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**THE EVOLVING BRAIN**  
**The Mind and the Neural Control**  
**of Behavior**

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by

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# Preface

The study of the higher level neural control of behavior has been dominated by the theory that many aspects of cerebral activity are functionally organized in accordance with psychological concepts such as perception, attention, motivation, memory, emotion or cognition. I believe that this entire approach is misguided because it is based on false assumptions derived from the speculations of the ancient Greek philosophers. The series of essays in this book discusses the implications of a mentalistic approach to the study of brain function and points out the absence of significant progress associated with it. The alternative that is proposed is that we abandon attempts to discover the neural basis of mind as classically conceived and turn instead to an analysis of the neural mechanisms that control behavior. This broad topic touches on a variety of traditional fields. Therefore, the material discussed in this book may be of interest, not only to neuroscientists and psychologists, but also to animal behaviorists, anthropologists, evolutionary biologists, neurologists, philosophers, psychiatrists, and others interested in the general field of the brain, behavior and the mind.

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# **I. The mind and the explanation of behavior**

It is conventional to explain human behavior in terms of mental activity. We are said to act as we do because of desires, wishes, opinions, beliefs, motives, etc. This common sense approach to the mind and behavior has been very influential in the broad field of brain research and neuroscience. In the past half century an enormous research effort has been devoted to the study of the neural basis of cognition (cognitive science, cognitive neuroscience), of memory, and also of attention, motivation and emotion. It appears to be widely assumed that we are in possession of a valid taxonomy of mental processes, a fund of well-established knowledge about the organization of high level neural activity that is obvious to everyone. What is the nature of this taxonomy, how was it established and agreed on, and lastly, can we be certain of its validity?

Present day ideas about the mind do not appear to have departed very far from the classic summary of psychological knowledge provided by William James in 1890.<sup>1</sup> Chapter headings listed by James include: “The stream of thought, The consciousness of self, Attention, Conception, Discrimination and comparison, Association, The perception of time, Memory, Sensation, Imagination, The perception of things, The perception of space, The perception of reality, Reasoning, Instinct, The emotions, and Will”.

David Hume, writing in the 18<sup>th</sup> century<sup>2</sup> provided a similar though more extensive list of mental faculties, processes, or states including the following: “impressions, ideas, pride, humility, pleasure, pain, vice, virtue, vanity, wit, humour, love of fame, sentiments, passions, love, hatred, esteem for the rich and powerful, sympathy, benevolence, anger, compassion, pity, malice, envy, respect, contempt, amorous passion, desire, aversion, grief, joy, hope, fear, will, imagination, curiosity, reason, understanding, moral sense, feelings, selfishness, generosity, a sense of justice, beliefs, respect, vanity, prejudice, gratitude, zeal, disinterestedness, fidelity, esteem, industry, perseverance, patience, vigilance, application, constancy, temperance, frugality, irresolution, uncertainty, reveries, thoughts.”

In addition to all the foregoing, one cannot ignore such concepts as the conscious mind, the preconscious, the unconscious, the ego, the id, the superego, repression, and sublimation. All these concepts, and more, were introduced by Sigmund Freud in the 20<sup>th</sup> century.<sup>3</sup>

If one seeks the source of this long mentalistic tradition in the history of Western thought, one comes, at last, to Aristotle, a Greek philosopher living from 384–322 BC,<sup>4</sup> and his teacher Plato (428–348 BC). Aristotle proposed that living things differ from non-living things because they possess a non-corporeal psyche. The presence of the psyche, he thought, keeps the body together throughout a long life but at death, when the psyche has departed, the body speedily rots and disintegrates (especially in a hot Greek summer!). All living things, said Aristotle, possess a vegetative psyche responsible for nutrition, growth and reproduction. Plants, he said, have no further psychic powers but animals have both a vegetative psyche and a sensitive psyche, permitting reactivity to touch and other sensory stimuli. Only humans possess the highest type of psyche which confers a capacity for rational thought. In addition to these major subdivisions, the Aristotelian psyche also possessed numerous faculties such as desire, opinion, memory, imagination, belief, judgment, conviction, thinking, etc. Aristotle's theories of the psyche and of many other topics in what we now regard as physics, chemistry and biology were adopted by the Christian Church and disseminated throughout the Western world over a period of many centuries.<sup>5</sup> As a result his ideas were widely accepted. However, the discovery by William Harvey (1578–1657) that the circulation of the blood is a mechanical process and later work such as the discovery by Antoine Lavoisier (1743–1794) that animal heat and life depend on chemical processes gradually led to a general acceptance of the idea that life processes are dependent on physical and chemical processes. The Aristotelian theory of a psyche that was responsible for the phenomena of life became unnecessary.

