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Embodied cognitive neuroscience and its consequences for psychiatry

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Abstract Recent years have seen the emergence of a new interdisciplinary field called *embodied* or *enactive cognitive science*. Whereas traditional representationalism rests on a fixed inside–outside distinction, the embodied cognition perspective views mind and brain as a biological system that is rooted in body experience and interaction with other individuals. Embodiment refers to both the embedding of cognitive processes in brain circuitry and to the origin of these processes in an organism's sensory–motor experience. Thus, action and perception are no longer interpreted in terms of the classic physical–mental dichotomy, but rather as closely interlinked. This paper describes the cycles of brain–organism interaction, of sensory–motor interaction with the environment and of embodied interaction with others. The brain is then interpreted as an organ of modulation and transformation that mediates the cycles of organism–environment interaction. Finally, consequences of the embodied and enactive approach for psychiatry are pointed out, in particular for a circular concept of mental illness.

Zusammenfassung Im letzten Jahrzehnt hat sich die *"embodied"* oder *„enactive cognitive science"* als ein neues, interdisziplinäres Forschungsgebiet etabliert. Während der herkömmliche Repräsentationalismus auf einer grundsätzlichen Innen-Außen-Unterscheidung beruht, betrachtet der Ansatz der *„embodied cognition"* Geist und Gehirn als ein biologisches System, das in der körperlichen Erfahrung und Interaktion mit anderen Individuen begründet ist. Der Begriff der Verkörperung bezieht sich dabei sowohl auf die Einbettung kognitiver Prozesse in neuronale Netzwerke also auch auf den Ursprung dieser Prozesse in der sensomotorischen Erfahrung eines lebendigen Organismus. Handeln und Wahrnehmen werden nicht mehr im Rahmen der klassischen Trennung von Mentalem und Physischem,

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sondern als eng miteinander verknüpft aufgefasst. Der Aufsatz beschreibt im Einzelnen die Kreisprozesse (1) der Interaktion von Gehirn und Organismus, (2) der sensomotorischen Interaktion mit der Umwelt und (3) der verkörperten Interaktion mit anderen. Das Gehirn wird dann als ein Organ der Modulation und Transformation aufgefasst, das diese Kreisprozesse der Organismus-Umwelt-Interaktion vermittelt. Abschließend werden die Konsequenzen des *embodiment*-Ansatzes für die Psychiatrie aufgezeigt, insbesondere für eine zirkuläre Konzeption psychischer Krankheit.

Résumé Au cours des dernières années, est apparu un nouveau domaine interdisciplinaire appelé *Science cognitive incarnée* ou *énaction*. Alors que la représentation traditionnelle repose sur une distinction interne/externe fixe, la cognition incarnée perçoit le cerveau et l'esprit comme un système biologique dépendant des expériences corporelles et des interactions sociales. L'incarnation suppose l'intégration des processus cognitifs dans les circuits neuronaux mais fait également référence à l'origine de ces processus dans les expériences corporelles et sensorielles d'un organisme. Ainsi, les actions et les perceptions ne sont plus interprétées comme une dichotomie sensori-moteur classique. Nous les voyons plutôt comme la résultante de relations étroites entre les domaines sensoriel et moteur. Cette étude décrit les cycles d'interactions entre le cerveau et l'organisme, entre l'activité sensori–moteur et l'environnement, ainsi que les cycles d'interactions incarnées avec les autres individus. Le cerveau est ainsi représenté comme un organe de modulation et de transformation qui intervient dans les cycles d'interactions entre l'organisme et son environnement. Pour finir, l'impact de l'énaction sur la psychiatrie est abordé, en particulier sur le concept circulaire de la maladie mentale.

1 Introduction

Progress of brain research during the past two decades demonstrates the power of the neurobiological paradigm. When applied to the phenomenon of mental illness, however, this progress often generates a restricted perspective, as is typical for any scientific paradigm. Psychiatrists should be aware of this restriction since, unlike brain scientists, they deal with patients, not with brains. The restricted view may be critically described by the terms (1) reductionism, (2) reification and (3) isolation.

