sense. The psychoid is an objectively active rule, which we must observe in operation. The word psychoid indicates that here we have to do with a creation by the psyche, for a super-spatial law comes in, not belonging to the body, but controlling it. Can it be that in the function-rule we have come upon something that speaks for the existence of an animal psyche? A something that justifies the psychologists in setting their science on an objective basis?

I do not think that such an assumption is justified. There can be no doubt that there are super-spatial rules to which in the last instance the control of even the animal body is assigned. But knowledge of these rules, just as of those governing the animal body itself, must be referred to the laws of our own mind: and the term "psychoid" may easily mislead us into supposing that we have here the proof of an apperception by the animal subject. This is not the case. All we can make sure of is the operation of a rule controlling

the material of the central nervous system. We have absolutely no knowledge as to whether that is apperceived by the animal.

#### THE WORLD OF ACTION

When we considered the world-as-sensed and the inner world of animals, we could not fail to recognise a certain parallelism between the physiological and biological ways of considering them, a parallelism which permitted of the two sciences being mutually complementary and corroborative; but when we turn to consider the world of action, this parallelism completely disappears.

According to physiological notions, every animal imparts to the universe the effect released by the movements of its limbs or the secretion of its glands. And in the universe, these manifestations of the animal body continue their effect from atom to atom according to the law of causality. In principle, the step of a beetle's foot or the stroke of a dragon-fly's wing must carry their effect as far as the dog-star. For, according to the causal conception, even the smallest component of natural phenomena is absolutely necessary, and cannot be thought away from the general system of action and reaction, without making the whole impossible.

It is perfectly obvious that this point of view does not do justice to the marvellously constructed effector apparatus of animals.

To appreciate rightly what the effector organs perform in the function-circle, we must consider in more detail the laws that govern our human implements. Hitherto we have considered only our unified tools (such, for instance, as the ladder), and shown that they have a framework constructed in accordance with a function-rule, which fits them for a counter-action in support of our human activities—in this case, the act of climbing.

Now there are a whole number of tools, the framework of which does not express the entire counter-action ; and these always require the help of other implements in order actually to carry out a function. If, for instance, we take the nail of a box, there is required for its counter-action (which backs up our action of holding the box together) firstly, the hammer, for the blows of which the head of the nail is suitably shaped, and, secondly, the wood of which the box is made, the consistency of which permits the nail to penetrate, but prevents its coming out again easily.

The framework of the nail, then, unlike that of the ladder, is not in itself adequate for the exercise of a counter-action. In addition, a hammer and some wood are necessary, if the counter-action is to be achieved. If we give a special name to the connection that exists, in strict conformity with plan, between different implements not having any lasting material association, we may speak of "*inter-adjustment*." In contrast to the framework, which word means a lasting functional connection according to a rule, "*inter-adjustment*" means a functional connection that appears only for a time ; it likewise is subject to a rule.

Graber has called the effectors of animals their tools. We might let this term pass, if the relations between tool and material were not really far too general to do justice to the extraordinarily close connection that is manifested in the function-rule.

In the function-circle, all the parts, even if not crescent as in the organism, are nevertheless so perfectly fashioned with relation to one another, that they form temporarily an actual framework. Knowing this, we see that, in considering the world of action, the biologist must follow a completely different route from that taken by the physiologist.

To define briefly the very different attitudes of the two sciences, we may say that physiology regards the effectors of

an animal in their relation to the world as it regards human tools, whereas biology regards them as human tools that become effective in conformity with plan only when they are fitted into the surrounding-world.

#### INTER-ADJUSTMENT

In considering the inner world of animals, we have learnt to distinguish between mark-rule and action-rule. These two rules constitute only portions of the general plan that is expressed in the whole structure and in all the actions of animals. We have seen that organs are fitted into one another like the parts of a machine, and so we have spoken of framework. But there can be no doubt that this entire framework is likewise subject to a rule. This rule is manifested so clearly in the permanent anatomical framework that we need not discuss it further. On the other hand, we must seek for the rule of inter-adjustment, when the effectors, as they deal with the things of the external world, create a temporary framework.

As a matter of fact, in the world of action we are dealing with a temporary framework of this kind, which becomes apparent only when the animal shows activity in one of its function-circles. The most obvious inter-adjustment is that which connects the effectors of animals with the medium. Merely by looking at these, we can tell whether we have to do with an animal belonging to the air, to the water, or to the land. Fins, wings and feet bear the unmistakable imprint of their vocation. The more closely the function is confined to a narrowly circumscribed medium, the more clearly can we recognise from the effectors to what it is they are adjusted. We distinguish feet that act as suckers, feet for running, feet for leaping, and feet for climbing, and these give us a secure basis whence we may proceed to further classification of land