

Experience-dependent brain plasticity: A key concept for studying nonconscious decisions

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Abstract. The development of normal or abnormal psychosocial behavior is discussed in the framework of a brain model centered around findings on experience-dependent plasticity. Plasticity is the brain's basic mechanism that leads to the creation of autobiographical memory with which the memory-driven conscious and nonconscious (automatic) information processing operations organize the individual's cognition, emotion and action. Psychological problems treatable with Freud's talking cure are understood as products of automatized, maladaptive memory contents (skills and cognitive-emotional coping strategies) that represent conflictive (uncooperative) interactions between developing individual and social realities. © 2005 Elsevier B.V. All rights reserved.

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1. Introduction

The paper that we presented to this symposium on “Psychoanalysis and the human body: Beyond the mind–body dualism” has two aims: Firstly, to review proposals of an integrative model of the brain functions that ensure the development of psychobiosocial healthy behavior of a healthy-born child in a suitable environment; this development uses conscious and nonconscious information processing operations [1–4], and secondly, to use the proposal of our model in order to discuss how and why the same brain functions may lead to the development of the intrapsychic conflict and to the nonconscious manifestation of psychological problems that can be treated with Freud's talking cure.

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There is a plethora of experimental evidence from integrative, non-dualistic approaches to human nature that show the following: Psychosocial development is the result of the brain's functions that transform experiences into mnemonic (neuronal) networks and herewith create biography, i.e., the autobiographic memory that represents the interactions of an individual with its social environment. The brain functions that create biography lead consciously and nonconsciously to an individual as well- or maladaptive member of its society.

2. Why do we need a model?

Biopsychosocial development is the topic of research and theory in all disciplines concerned with life phenomena from philosophy and psychoanalysis to neurobiology and genetics. Consensus appears to have been reached that (a) human development is a multifactorially determined process that can be studied in all levels of its complexity (from genes to the social reality with which the individual has to deal), (b) there is a close association between quality of biopsychosocial development and quality of social relationships, and (c) further understanding of physiogenesis and pathogenesis of human behavior needs to be based on a comprehensive theoretical framework, a model covering widely accepted concepts and multidetermined processes (e.g. [5,6]).

However, despite of many bridge-building efforts, a widely accepted model is still missing. Further, a survey of the humans' efforts to explain the nature of their behavior shows that there are dualisms in scientific positions about human nature and the determinants of human behavior. These are the subject of controversial debates and fundamental conflicts between scientists: mind/body, mind/brain, biology/psychology, nature/nurture, intrinsic/extrinsic motivations, rational/emotional processes, localistic/holistic cortical functions, etc. It was proposed [6–8] that dualisms in human sciences hinder the interdisciplinary dialogue and thus, the integration of findings into a comprehensive theoretical framework, a model that can be used for further research into how and why human nature produces psychological problems. Focusing on psychoanalysis: such a model must be useful for research into the nature of the unconscious and how it produces the intrapsychic conflict and the subjective experiences that are perceived as psychological problems.

3. The model of the brain functions that create human behavior

Our model follows basic principles of dynamic systems theory as used in human neurosciences to study brain–behavior relationships [9], specifically, to study the brain functions that create the individual's thoughts, emotions, decisions, actions, problem solving strategies, dreams, etc. The following principles of dynamic systems theory are important for models such as the one we work with: (a) postnatal survival and biopsychosocial development presupposes and emerges out of the continuous and dynamic interaction of individuals with their internal realities (the organs, including the brain) and external, physical and social realities in which they live, i.e., their natural partners; (b) a given degree of cooperative interactions between age-important social realities (the caregivers) and developing individual is the prerequisite for a healthy

biopsychosocial development; and (c) humans like all complex living systems follow an ontogenesis; they pass through stages of development.

The model draws on findings about (a) the functions of the nervous system that enable the newborn to start and maintain postnatal life as dynamic and parallel interactions with the external and internal realities with which and in which it was born, and on (b) the experience-dependent cortical plasticity that creates biography and thus enables the biopsychosocial changes that characterize individual development [7,8,10–12]. The model centers around the nature of the brain functions that influence the quality of the interactions between child and social environment and hereby may influence the level of cooperative interactions—the prerequisite for a healthy psychobiosocial development.

In sum, the model focuses on how the different determinants of behavior interact (operating factors from genes, nerve cells and intrinsic motivation to specific elements of the social environment) and are integrated in the autobiographical memory and define the course and character (the quality) of the individuals' thoughts, emotions, actions, decisions, etc.