(1) *Reductionism* In its reductionist forms, neurobiology tends to regard subjectivity as a mere by-product of the brain's activity as a symbol-manipulating machine or an information processor. Consciousness becomes an epiphenomon of the neuronal machinery which, operating behind our back, creates the illusion of a continuous self and an autonomous will (Churchland 1995; Roth 1996).
(2) *Reification* It seems that mental or subjective states can be localized in the brain; thoughts or feelings, it appears, may be observed in the coloured illumination of cortical and subcortical structures. This results in the belief that brain images could also show the cause of a mental illness, or even the illness

itself, which then, for example, consists in a reduced metabolic activity in certain areas of the cortex.

(3) *Isolation* As a further consequence, this view isolates the individual patient and treats his illness as separate from the interconnections with his environment. However, it is on these interconnections that his personal experiences and dispositions are founded, and it is often the actual interpersonal situation that triggers his illness.

These tendencies towards a neurobiological reductionism are by no means inevitable. They may be countered by what I call an *extended* or *ecological view of the mind and the brain*. According to this view, the mind is not in the brain; it is not located in any one place at all but is rather distributed among the brain, the body and the environment. In order to explain this statement I quote the nineteenth century philosopher Ludwig Feuerbach:

> "It is neither the soul that thinks and senses, nor the brain; for the brain as such is a physiological abstraction, an organ cut out from the totality of the skull, the face, the body as a whole. The brain is only the organ of the mind as long as it is connected to a human head and body"
>
> (Feuerbach 1846/1985, p. 177).

To this I would add: … a human body that is connected to its environment and to other embodied human beings. With this addition, the quotation basically captures the essence of my argument, which will take the following course:

Present cognitive neuroscience regards the mind as somehow localized in, caused by, or identifiable with the brain. However, this short-circuit between mind and brain leads into a conceptual and methodological impasse, for it misses the essentially embodied, relational and biographical character of the human mind. To find our way out of this impasse, we have to overcome the dualism of mind and brain by taking into account the phenomenon of *life*, including the organism, the lived body and the life world in which both mind and brain are embedded. This leads to my thesis: *The individual mind is not confined within the head, but extends throughout the living body and includes the world beyond the membrane of the organism, especially the interpersonal world of self and other; this is also the world in which mind and brain are essentially formed.*

In what follows, I will first discuss and try to support this thesis, then explain some of its consequences for psychiatry and the concepts of mental illness.

2 The mind–body divide and dual aspect theory

Cognitive neuroscience is still based on the principal divide between the "mental" and the "physical", or between the subjective mind and the objective body, the one only accessible from within, or from the so-called first person perspective, the other only accessible from without, or from a third person perspective. Thus, mind and world are also treated separate from each other, with the outside world mirrored by the mind as a representational system inside the head. As Thompson (2007, p. 36)

points out, this has yielded "abstract and reified models of the mind as a disembodied and cultureless physical symbol system" in the brain of a solitary individual. What is lost in the principal divide is the human *person* which essentially means a *living being*, an *embodied subject*. The person is neither pure subjectivity experienced from within, nor a complex physiological system observed from without: it is a living being interacting with others within the *second person or the "you"-perspective*.

However, present philosophy of the mind is mainly based on the assumption of a profound difference between consciousness and biological life—the one conceived as internal and purely mental, the other as an external, functional property of certain physical systems. Thus, the basis of the mind shrinks to the brain, and the body with its sensors and actors becomes a mere input–output device in the brain's service. Hence there is no way to close the gap between mind and life (Thompson 2007, p. 222). Disconnected from their harbourage in the living organism, mental processes and neuronal processes may only be directly related to each other, leading to a *short-circuit of mind and brain* and the manifold vain attempts to overcome this Cartesian divide. The so-called hard problem of consciousness cannot be solved as long as mind and life are conceptualized in such a way that they intrinsically exclude one another.