It appears that the French philosopher Rene Descartes (1596–1650) played a major role in establishing the mechanistic point of view in biology.<sup>6, 7</sup> Descartes assumed that the bodies of humans and all aspects of the functioning of non-human animals depended on mechanical principles. Animal behavior was attributed to reflexes, simple sensori-motor reactions involving the nervous system, but human behavior, although partly reflex, was held to be mainly dependent on the activity of a rational soul. These ideas had two important effects: (a) the study of the function of the body, up to and including the level of reflexes, could be studied freely by physical and chemical methods, giving rise to modern physiological science; and (b) human behavior was placed outside the field of materialistic science, effectively separating psychology from the rest of biological science and permitting Aristotelian ideas about the higher levels of the psyche to persist into modern times.

To a modern scientifically literate reader, most of Aristotle's ideas seem bizarre and primitive. He tells us that circular motion is the fundamental type but Galileo and Newton taught us to think that linear motion is fundamental. Aristotle thought that falling objects move at a constant velocity; having



no understanding whatever of gravity, he did not realize that falling bodies accelerate. Knowing nothing about chemistry, Aristotle accepted the theory that all material objects are made up of four elements: fire, water, earth and air. We recognise a periodic table listing up to 107 elements that have no resemblance to Aristotle's elements.

In contrast, Aristotle's discussion of psychological topics sounds rather modern. Reason is said to be distinct from emotion, and is often opposed to it. Thought always involves mental images and thought proceeds by a process of association of ideas. Memory is compared to a physical information storage device (a signet ring pressed into wax) in a manner that has many parallels with modern comparisons of human memory to computer memory. There can be little doubt that although Aristotelian ideas have been supplanted in physics, chemistry and biology they have persisted to the present in philosophy, psychology, psychiatry and common popular opinion.

As an example of the process by which mentalistic concepts were developed, let us consider the origin of the concept of cognition which forms the intellectual basis of present-day cognitive science and cognitive neuroscience. In the *Republic*, Plato<sup>8</sup> concludes that the ideal state should consist of three social classes: a) rulers; b) soldiers; and c) farmers and workers of all kinds. Further, Plato thought, what is true of the state must also be true of individuals. Therefore, the psyche will also consist of three parts: a) reason, intellect or cognition (corresponding to the rulers); b) feelings, spirit, will or conation (corresponding to the soldiers); and c) desires, emotions or appetites (corresponding to the farmers and workers). As evidence favouring this tripartite division of the psyche, Plato pointed to the common observation that people often seem to experience internal conflicts. For example, a man might be thirsty yet unwilling to drink.

Although conation is rather neglected nowadays, cognition and emotion figure prominently in cognitive neuroscience and the philosophy of mind. It is, for example, widely believed that there is a separate entity, the limbic system of the brain, which is the basis for emotion while the neocortex and its connections provide the basis for intellect or cognition. However, one may legitimately ask whether Plato and his followers really got it right. Are reason, cognition, etc., really different in principle from desires, emotions, appetites, etc.? When making decisions in everyday life, people often seem to have difficulty distinguishing among self-interest, prejudice, and a logical consideration of the available evidence. If such things were truly different there should be no such difficulty. Self-deception would be less common than it is now. If a thirsty man does not drink, perhaps because he thinks the available water may be contaminated, one need not assume a conflict between desire and intellect, as Plato thought. Perhaps there is a conflict between two desires (thirst versus a desire to avoid illness). Perhaps there is a conflict between two

equally rational ideas: a) this water will do me good; and b) this water will do me harm. Are arguments and evidence of the type presented by Plato really sufficient to decide the question of the overall organization of the mind or the brain? Is it reasonable to lump together such diverse things as hunger, thirst, fear, rage, hatred and sexual lust into a single category? Why should Plato's idea of a tripartite psyche be taken seriously?