4. The functions of the nervous system that enable postnatal development

Humans are born with mature functions of the central, peripheral, and autonomic nervous system that enable a newborn to start postnatal life as a dynamic interaction between its body functions and the physical and social environment into which it was born. Specifically, humans are born with (a) sensory organs that encode the human-specific signals (smells, sights, tastes, sounds, touches, postures, phonemes) and transfer them to the central nervous system, and (b) brain structures that (b1) based on innate knowledge about the organism's basic needs for survival and well-functioning, i.e., about what supports well-being or the opposite, encode the sensory qualities of the received information and herewith estimate their effects on well-being, and (b2) as the result of this estimation, initiate a complex response pattern manifested by the functions of the central, peripheral and autonomic nervous system in all aspects of behavior that can be measured in physiology, behavior and subjective experience [3,5].

With this complex response pattern, humans (a) may keep or restore well-being by restoring the functional levels of the homeostatic values, (b) communicate these effects to the caretakers and invite them to take care of the well-being, and (c) initiate the molecular mechanisms of learning and memory. These mechanisms translate the effects of experiences on the organism's basic needs into the neural architectures of the experience-dependent, synaptic plasticity (experience-induced cortico-cortical connectivity) of the neocortex, and herewith extract personal meaning and create biography.

At birth, humans have most of the brain neurons they will ever have (more than 100 billions). The mass of the brain at birth is however only one fourth of the adult brain. The increase of brain mass during development reflects the tremendous increase of the experience-dependent cortico-cortical connections [7,8,10]. Thus, experience-dependent plasticity refers to the learning and memory mechanisms that extract personal meaning out of the interaction of individuals with their environments and that lead to the genesis of the neuronal networks that represent autobiographical memory; the myriad of idiosyncratic associations of experiences—events, objects, names, actions, thoughts, emotions, decisions and so on characterize the individual's cognitive-emotional and behavioral styles.

The main conclusion of the integrated evidence is: The brain functions that coordinate the continuous interactions of humans with their physical and social environment create individual memory, i.e., neuronal networks that represent the biography. The biography's contents shape with memory-driven, consciously and nonconsciously functioning information processing operations (a) all aspects of behavior: thoughts, emotions, decisions, actions, etc., and (b) the individual's interaction style with him/herself, with others and with the physical world. Behavior thus defined is initially always purposeful and well-adaptive. The "purpose" of behavior is primarily the maintenance of psychobiological health (=psychobiological well-being) of the individual in his/her often unpredictably changing environment, and secondarily the creation of knowledge which enables the dynamic maintenance or reinstallation of psychobiological health or the avoidance, reduction, removal, or change of obstacles to this goal. Humans are seen as living systems that are oriented towards psychobiosocial health, growth, differentiation and autonomy, and that are knowledge-dependent and knowledge-implementing. Psychobiosocial health reflects the use of knowledge that was created in the individual's brain as result of cooperative interactions with his/her social realities, especially during development. The human brain is a self-organizing system that organizes the individual's behavior on the basis of its biography (=acquired knowledge).

5. Acquisition of knowledge and its nonconscious role in the creation of behavior

Acquired knowledge consists of three basic, associatively connected categories of multidimensional, complex mnemonic representations (neuronal networks): units of data, skills, and cognitive emotional coping strategies. All three categories are multi-coded in all innate and acquired languages, i.e., coded in the non-verbal, verbal, and emotional languages that humans acquire as result of the interactions with their natural partners.

Units of data represent "factual" knowledge not only about feelings (of smells, sounds, tastes, touches, sights, etc.), objects, situations, meanings, and interpersonal relations, but also about organized sets of facts such as "beliefs" about what has to be done in a specific situation like school, family, etc. Skills are the created mnemonic representations of particular response patterns (sequences of motor and vegetative actions, and of cognitive-emotional states, e.g., reading, playing an instrument, relaxing). Cognitive-emotional strategies refer to knowledge about how to perform various brain activities in order to analyze and to cope with the physical, social and internal realities in a systematic way.