A possible way out of this impasse might be based on the notion of *embodiment*, referring to both the *embedding* of mental processes in the living organism and to the origin of these processes in an organism's sensory–motor experience. The brain is primarily an *organ of the living being*, and only by this becomes an organ of the mind. For both life and mind are essentially related to what is *beyond them*, dependent on the continuous exchange with their environment (Jonas 1966). Just as respiration cannot be restricted to the lungs but only functions in a systemic unity with the environment, so the individual mind cannot be restricted to the brain. For consciousness is not an object or state that can be localized at all but rather a *process of relating to something*: a perceiving of, remembering of, wishing for, aiming at, etc. This dynamic and intentional character of consciousness is not covered by the concept of single "mental events" that could be translated into corresponding brain states. Therefore, the neurocognitive system cannot be grasped separately either; it exists only enmeshed in the world in which we move and live with others through our bodily existence.

There is a fine observation made by Lichtenberg when confronted with contemporary attempts to localize the soul in the brain:

"If in beholding the setting sun I take a step forward, I come nearer to it, how minimal this may be. However, it is quite different with the organ of the soul. It might well be possible that by an all too near approximation, as with the microscope, one *removes oneself* from what can be approached" Lichtenberg (1796/1973, p. 852).

Mind, consciousness and life are not "micro-", but "macro-phenomena" that only show themselves in co-existence, from the second person perspective. Below a certain distance they simply disappear. This is not only a romantic idea, but one that is most important for the *development* of the mind and brain. Mothers interacting with their babies intuitively keep themselves at just the right distance so that the

babies can seem them clearly (Papoušek and Papoušek 1995). Imitation, affect attunement, joint attention and empathy—all processes of central importance for the early development of the human brain as a social organ—depend on the "right distance", on the second person perspective. It is only in the course of these embodied and meaningful interactions that the neural systems responsible for social cognition can mature (Fuchs 2008).

On that condition, a rational option seems to take a *mixed or hybrid approach* to mind and brain which does not create an explanatory gap in an absolute sense. For this mixed approach, lived embodiment on the one hand, and the physical body including the brain on the other hand (*Leib* and *Körper*, in German) are two aspects of one living organism in relation to others—the one corresponding to the first and second person perspective, the other to the third person perspective. Now, instead of a gap between two radically different ontologies (the mental and the physical), we have a duality of aspects within embodiment, a "Leib–Körper problem", so to speak, but with a common reference to the living being or the person (Fuchs 2008, p. 103ff.). The question now is about the relation between one's body as subjectively lived and one's body as an organism in the world. So instead of trying to identify brain states with mental states in such a way that the brain terms and the mind terms are obviously incommensurable, we should rather explore how brain states and conscious states each participate in dynamic interactive processes involving the whole organism.

3 Cycles of embodiment

Having outlined some basic features of the embodied approach, I will now take a closer look at embodiment. Three permanent and intertwined modes of embodiment form the basis of the human mind (cf. Thompson and Varela 2001):

1. *cycles of organismic self-regulation*, including a basic affective sense of self;
2. *cycles of sensorimotor coupling* between organism and environment;
3. *cycles of intersubjective interaction*, involving intentional co-operation, joint attention and verbal communication.

3.1 Cycles of organismic self-regulation

I will only briefly touch upon the cycles of organismic self-regulation. Of course the integrity of the entire organism depends on such regulatory cycles involving brain and body at multiple levels. But organismic regulation also has an affective and conscious dimension. Affective neuroscience, represented in particular by Damasio (1999) and Panksepp (1998), has emphasized the dependence of a *background consciousness* on the homeodynamic regulation of the whole body, mediated and integrated by brainstem, diencephalic and limbic structures such as thalamus, cingulum and insula. Background consciousness means a feeling of being alive, a basic self-affection or a core consciousness of one's bodily self-hood. Thus, *processes of life and processes of mind are inseparably linked*. Every conscious

state is rooted in the homeodynamic regulation between brain and body, and, in a sense, integrates the present state of the organism as a whole.