It is widely believed that the conventional theory of the mind or psyche can be verified by simple introspective examination of one's own thoughts, feelings, motives, etc. Rene Descartes wrote: "I see clearly that there is nothing which is easier for me to know than my mind."<sup>7</sup> However, a systematic attempt to analyze the mind in detail by introspection in the period between approximately 1880–1910 lead to failure and the conclusion that introspection is not a valid method of study.<sup>9</sup> What one might call "mentation" or "cerebration" is generally not available to introspection. There is a good deal of evidence that what people are really aware of when they "introspect" is sensory input from muscles, joints, viscera, etc.<sup>10</sup> There appears to be no capacity for the mind to examine itself directly. The conventional sensory channels (visual, auditory, gustatory, olfactory, tactile, thermoceptive, proprioceptive, nociceptive, and interoceptive inputs) provide information about the state of the body and the outside world, not the mind or the brain. Therefore, the conventional taxonomy of mental processes cannot be verified by "introspection".

The conclusion that introspection is impossible, that one cannot directly observe one's own mental activity, is intuitively implausible. As William James put it (1, p. 185) "The word introspection need hardly be defined – it means, of course, the looking into our own minds and reporting what we there discover". If we live a life of comfortable routine, we know very well our own likes and dislikes and we feel confident that we know what we will do in the future. Surely, a critical reader may suggest, this is due to introspection. Doubts about this may appear if the settled routine of everyday life is suddenly overthrown and one finds one's self unexpectedly in great physical danger or in any situation that elicits a strong reaction, violent sexual jealousy, for example. One reacts to such situations in ways that may, on later sober reflection, appear admirable or shameful, but in all such cases it seems to be common to be rather startled by one's own behavior. One asks: "How could I have done that?"

It may be that we are familiar with our own behavior, not through any direct insight into the mechanisms that cause that behavior, but merely because we have, many times over, experienced the sensory consequences of that behavior in the past. Formal evidence that this is indeed the case is provided by a famous series of experiments on obedience to authority by Stanley Milgram of Yale University.<sup>11</sup> Under the guise of an experiment on the effect of punishment on human learning, naïve subjects were instructed to deliver electric shocks to a man strapped in a chair (the victim) whenever the victim made an error in a

learning task. Although severe shocks were never, in fact, applied, the naïve subject was led to believe that he was administering shocks of increasing intensity up to a level that might be dangerous (450 volts). Under the various conditions of the experiment, 30–65% of the naïve subjects were willing to administer shocks at the maximum voltage even though the victim, apparently a talented actor, was struggling and screaming, and even though, under one condition, the naïve subjects had to hold the victim's hand forcibly on the shock plate. Thus, a high proportion of normal adult men will obey an authority (the experimenter) who orders them to do cruel and dangerous things to other people.

These results, in addition to their relevance to the question of how despotic regimes can induce ordinary people to perform acts of torture and murder, have relevance to the question of how well people know their own mind. Milgram asked groups of people (college students, middle-class adults) who had not actually taken part in these experiments but had the methods used described to them, how they themselves would have reacted if they had played the role of naïve subjects. Not one of a group of 110 people believed themselves willing to deliver high intensity shocks to the victim. A group of 39 psychiatrists thought that perhaps one person in a thousand (0.1%) would be willing to do it, not the 30–65% that actually will do it. We can conclude that people have no introspective access to the behavioral control mechanisms that are activated by the commands of someone in authority.

There is also reason to doubt that humans have conscious access to the mechanisms that control purposive behavior in a general sense. It is conventional to believe that people do things that result in a feeling of pleasure and avoid doing things that result in pain. A clear demonstration that this may not be entirely correct is provided by an experiment on the reinforcing and subjective effects of morphine administration in men with a past history of intravenous morphine use (post-addicts).<sup>12</sup> The term “reinforcing effect” refers here to the ability of morphine injections to increase the rate of pressing a lever above the rate obtainable with control (placebo) injections if, and only if, the morphine injections are dependent on pressing the lever. The term “subjective effects” refers here to the ability of the post-addicts to demonstrate that they could detect the morphine injection by correctly stating, on a questionnaire, that they had received the morphine and not the placebo. A dose of morphine of 3.75 mg maintained lever pressing above control levels in four of the five post-addicts, and doses of 7.5, 15 and 30 mg maintained lever pressing in all five cases. However, according to the questionnaire results, the post-addicts were aware only of the 30 mg dose. These results show that the reinforcing effect of morphine is not dependent on a pleasurable effect that can be reported verbally (on a questionnaire). This is consistent with the general conclusion that behavior control mechanisms are not open to introspective examination. We