Skills and coping strategies are formed via intensive and normally purposeful practice via repeated interactions between specific aspects of the realities (units of data) and the subjective and/or behavioral aspects of the skills and strategies. The mnemonic representations of skills and strategies if well learned (faultlessly executed) are tightly associated in memory with the mnemonic representations of experiences from particular events (units of data) and to the response-evoking structures. That means that, if the specific event is detected in the momentarily perceived information, the required skill and the strategy is initiated and executed with reflexive speed and thus nonconsciously. Such behavior is automatized, it is executed in parallel processing with the automatic information processing mode [13,14]. This is how the brain's functions that create biography may lead to nonconscious decisions [15–17].

6. The automatic information processing mode and the genesis of the intrapsychic conflict

We now focus on the question how and why brain functions that create biography may lead to the creation of skills and cognitive-emotional strategies that nonconsciously produce the intrapsychic conflict, thus leading to subjective experiences that motivate an individual to ask for psychotherapy. Human behavior arises from (a) continuous and dynamic interactions of individuals with their social and physical environment and with themselves (acquired knowledge about themselves and the best way to cope with the environment), and (b) continuous knowledge-dependent and -implemented as well as knowledge-reflecting adaptations of all dimensions of behavior (thoughts, emotions, motives, goals, actions, etc.) to the significance of the messages that come from these environments [18]. From the perspectives of the dynamic system's theory-based model of the brain functions that create behavior, the prerequisite for biopsychosocial healthy development is the cooperative involvement—the adequate dialogue—of the caretakers (the social environment) with the developing individual. This occurs only if the caretakers are equipped with knowledge (innate and/or acquired) that enables them to understand the “real meanings” of the child's messages and to respond to them in the “right way”.

Humans often encounter difficulties in dialogues with their children. Various sciences from genetics to psychoanalysis explain these difficulties by an instinctual, aggressive drive and/or by a dysfunction (a breakdown) of a human parental instinct. But the data integrated in our and in similar models show that the genetic program that ensures that the newborn belongs to the human species and thus will develop human behavior does not include such an instinctual aggressive drive. Pierre Karli writes in the introduction of “*Animal and Human Aggression*” [6]: “. . .The notion of an aggression instinct which is claimed to be a biological fate is ill-founded, human aggression is neither inevitable nor unalterable, the time has therefore come to get rid of the evil myth of the beast within. In my capacity of a neurobiologist, I may add briefly—before elaborating in the book—that no one has ever found within the brain any center or neuronal system that could be considered to be the generator of an “aggressiveness” supposed to be—and to act as—a natural entity, a causal reality, an endogenous driving force.”

Evidence from a variety of studies shows that the goal (the primary motivating factor) of the initiation and maintenance of the developing individual's interactions with the social environment (the aim of action and interaction) is the maintenance of his/her psychobiological well-being in a dialogue with the caregivers. At the behavioral level, this motivating factor is recognized as curiosity and is studied in exploratory and play behavior of children. These behaviors have erroneously been interpreted to be aggressive, egocentric, etc. Exploratory and play behavior enables the child to discover the realities in which and with which it is born, and to acquire own knowledge about these realities and about itself. It leads to the extraction of personal meaning about the quality of the interactions between self and realities. This personal meaning forms the skills and cognitive-emotional strategies that characterize the individual's emotions, cognitions, decisions and actions.

As to parental behavior: Humans are not equipped with innate knowledge of parental behavior such as instincts in animals; they are not equipped with a complex behavior that is

automatically activated by giving birth to a child, and that enables mothers and/or fathers to an a priori understanding of the child's messages and to the "right way" of taking care of the child's well-being. Humans are equipped with a tremendous plasticity of their neocortex. This plasticity enables them to acquire knowledge about all kinds of complex behaviors including parental roles and child-rearing practices that, in their individual cultures and sciences, are considered as "correct" or "wrong" practices. Thus, the embedding culture defines the way with which natural and professional caretakers of a given society (mothers, fathers, pediatricians, teachers, psychologists, etc.) interact with children, i.e., use the needed degree of cooperativeness and thereby take care of the child's and/or their own well-being. In other words, humans evaluate the child's behaviors and respond to them on the basis of cultural and/or scientific convictions about human nature and specifically, about mother/father roles, natural abilities and needs of children, aims and ways of education, what is good or bad, normal or abnormal, etc.

Repeated child–caretaker interactions that maintain or disturb the child's well-being lead to the acquisition of own knowledge about the effects of such interactions on well-being, and to the creation of skills and cognitive-emotional strategies that aim at the best way for coping with these effects. Such coping aims primarily at the maintenance or reinstallation of the biopsychosocial well-being in keeping the playful character, the interaction with the social realities in a cooperative level, and secondarily at avoidance, reduction, removal, etc., of obstacles to this goal.