3.2 Cycles of sensorimotor coupling between organism and environment: embodied cognition and action

Apart from inner regulation, the main task of the nervous system is to establish the sensorimotor cycles that connect organism and environment. Here embodiment implies the inherent connection of perception and bodily action, as already developed in the concepts of von Uexküll's (1973) *Funktionskreis* and von Weizsäcker's (1986) *Gestaltkreis*. What the organism senses is a function of how it moves, and how it moves is a function of what it senses. A classical experiment by Held and Hein (1963) has shown that new-born kittens are unable to develop any spatial perception if they are only carried around in their environment, thus seeing without actively moving. Hence, perceptual space is not a pre-given external container, but rather a medium or working-space, moulded by our sensing and moving bodies from undifferentiated visual stimuli. This means that living systems do not operate on the basis of internal representations of an external world. Rather, they *enact an environment* inseparable from their own structure and actions, an *Umwelt* in von Uexküll's sense.

Following these tracks, Varela et al. (1991) have put forward their "enactive approach" to cognition as being equivalent to embodied action. In this view, situated movements are the very tools of perception and cognition. In vision, for example, when the eyes rotate, the sensory stimulation on the retina shifts and distorts in precise ways, similar to when the body moves forward or backward, etc. (O'Regan and Noë 2001a, b). In touch, the sensorimotor dependencies are even more obvious. Hence, to perceive means to rely implicitly and fluently on these patterns of sensorimotor dependencies in order to actively explore the world. This is supported by the discovery of so-called *canonical neurons* in the premotor cortex that are activated both when dealing with tools and when only looking at them (Grafton et al. 1997; Gallese and Umiltà 2002). Perception thus "evokes" the corresponding practical interaction schemas, derived from similar earlier experiences, or, in other words, *to know a thing is to have learnt how to deal with it.*

The same applies for motor action as well. My actions are embodied, which means they are not somehow triggered by an inner mind, but rather are enacted by me as an embodied subject. When I am writing a letter, for example, there is no point in the unity of action where my "self" ends and the "world" begins, no border that separates "inner" and "outer" world. Neural networks, muscular movements of my hand, pencil and paper synergically work together to put down my thoughts, and the whole body–environment system creates my experience of agency. I am not a pure consciousness outside of my own writing, but an "*ecological self*" (Neisser 1988) whose borders do not stop at my skin. In the skilful handling of tools, in playing piano or driving a car, I embody these instruments. Thus, I feel the paper scratching at the top of the pencil, and I feel the roughness of the street below the wheels of my car, just as the blind man feels the ground at the top of his stick, not in his hand.

3.3 Cycles of intersubjective interaction: embodied intersubjectivity

Cognition and action, as we have seen, are both activities of the embodied subject. However, the development of the specific human subjectivity requires not only the interaction of brain and body, and body and environment, but above all the interaction with others. It means primarily embodied intersubjectivity, or to use a term by Merleau-Ponty (2003, p. 256), "intercorporeality." Thus, recent research has shown that the capacity of imitation in human infants is essential for understanding others. From birth on, infants possess interpersonal body schemas for spontaneous facial imitation and emotional resonance (Meltzoff and Moore 1989; Meltzoff and Brooks 2001). They experience the other's body as similar to their own, and thus, they also transpose the seen facial expressions and gestures of others into their own feelings. These schemas underlie the development of more sophisticated empathic abilities in the course of early interactions. Embodiment and interaffectivity thus form the basis of social understanding through an interactive practice of meaningful and expressive bodies.

