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## Jose Delgado's "Physical Control of the Mind"

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### Characteristics and Limitations of Brain Control

The possibility of man's controlling the thoughts of other men has ranked as high in human fantasy as the control over transmutation of metals, the possession of wings, or the power to take a trip to the moon. Our generation has witnessed the accomplishment of so many nearly impossible tasks that today we are ready to accept almost anything. In the world of science, however, speculation and fantasy cannot replace truth.

There is already abundant evidence that ESB can control a wide range of functions, including motor activities and mental manifestations, in animals and in man. We know that by electrical stimulation of specific cerebral structures we can make a person friendlier or influence his train of thought. In spite of its spectacular potential, ESB has practical and theoretical limitations which should be delineated.

#### *Predictability*

When we get into a car and press the starter, the motor will almost certainly begin to run in a few seconds. The brain, however, does not have the simplicity of a machine. When electrodes are introduced into a cerebral structure and stimulation is applied for the first time, we really cannot predict the quality, localization, or intensity of the evoked effects. We do not even

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know that a response will appear. This is especially true for complex structures, like the amygdaloid region, which have great functional multiplicity; but it is also the case in relatively simple areas like the motor cortex. The anatomical and functional variability of the brain are factors which hinder prediction of ESB results (53). The importance of these limiting factors is compounded by alterations in regional activity related to changes in local, general, and environmental circumstances. We know that certain functions are represented in specific cerebral structures, but the precise location of a desired target requires careful exploration, and implantation of only a few contacts may be rather disappointing. After repeated explorations of a selected area in several subjects, predictability of the observed responses in that area for that species can be assessed with a higher degree of confidence. Present information about functional mapping in most cerebral areas is still rather incomplete.

#### *Functional Monotony*

Electrical stimulation is a nonspecific stimulus which always activates a group of neurons in a similar way because there is no coded neural message or feedback carried to the stimulating source. The responses, therefore, are repeated in a monotonous way, and any variability is related to changes in the stimulated subject. This functional monotony rules out the possibility that an investigator could direct a subject toward a target or induce him, like a robot, to perform any complex task under remote-controlled orders.

Science fiction has already imagined men with intracerebral electrodes engaged in all kinds of mischief under the perverse guidance of radio waves sent by some evil scientist. The inherent

limitations of ESB make realization of this fantasy very remote. The flexion of a limb can be radio controlled and an emotional state could also be set remotely, but the sequences of responses and adaptation to the environment depend on established intra-

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cerebral mechanisms whose complexity cannot be duplicated by ESB. Even if we could stimulate different points of the brain through twenty or thirty channels, it would be necessary to have sensory feedback and computerized calculations for the programming of simple spatiotemporal sequences. Induced performance of more complex acts would be far beyond available methodology. It should be clarified that I am talking about directing each phase of a response, and not about complex behavior such as lever pressing or fighting, which may be triggered by ESB but develops according to individual experiential circumstances which are beyond electrical control.

### *Skillful Performance*

Many of the activities elicited by ESB certainly can be categorized as skillful. Pressing a lever, climbing a cage wall, and looking for a fight require good motor coordination and suitable processing of information. Walking on two feet, which has been repeatedly elicited in monkeys during stimulation of the red nucleus (Figure 12), is another example of refined coordination and equilibrium seldom observed in spontaneous behavior.

These facts demonstrate that ESB may result in different types of skillful performance, but it must be understood that these responses represent the manifestation of skills already familiar to the subject. Motor learning requires the reception of sensory inputs not only from the environment but also from the performing muscles, and a relatively lengthy process of motor training is required to perfect reactions related to each type of performance and to store the appropriate ideokinetic formulas in the brain for future reference and use. Much of the brain participates in learning, and a monotonous train of pulses applied to a limited pool of neurons cannot be expected to mimic its complexity. The acquisition of a new skill is theoretically and practically beyond the possibilities of electrical stimu-

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lation, but ESB can create the desire to perform certain acts which may be skillful.

### *Individual Stability*

Personal identity and reactivity depend on a large number of factors accumulated through many years of experience interacting with genetic trends within the complexity of neuronal networks. Language and culture are among the essential elements of individual structure. All these elements cannot be substituted for by the delivery of electricity to the brain. Memories can be recalled, emotions awakened, and conversations speeded up by ESB, but the patients always express themselves according to their background and experience. It is possible to disturb consciousness, to confuse sensory interpretations, or to elicit hallucinations during excitation of the brain. It is also possible to induce fear, pleasure, and changes in aggressive behavior, but these responses do not represent the creation of a new personality - only a change in emotionality or reactivity with the appearance of manifestations closely related to the previous history of the subject.

ESB cannot substitute one personality for another because electricity cannot replicate or influence all the innumerable factors which integrate individual identity. Contrary to the stories of science fiction writers, we cannot modify political ideology, past history, or national loyalties by electrical tickling of some secret areas of the brain. A complete change in personality is beyond the theoretical and practical potential of ESB, although limited modification of a determined aspect of personal reactions is

possible. In spite of important limitations, we are certainly facing basic ethical problems about when, why, and how some of these changes are acceptable, and especially about who will have the responsibility of influencing the cerebral activities of other human beings.

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### *Technical Complexity*

Electrical stimulation of the central nervous system requires careful planning, complex methodology, and the skillful collaboration of specialists with knowledge and experience in anatomy, neurophysiology, and psychology. Several prerequisites, including construction of the delicate multilead electrodes and refined facilities for stereotaxic neurosurgery, are necessary. The selection of neuronal targets and appropriate parameters of stimulation require further sophistication and knowledge of functional brain mapping as well as electronic technology. In addition, medical and psychiatric experience is necessary in order to take care of the patient, to interpret the results obtained, and to plan the delivery of stimulations. These elaborate requirements limit the clinical application of intracerebral electrodes which like other modern medical interventions depends on team work, equipment, and facilities available in only a few medical centers. At the same time, the procedure's complexity acts as a safeguard against the possible improper use of ESB by untrained or unethical persons.

### *Functions Beyond the Control of ESB*

We are in the initial steps of a new technology, and while it is difficult to predict the limits of unknown territory, we may suppose that cerebral manifestations which depend on the elaboration of complex information will elude electrical control. For example, reading a book or listening to a conversation involves reception of many messages which cannot be mimicked by ESB. A pattern of behavior which is not in the brain cannot be organized or invented under electrical control. ESB cannot be used as a teaching tool because skills such as playing the piano, speaking a language, or solving a problem require complex sensory inputs. Sequential behavior or even elemental motor responses cannot be synthesized by cerebral stimulation,

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although they are easily evoked if they have already been established in the excited area as ideokinetic formulas. Since electrical stimulation does not carry specific thoughts it is not feasible as a technique to implant ideas or direct behavioral performance in a specific context. Because of its lack of symbolic meaning, electricity could not induce effects comparable to some posthypnotic performances.

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