Summary and Preface*

THE BOOK is not a treatise on all cerebral mechanisms but an attempt to solve a specific problem: the origin of the nervous system's unique ability to produce adaptive behaviour. The work has as basis the fact that the nervous system behaves adaptively and the hypothesis that it is essentially mechanistic; it proceeds on the assumption that these two *data* are not irreconcilable. It attempts to deduce from the observed facts what sort of a mechanism it must be that behaves so differently from any machine made so far. Many other workers have proposed theories on the subject, but they have usually left open the question whether some different theory might not fit the facts equally well. I have attempted to deduce what is necessary, what properties the nervous system *must* have if it is to behave at once mechanistically and adaptively.

Proceeding in this way I have deduced that any system which shows adaptation must (1) contain many variables that behave as step-functions, (2) contain many that behave as part-functions, and (3) be assembled largely at random, so that its details are determined not individually but statistically. The last requirement may seem surprising: man-made machines are usually built to an exact specification, so we might expect a machine assembled at random to be wholly chaotic. But it appears that this is not so. Such a system has a fundamental tendency, shown most clearly when its variables are numerous, to so arrange its internal pattern of action that, in relation to its environment, it becomes stable. If the system were inert this would mean little; but in a system as active and complex as the brain, it implies that the system will be self-preserving through active and complex behaviour.

The work may also be regarded as amplifying the view that the nervous system is not only sensitive but 'delicate': that its encounters with the environment mark it readily, extensively, and permanently, with traces distributed according to the 'accidents' of the encounter. Such a distribution might be expected to produce a merely chaotic alteration in the nervous system's behaviour, but this is not so: as the encounters multiply there is a fundamental tendency for the system's adaptation to improve, for the traces tend to such a distribution as will make its behaviour adaptive in the subsequent encounters.

* The summary is too brief to be accurate; the full text should be consulted for the necessary qualifications.

The work also in a sense develops a theory of the 'natural selection' of behaviour-patterns. Just as, in the species, the truism that the dead cannot breed implies that there is a fundamental tendency for the successful to replace the unsuccessful, so in the nervous system does the truism that the unstable tends to destroy itself imply that there is a fundamental tendency for the stable to replace the unstable. Just as the gene-pattern, in its encounters with the environment, tends towards ever better adaptation of the inherited form and function, so does a system of step- and part-functions tend towards ever better adaptation of learned behaviour.

These remarks give an impressionist picture of the work's nature; but a description in these terms is not well suited to systematic exposition. The book therefore presents the evidence in rather different order. The first five chapters are concerned with foundations: with the accurate definition of concepts, with basic methods, and especially with the establishing of exact equivalences between the necessary physical, physiological, and psychological concepts. After the development of more advanced concepts in the next two chapters, the exposition arrives at its point: the principle of ultrastability, which in Chapter 8 is defined and described. The next two chapters apply it to the nervous system and show how it explains the organism's basic power of adaptation. The remainder of the book studies its developments: Chapters 11 to 13 show the inadequacy of the principle in systems that lack part-functions, Chapters 14 to 16 develop the properties of systems that contain them, and Chapters 17 and 18 offer evidence that the principle's power to develop adaptation is unlimited.

The thesis is stated twice: at first in plain words and then in mathematical form. Having experienced the confusion that tends to arise whenever we try to relate cerebral mechanisms to psychological phenomena, I made it my aim to accept nothing that could not be stated in mathematical form, for only in this language can one be sure, during one's progress, that one is not unconsciously changing the meaning of terms, or adding assumptions, or otherwise drifting towards confusion. The aim proved achievable. The concepts of organisation, behaviour, change of behaviour, part, whole, dynamic system, co-ordination, etc.—notoriously elusive but essential—were successfully given rigorous definition and welded into a coherent whole. But the rigour and coherence depended on the mathematical form, which is not read with ease by everybody. As the basic thesis, however, rested on essentially common-sense reasoning, I have been able to divide the account into two parts. The main account (Chapters 1–18) is non-mathematical and is complete in itself. The Appendix (Chapters 19–24) contains the definitive theory in mathematical form. So far as is possible, the main account and the Appendix have been written in parallel to facilitate cross-reference.

Since the reader will probably need cross-reference frequently, the chapters have been subdivided into sections. These are indicated thus: S. 4/5, which means Chapter 4's fifth section. Each figure and table is numbered within its own section: Fig. 4/5/2 is the second figure in S. 4/5. Section-numbers are given at the top of every page, so finding a section or a figure should be as simple and direct as finding a page.

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W. ROSS ASHBY