Research on the mirror neuron system has supported the linkage between perception and action also in social cognition, namely a tight functional coupling between actions produced by the self and actions perceived in others (Gallese 2001; Gallese et al. 2004). The movement of the other is already understood as a goal-directed action because of its match to a self-performed action. This seems to apply for the emotional coupling or bodily resonance as well. The infant uses her proprioceptive and emotional self-awareness to feel what she sees in the face of the other person. Thus, the neural systems involved in mutual understanding and empathy appear to be of a practical nature, for they involve the dynamic pairing of the bodies of self and other.

However, brain mechanisms such as the mirror neuron system can hardly be taken as a sufficient basis for mutual understanding. First, "mirrors" certainly do not exist in physical nature. A mirror on the wall does not mirror anything except to *a subject* who is able to take its reflections *as* a mirror image. Thus, the infant has to learn herself that others are "like me" *in the course of mutual exchange and interaction*. Moreover, assuming an embodied and developmental view of mirror neurons, infants are not expected to understand others' action goals by means of the mirror system before they can perform the action themselves. Accordingly, studies of anticipatory eye move during observation of a goal-directed action showed that it is present in 12-month-olds but not in 6-month-olds (Falck-Ytter et al. 2006). Hence, a merely cross-sectional view misses the embedded and biographical character of the mirror neuron system. It only develops and functions as enmeshed in a common space of embodied and meaningful interactions. In other words: *To understand others is to know how to deal and to co-operate with them.* Just as the ecological self is constituted by the cycle of action and perception, the intersubjective self or self-consciousness develops in the course of social interactions. The embodied mind is intersubjectively constituted at the most fundamental level.

In turn, patterns of interaction have a direct influence on the continous dispositions of the individuals involved, for due to its singular plasticity, *the human brain is fundamentally adapted to develop within a social context.* It is not inserted

into the world as a prefabricated apparatus, but rather is structured epigenetically by the continuous interaction of an organism and its environment, like a key and its lock. This applies in particular to the social environment, which becomes the decisive "ontogenetic niche" for individual development. In its course, customs, habits and cultural techniques are acquired by imitation and co-operative learning. From birth on, our mind, as well as its correlated brain structures, are essentially formed by social and cultural influences. We may speak of an "embodied socialisation", for specific human faculties can only develop through mutual co-operation and are thus imprinted on the organic growth processes of the brain. Culture in this encompassing sense is not only a cognitive system of signs and meanings, but rather implies that all formation processes of the individual and her faculties are engrained into her brain structures. By this, the human brain becomes an essentially social and biographical organ.

3.4 Summary

To summarize, I have briefly described three cycles of embodiment:

1. *cycles of organismic self-regulation*, including a basic affective sense of self;
2. *cycles of sensorimotor coupling between organism and environment*, resulting in an *"ecological self"*;
3. *cycles of intersubjective interaction, underlying the intersubjective self.*

The human brain is crucial for all three modes of embodiment. It does not create, but instead mediates and regulates the cycles, and it is also reciprocally shaped and structured by them throughout the duration of life. Now, if the human mind emerges from these modes of embodied interaction and if it is accordingly embodied in the living organism, then neuroreductionist claims such as, "You are but a pack of neurons." or "You are your brain." are both a category error and biologically unsound. On the contrary, you are a living bodily subject of experience in relation to others. Whatever we may conjecture about a fictitious brain-in-a-vat, the most reasonable would be that in order to create the illusion of a self and a world, the device would need to duplicate not only homeostatic regulation but all brain–body–environment interactions, and thus it would require a vat that is nothing else than a living body engaged in the world. The brain is only an organ, and it is not the brain, but the organism or living person that has conscious access to the world.

4 The brain as an organ of translation

Therefore, an ecological notion of life is indispensable for a non-reductionist and non-dualistic approach to the mind–body problem. Mental and conscious processes are first and foremost manifestations and expressions of the living being, of the organism as whole. Certainly, the brain is a central organ of mental processes, but not their only "seat." The mind is not located in any one place at all, but distributed among the brain, the body and the world, and thus continuously crosses the borders of the skull (Clark 1997).