Skills and cognitive-emotional coping strategies created as result of child–caretaker interactions that result in the well-being of children and caretakers have a well-adaptive character. They serve consciously and nonconsciously the normal (non-disturbing) inter- and intrapersonal communication of the interacting individuals within their realities. Well-adapted knowledge enables the child to do two things: (a) to recognize his/her biopsychosocial priorities and needs at each moment and then to take care of them either by own activity or by the effective involvement of the caretakers, and (b) to recognize "demands" of the caretakers that disturb biopsychosocial priorities and needs, and then to avoid them either by own activity or by the effective involvement of the caretakers. Well-adapted knowledge enables an age- and state-adequate (normal) behavior. Contrariwise, skills and cognitive-emotional coping strategies created as result of conflicting and non-cooperative child–caretaker interactions often are maladaptive. They are maladaptive because such behaviors were created in order to avoid disturbances of well-being caused by the age-important social environment. The mnemonic representations of maladaptive skills and coping are the latent memories of Freud's intrapsychic conflict; with the automatic information processing mode they lead nonconsciously to the subjective experiences that motivate the individual to ask for psychotherapy.

7. Conclusions

We presented a review of findings and contextual issues about the brain functions that create relationships between experiences, personal meanings of these experiences, and normal or abnormal human behavior. In the light of recent developments in human neurosciences summarized under the heading of experience-dependent brain plasticity, we discussed the causes of the psychological problems that are treatable with psychotherapy.

We saw that plasticity results from the brain's intrinsic capacity to recognize the effects of experiences on the organism's basic needs, and to initiate the learning and memory processes. These processes lead to the building of the myriad of neuronal (mnemonic) networks of the neocortex that represent personal meaning, the contents of the autobiographic memory. These contents are basically shaped by the quality of the child-caregiver interactions, and hereby determine the individual's normal or abnormal behavior with consciously and nonconsciously functioning information-processing operations. We also saw that in human sciences there is no agreement about the nature of the determinants of human behavior: there are dualisms that include wrong assumptions about brain-behavior relationships and specifically, about the brain functions that motivate the developing individual's interactions with its social environment. This also applies to Freud's and later psychoanalysts' assumption of a dynamic unconscious that emerges out of defenses against aggressive thoughts and wishes generated during development by an inherent aggressive instinct. We saw that human nature does not include any aggressive instincts as it has been proposed erroneously, not only in psychoanalysis.

Thus, it is important for the study of the causes of psychological problems that we consider the following: Wrong assumptions about the nature of motivation of humans lead to misunderstanding of the children's behavioral messages and thus may lead to dysfunctional interactions between parents or other caregivers and children. This is the way with which the social environment contributes to the genesis of thoughts, emotions and actions that are perceived as psychological problems.

In sum, in the context of scientific approaches to brain-behavior relationships that go beyond dualisms and within the framework of brain models that consider the brain as a self-organizing system that creates behavior on the basis of its own biography, it can be said: behavior that humans recognize as psychosocially deviant, abnormal is not the result of a fault in the biological evolution of mankind. The evidence shows that the basic causes of the failure of human sciences to master the many different dysfunctional relations of humans with themselves, with their children as well as with their world result from a misunderstanding of the very meaning of human nature and of brain-behavior relationships. However, as long as scientists concerned with human behavior continue to misunderstand the real nature of human conflicts, the efforts to find solutions cannot be successful. Thus, it is important that we are aware of two things: firstly, there are false scientific assumptions about our nature. We have inherited these assumptions not via genes but via the brain's adaptive, autobiographic memory functions with which we internalize our cultures and sciences. Secondly, false internalized assumptions about the determinants of our behavior form the way we evaluate the external world and ourselves and hereby influence the quality of our behavior as manifest in our (well- or maladaptive, functional or dysfunctional) interactions with ourselves, with our own children and with the world. The challenge to the sciences (neurosciences, sociology, psychoanalysis) is to try to understand the way in which internalized assumptions affect the brain's functions that create biographies. This will make it possible to recognize that the same meaning-extracting functions of our brain that have led to well-founded and useful scientific discoveries can be used to re-think our nature and to get rid of scientific assumptions that proved to be ill-founded. In doing this, we will use our brains to produce functional interventions, and thus produce well-being for the earth and its inhabitants, including our children and ourselves: Doing this, we will display wisdom.

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