Cognitive plasticity: Increasing or decreasing over the course of development?[1]

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Over the course of this century, the focus of developmental theories in psychology has been the battle over nature versus nurture, a battle that inneists (e.g. Chomsky), environmentalists or empiricists (eg. Skinner), or constructivists (e.g. Piaget) were unable to resolve. Since my perspective is not historical, my talk will concentrate on the concept of plasticity which could potentially go a long way towards helping us to better understand and clarify what is meant by development :

-Do the cognitive structures (or the neuronal networks) emerge during development as gradually more specific or on the contrary gradually more general?

-Are these structures more closely related to specific content which implies increased adaptation but also increased contextualization and decreased plasticity, or do they become more general in the sense of transferable, generalizable which implies increased adaptability, decreased contextualization and increased plasticity?

I will begin by comparing in a caricatural way neuronal and psychological developmental theories from the point of view of plasticity (for a detailed presentation, cf. Mounoud, 1990).

- Neuronal theories such as proposed by Changeux (1983) or by Edelman (1987) under the label of neuronal darwinism have considered the development mainly as an impoverishment process described in terms of selection (selection of neuronal groups for Edelman; selective stability for Changeux), resulting from various phenomenona such as neuronal death, dendritic pruning, etc. In this view, the nervous system is considered adapted in an increasingly specific way to various environments, and its plasticity decreases, the organism becoming consequently less and less adaptable. This perspective could be modified or corrected by more recent data as well as by other approaches such as Thatcher's (1994) who has studied the development of inter and intrahemispheric connections.

- By contrast, a large number of psychological theories give an opposite description of development and Piaget is a good example. Development is mainly characterized in terms of enrichment defined first of all by growing capacities to establish relationships, to integrate or coordinate information located at ever greater temporal and spatial distances (increasing capacities to relate dimensions or objects or events to each other). In this view, behaviors are more and more adaptable, their plasticity in the sense of flexibility increases, knowledge is less and less bound to specific contexts.

This growing capacity to relate things to one another, to integrate or coordinate diverse information has been mainly attributed to the prefrontal cortex (Fuster, 1997; Golman-Rakic, 1987; Diamond, 1988, etc.) and various steps of its maturation have been illustrated (at 12

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months, 24 months, 48 months, 6 years, 8 years, 10 years, in the course of adolescence). Each step characterizes an improvement in plasticity defined as flexibility.

Nevertheless, and still from a psychological point of view, experimental data and observations demonstrate a decrease in plasticity, a loss of flexibility related to the specialization of different behaviors. It looks like a loss of adaptability, some kind of impoverishment of the cognitive capacities.

In order to discuss this problem, I will present two prototypical examples.

Ex. 1 - One of the most famous examples of what has been called a "loss" or impoverishment (which I have extensively referred to and discussed, i.e. Mounoud 1988) was discovered by Werker & Tees (1983) and is related to the perception of sound language. More precisely it is, in the course of the first year of life, the loss of discriminative capacities related to some phonological contrasts not belonging to the mother tongue. Although newborns are capable of discriminating phonological contrasts belonging to various languages, several phonological contrasts which do not belong to the mother tongue are no longer discriminated by the one year old baby. The interesting aspect regarding plasticity is the fact that this phenomenon was initially interpreted as a loss in discriminative capacities related to phonological contrasts. Later on it was reinterpreted, in particular by Jusczyk (1985) and Kühl (1992) as resulting from attentional processes (i.e. the native language magnet theory (NLM) developed by Patricia Kühl). New results in fact have demonstrated that the discriminative abilities are not lost stricto sensu, they are temporally no longer available. If subjects (including adults) are submitted to learning procedures (e.g. the acquisition of a second language) which requires discriminations that are supposedly lost, then these capacities reappear (the listener has to learn to pay attention to acoustical parameters without functional value in his/her mother tongue). Consequently, instead of losing a competence, the baby acquires in the course of his first year the ability to pay selective attention to the useful phonological contrasts (acoustic parameters) belonging to his/her mother tongue and/or to neglect others which are unnecessary for the learning process (the perceptual space is distorted in order to maximize the relevant differences for words recognition and to minimize the irrelevant one).