This also corresponds to the primary evolutionary role of the brain. Even primitive organisms without central nervous system react to environmental changes and stimuli. The primordial function of the central nervous system consisted in the connection of repeated environmental stimuli with adequate reactions or movements. The central nervous system does not create, but is rather inserted into the cycle of afferent and efferent, or sensory and motor processes, as a transforming and co-ordinating relay station. As the development of the brain grew, its co-ordinating functions increased, in particular by the establishment of feedback and feed-forward loops. However, this did not change its principal character as a connecting organ, inserted in the organism–environment interactions (Fuchs 2008).

The decisive progress brought about by the evolution of the mind was not just an improved reaction to stimuli but a *Gestalt* formation, i.e. the grasping of complex wholes or situations. A situation is the situatedness of a living being in its environment, and to grasp a situation is to grasp oneself in relation to it. This is mainly brought about by (1) a synthesis of sense experiences, creating our *embodied being-in-the-world*, (2) an integrated evaluation of the meaning and the options of a given situation, which we experience as *emotion* and (3) in later and particularly human stages, the iconic and symbolic representation of the world, i.e. by *ideas* and *language*. The mind creates wholes, such as "body", "feeling", "self", "ideas" and "concepts." This allows the organism to represent its relation to the environment, and thus to act not merely in an automatic, but instead in a meaningful way.

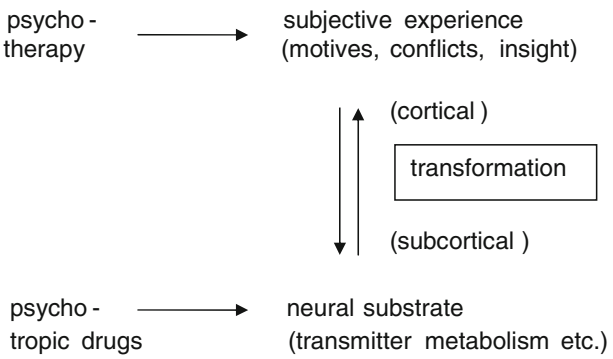
If we now try to describe the role of the brain on this systemic basis, we may conceive it as an organ of *transformation* or *translation*, which translates the relations between single elements of a given situation ("stimuli") into wholes or *Gestalt* units. The constantly changing patterns of synchronized neuronal excitations correspond to the wholes emerging in subjective experience. We may illustrate this transformation by pictures like this.

Or we may illustrate the transformation by the synthesis of single letters to a word (such as "apple") which we grasp immediately through its components, without even being aware of the letters. Of course, we once had to learn this word letter by letter ("a-p-p-l-e"), but by stabilizing the pattern or picture in our subjective experience, our brain became induced to form a corresponding neuronal pattern (in systems theory: an "attractor") in such a way that the constellation of single letters took on the new meaning of "apple."

The brain thus transforms configurations of single elements into higher level units, corresponding to our perceptions. The same applies in the reciprocal direction: If I want to write the word "apple" in a letter, the brain automatically transforms the underlying patterns of neural activity into the required motor patterns and impulses to the muscles. Thus, the brain is an organ of transformation of configurations of single elements into higher level units corresponding to our perceptions or actions. By this, it becomes the organ of mediation between the microscopic world of material or physiological processes on the one hand, and the macroscopic world of the living organism and its experiences on the other hand. By integrating elementary processes into higher-order patterns, it enables the living being to relate to the world by perceiving and acting.

