J. Biol. Res. 2006 n. I - Vol. LXXXI - Rubbettino - Soveria Mannelli

Continuous interactions between the brain and the surrounding world

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As our life passes, we become aware of what happens inside us. In the village where we live together with many others, we record many events, we acquire new experiences, we wonder about their significance: perceptual categorizations, opinions and thoughts become defined within us and they influence our behaviour. Our life, indeed all of society, depends on this: on the choices we make day after day. Lugaro said: "the brain looks, smells, tastes, touches, suffers and rejoices, justifies, hesitates, desires; and it is also an archive, a court, a government".

Well, the guiding organ of all this is the brain. In 1860 and 1894 respectively, Camillo Golgi and Ramon Cayal (along with several others) described a lot of neurones within this organ: cells characterized by a cell body (perikaryon) and thread-like prolongations (neurites and dendrites) that depart from the cell body and extend for some distance to reach and contact: a) other specific neurones, b) receptor organs, c) somatic and visceral effectors such as striated muscle fibres, smooth muscle cells and secretory cells. The guiding signals that permit the prolongations of a neurone to reach and make contact with these targets have been (and still are) extensively studied. As the growth cones of axons and dendrites gradually advance, they find guiding signals that either attract or repel them: these signals act as "road signs"! They are probably chemotropic molecules released into the environment by the target cells, which induce the formation and stabilization of specific contacts; the prolongations also collaborate by synthesizing interacting chemotropic molecules. Fundamental among such molecules are neuropeptides, bradykinin, calcitonin, encephalin, endorphin, substance P, and others still.

In this way, circuits are formed day after day. Embryological, histological and (especially today) physico-chemical studies have demonstrated that electrical impulses originate from the receptor organs and the first perikarya. Travelling near or far along a circuit, the impulses arrive from the receptor and discharge on an effector organ. The passage of the stimulus from the neurites of the first neurone to the cell body or dendrites of the second neurone occurs via a physico-chemical mechanism in addition to the electrical one. The former mechanism involves chemical substances called transmitters, such as acetylcholine, adrenalin, glutamate, dopamine, etc. The function is rather simple: the first neurone receives a specific impulse and responds by stimulating subsequent neurones of the circuit as far as the effector. The transmitters can be excitatory or inhibitory with respect to the activity of the circuit.

Hence, a very simple physiological activity takes place within the circuitous structure: the first neurone of a circuit receives a stimulus from a specific receptor and responds by eventually stimulating the final effector with a single type of information. Sometimes, however, contacts arriving from other circuits are formed at synapses along the circuit, which transport sensory flows different from the preceding one: consequently, the motor responses of the circuit depend on the different types of stimuli, which are either simple (a single type of information) or manipulated (multiple types of information from the external and internal world). For instance, information about a flower consists not only of the shape but also the colour, odour and a whole set of other details.

It must be underlined that certain areas of the brain contain centres that receive specific data (centres for vision, for hearing, etc.), while other centres carry out complex manipulations of various higher-order activities related to memorization, emotional activities of pain, pleasure, etc., and socialization. By sending messages to the circuits, these areas can modulate our behaviour in a fundamental manner: thus, inserted between the simple sensory information and the motor response (stimulus-response) are modulatory factors deriving from conscious and unconscious mental manipulations concerning memory, emotions and relationships with others. These cortical centres can interfere at any time with the specific inputs from a receptor.

The brain is an entity to study scientifically and to understand in terms of both the mechanisms that determine the progressive development of the neuronal organ and the creation of an association of billions and billions of cells which, in daily life, is expressed in endless varieties of functional activities.

The development of the individual and of his brain is the result of an interaction between his hereditary characters and the environment: nature and nurture. The substratum of the individual is his genome, but the environment in which the genome is expressed can profoundly modify the result. This interaction is the basis of evolution of the individual and the species: the genome includes variations in DNA sequences (polymorphism) that constitute the basis of evolution. This allows the individual and the species

to adapt to the environment and to particular situations, and thus to be plastic.
Many examples illustrate the influence of genes on the development of the nervous system and of individual behaviour. For example, simple insertion of the vasopressin receptor V1a gene of the prairie vole (*Microtus ochrogaster*) into the mouse induces monogamous behaviour.
On the other hand, there are many examples of how experience can modify the genetic blueprint (*bauplan*). This is evident if we consider the influence of visual and somatosensory experience on the development of the related cerebral areas. Indeed, experience plays the role of moulding the substratum determined by the genome, and different visual experiences can result in completely different behaviours and functional abilities. At the DNA level, experience of the environment can modify gene expression via DNA methylation, demonstrating that the same genome can produce different phenotypes and behaviours. For example, in rats, the gene coding for the glucocorticoid receptor is fundamental in the response to stress: hence, mothers may care for their offspring with greater or lesser affection, even in the absence of genetic polymorphism. Poor infant care by the mother leads to alterations of the newborn's genome, which will be reflected in its adult behaviour.
The dilemma between nature and nurture has always fascinated scientists and has divided them into proponents of one or the other. As usual in these cases, the dichotomy has no sense, since there is evidence that both factors are important. In fact, they are two fundamental elements in the development of the species, of the individual and of the nervous system, whose maximal potential is expressed only through the interaction of one with the other.
The journey that science has undertaken to understand our structure commenced a long time ago. It has left large mysterious gaps, but it has given us hope of knowing how to use the brain ever more effectively in our daily social life.
Some say that the brain contains a book of instructions that tells us how to use it; others believe, instead, that we do not always demonstrate that we have found that book! Scientific knowledge is still uncertain. Scientists live with doubt and uncertainty. For the purposes of scientific progress, recognition of the value of this ignorance is of primary importance, in that we will continue to look, and conduct research, in many directions.
Every day, scientific and technological development opens new frontiers in the study of the brain, and new questions entice us collectively into various biological adventures that might free us from the laws of nature. At times, we are all drawn into freeing ourselves from these laws and into not justly considering the utility of the acquired knowledge: the brain can err! Thus, new responsibilities are created, especially during the development of children and adolescents, since at that age the environmental factors of new learning experiences can greatly modify the circuits of our brain and the neuronal plasticity does not always behave correctly in mental education. In this way, we are drawn into various adventures that are not always aimed at the well-being of each and everyone, with full respect for the life and dignity of Man.