Ex. 2 - My second example relates to face perception. Each of us has experienced difficulties in discriminating faces of people belonging to a different race. Thus, for us all Asian faces seem to be very similar in opposition to faces belonging to the Caucasian race. This phenomenon has been extensively studied by psychologists under the label of "*the other race effect*" (for a review, cf. Shapirod & Penrod, 1986; Shepherd, 1981). (This problem is actually under study by Roberto Caldara (1999) for his doctoral thesis in Geneva). According to Schonen (1999), this effect is already present in ten month old babies which is interesting for our parallel with the perception of sound language.

The other race effect has been demonstrated experimentally in the following way: Subjects are trained to recognize a set of Caucasian and Asian faces. They are then confronted to these learned faces interspersed with others not presented during the learning phase and are asked to decide as fast as possible if the faces are known or unknown. Response time and number of errors are higher for the Asian faces than for the Caucasian. This phenomenon seems very similar to the first one related to sound discrimination.

Once more we are confronted to the specification or specialization of a perceptual system which has defined (selected) in the course of development the relevant dimensions in order to discriminate faces that are usually encountered. These relevant or critical dimensions do not seem adapted to discriminate faces from other races. In fact, Ellis et al. (1975) have demonstrated that the critical features to characterize faces change with regard to the race they belong to. As in the case of discriminative capacities for sound language, the capacity to discriminate faces from other races increases with training or situations of necessity. Consequently, perceptual or conceptual systems responsible for processing faces can be considered only temporarily impoverished, as long as subjects are not confronted to situations requiring other discrimination or recognition.

A propos, I am unable to resist the temptation of reading for you a short paragraph from a book by James Lord (1980) entitled "A portrait by Giacometti".

(Quote) "… in the course of our conversation (James Lord with Giacometti) we started talking about geography, Europe, the six continents, Japan. I made the comment that I had never well known either a Chinese or a Japanese in contrast with him who has been very friendly during many years with Isaku Yanaihara, the Japanese professor having posed (as model) for a lot of painting and sculptures. I asked him if he had ever been conscious of some differences between him and Yanaihara, of some fundamental disparity in attitudes or instinctive reactions, disparity which could have been due to the diversity of environment, nationalities, races. - Absolutely none, answered Giacometti. He seemed exactly like me. In fact I came to consider him like the norm having been looking at him for so long. We were always together in the studio, in coffee places at the Dôme or at the Coupole (famous restaurants in Paris), in night-clubs. We have been so much together that one day I had a strange experience related to that. Yanaihara posed for me and suddenly Genet (Jean Genet, the French writer) came in the studio. I found that he looked strange with a round face, so rose and inflated lips. But I said nothing. Then Diego (Giacometti's brother) came in and I had the same feeling. His face looked very rose and entirely round, its lips looked inflated. I did not understand why. And then suddenly I became conscious that I saw Diego and Genet in the way they should appear to Yanaihara. I had been for so long and so intensively concentrated on Yanaihara's face that he became the norm for me and during a short time - this impression was very fugitive - I saw white persons in the way colored people (those who are not white) should see them".

That's it. This quotation from my point of view constitutes a nice demonstration related to the plasticity of our cognitive systems in spite of their selectivity or impoverishment. Developmental and learning processes of the discriminative (perceptual) capacities related to faces and sound language tell us that the specialization of cognitive systems or neuronal networks can produce a decrease of their plasticity or adaptability, but that this decrease (or impoverishment) corresponds to a temporary adaptation to a specific environment (one language, faces from one race) and above all that adaptations to new environments are still possible. In order to explain such phenomenona we have to look at the attentional mechanisms which correspond to strategies for selecting and processing information in order to be optimally adapted, but still potentially adaptable!

At this point, it is interesting to mention that in recent years, cognitive development is viewed more and more in terms of attentional mechanisms (i.e. Houdé, 1995; Pascual-Leone, 1994; Ribaupierre, 1994), as if a major process characterizing cognitive development required first of all to select which dimensions we must pay attention to and those we must inhibit, more so than constructing new structures to process information.

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