

Molecular psychobiology of memory: Its appearance, contributions, and decline

JOHN GAITO

York University, 4700 Keele Street, Downsview MSJ 1P3, Ontario, Canada

The development of molecular psychobiology in its concern with memory aspects is traced over four periods from its inception about 1950 to the present time. There was tremendous excitement during the second period (about 1958-1964) with the expectation that outstanding contributions concerning the molecular basis for memory would be provided. Unfortunately, little was produced of substantial nature; one of the main reasons was the extensive use of methodologies which emphasized quantitative aspects of RNA and protein, rather than methods which might indicate the presence of qualitatively different molecules and their role during learning and memory events. Only three procedures appear to have been suitable in handling these important aspects: DNA-RNA hybridization methods, polyacrylamide gel electrophoresis experiments, and the transfer paradigm. The latter is the only worthwhile one which is in extensive use today.

With the rapid development of molecular biology during the 50s and 60s, producing important basic contributions, it was inevitable that the ideas and methods of molecular biology would permeate the behavioral sciences as well. Thus it was that during the late 50s and early 60s a new area of research and theory gradually developed. This domain has been labeled molecular psychology (Gaito, Note 1), molecular psychobiology (Gaito, 1966, 1971), or molecular neurobiology (Schmitt, 1967). This area of endeavor had as its main concern the uncovering of the molecular mechanisms of memory. Now, however, it appears that molecular psychobiology as a separate and unique entity is rapidly disappearing. The purpose of this paper is to trace the development and decline of this area and to evaluate its contributions. The overall conclusion is that although the approach was a tremendously exciting one, with the expectation that important contributions would be forthcoming, and although much data were generated, *little of an outstanding nature was accomplished.*

BACKGROUND

Molecular psychobiology, as an area of research and theory, was concerned with the relationship between gene and gene products (the nucleic acids—DNA, RNA—and proteins) and behavior (mainly memory aspects). As the name indicates, it involved an integration of the ideas and methods of psychology with those from molecular biology. However, it included subject matter from a number of scientific disciplines, viz, biochemistry, physical chemistry, biophysics, virology, bacteriology, genetics, cytology, psychology, neurology, neurobiology, neurophysiology, neurochemistry, and neurohistology.

Because molecular biology had made rapid progress, it was assumed by many of the early workers in the area

that similar contributions would be provided relative to behavior. Although behavior in general was of some concern, the major effort of most investigators was relative to the molecular basis of learning and memory. Thus many individuals assumed that molecular psychobiology would determine the molecular basis of memory within a few years. The optimism and enthusiasm generated during the early days among a number of researchers was tremendous.

Many researchers in molecular psychobiology assumed that there were one or more specific DNA sites that were quiescent (or relatively so) during nonlearning periods. During learning events, these sites would become active in the synthesis of a specific RNA (presumably messenger RNA) (Bonner, 1964, 1966; Briggs & Kitto, 1962; Gaito, 1964a, b, 1966). This RNA was then to be translated into specific proteins or polypeptides which performed some important function, possibly at the synapse. There were variations of this theme. However, the important assumption was that there were unique RNA and/or protein molecules present during learning which were not present during nonlearning situations. Furthermore, these unique species of RNA and/or proteins were assumed to form the basis for memory events.

In attempting to determine the relationship between learning and the nucleic acids and proteins, there were two types of procedures utilized: the direct and the indirect procedures.

The direct approach used behavior as the independent variable and neurochemical aspects as the dependent variable. For example, Hyden and Egyhazi (1962) trained rats to climb a wire to obtain food and analyzed the RNA base ratios to determine if these ratios differed in trained and untrained animals; Gaito (Note 2) contrasted the amounts, and specific activities, of RNA and protein in avoidance conditioned and control rats.

The direct approach has a molecular biology empha-

Molecular Psychobiology

Toby A. Appel



Molecular Psychobiology:

The Biology and History of Molecular Biology: New Perspectives Sahotra Sarkar, 1996-09-30 This book is a collection of papers which reflect the recent trends in the philosophy and history of molecular biology It brings together historians philosophers and molecular biologists who reflect on the discipline s emergence in the 1950 s its explosive growth and the directions in which it is going Questions addressed include i what are the limits of molecular biology ii What is the relation of molecular biology to older subdisciplines of biology especially biochemistry iii Are there theories in molecular biology iv If so how are these theories structured v What role did information theory play in the rise of molecular biology The book will open the way for many future researchers

Shaping Biology Toby A. Appel, 2003-04-30 Historians of the postwar transformation of science have focused largely on the physical sciences especially the relation of science to the military funding agencies In *Shaping Biology* Toby A Appel brings attention to the National Science Foundation and federal patronage of the biological sciences Scientists by training NSF biologists hoped in the 1950s that the new agency would become the federal government s chief patron for basic research in biology the only agency to fund the entire range of biology from molecules to natural history museums for its own sake Appel traces how this vision emerged and developed over the next two and a half decades from the activities of NSF s Division of Biological and Medical Sciences founded in 1952 through the cold war expansion of the 1950s and 1960s and the constraints of the Vietnam War era to its reorganization out of existence in 1975 This history of NSF highlights fundamental tensions in science policy that remain relevant today the pull between basic and applied science funding individuals versus funding departments or institutions elitism versus distributive policies of funding issues of red tape and accountability In this NSF funded study Appel explores how the agency developed how it worked and what difference it made in shaping modern biology in the United States Based on formerly untapped archival sources as well as on interviews of participants and building upon prior historical literature *Shaping Biology* covers new ground and raises significant issues for further research on postwar biology and on federal funding of science in general

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