Following this line of thinking, we cannot regard subjective experience as a mere epiphenomenal picturing of underlying neuronal ("real") processes. On the contrary, it plays an essential role in the systemic interaction of an organism and its environment. For it is only by conscious experience that the organism is able to enter into a relationship with the environment at a higher level of meaning, of integrated perceptive and cognitive units, or "*Gestalten*." These subjective, meaningful units in turn influence the plasticity, the structuring and the functioning of the brain. A "biographical biology" implies the continuous formation and reconstruction of the brain via subjective experience. The mind works to constrain or structure the lower-level properties of the brain and the body: it consists mainly in forming and maintaining meaningful units of experience which stabilize corresponding neuronal activity patterns and thus trigger, accordingly, physiological reactions of the organism as a whole.

In this complementary relationship there is nothing like "a mind acting on a physical body" nor "a brain producing the mind." Instead, the brain acts as a transformer which may be addressed through input on different hierarchical levels and which translates in both directions: psychosocial influences on the level of meaning and intentionality are transformed into altered patterns of neuronal activity on the biological level, and vice versa. This means that any process concerning the aetiology and symptoms of mental illness is of a biological as well as a psychological nature (cf. schema below). On the one hand, the translation runs "top–down", i.e. from subjective experience (e.g. a perceived social situation, a psychotherapeutic intervention) to the level of neuronal and biochemical processes. On the other hand, it runs "bottom–up", e.g. from pharmacological effects on transmitter metabolism to modification of subjective experience (Fuchs 2004, 2005). Neurobiochemical changes become mood changes on the subjective level, but subjectivity in turn influences the plasticity, structuring and functioning of the brain.



Accordingly, procedural relearning in psychotherapy should be expected to influence the structure and functions of the brain by altering synaptic plasticity and gene expression. Long-term changes of pathophysiological patterns in the brain may be shown, e.g. by neuroimaging studies. Thus, in PET studies of depressive patients, Brody et al. (2001) and Martin et al. (2001) found decreases in prefrontal lobe activity following both interpersonal psychotherapy and the use of antidepressant medication. In a particularly interesting PET study of depressive patients, Goldapple et al. (2004) found differential target areas of successful cognitive behavioural therapy (CBT) vs. drug treatment: the medial frontal and cingulate cortex with CBT, and limbic–subcortical regions (brainstem, insula, subgenual cingulate) with pharmacotherapy. This fits to the idea of CBT interventions focussing mainly on modifying dysfunctional cognitions, and leading then to an alleviation of vegetative symptoms and inhibition; pharmacotherapy, however, rather takes the opposite course.

Psychotherapy seems to be based mainly on cortical "*top–down*", pharmacotherapy on subcortical "*bottom–up*" mechanisms. Such a *bidirectional concept* is also supported by results of the Mayberg group (Mayberg et al. 2002) showing mainly cortical ("subjective") effects of a placebo in contrast to subcortical–limbic and brainstem effects of fluoxetine in major depression. In another study, the authors found a similar reciprocal cortical vs. limbic affection in a normal sadness and depression group (Mayberg et al. 1999). This points out that there is no separation, but rather a mutual transformation of psychological into biological processes and vice versa, brought about by the brain.

5 Circular models of mental illness

Obviously this systemic and ecological concept of mind and brain goes against any biomedical reductionism operating in claims like, "Depression really is a chemical imbalance.", or, "Responsible psychiatrists should focus on the real causes of psychiatric illness, i.e. damaged brains." The bottom–up explanation of mental disorders as products of specific genetic or physiological aetiologies is inadequate to the causal complexity of most disorders. Instead we ought to develop aetiological

models which are based on a *circular causality* between an organism and its environment, with the brain acting as a mediating entity. Whatever the genetic basis of, e.g. depression, it can be only one precondition of a complex, interactive process that ends up as a psychiatric disorder. The final disorder is the product of a cascade of subjective, neuronal, social and environmental influences continuously interacting with each other. Within these circular interactions the brain acts as a mediating, translating and also amplifying "relay station", but not as "the monolinear cause."

Circular models involving negative feedback loops of primary symptoms, emotions, cognitions and social interactions have already been developed for disorders of depression or anxiety (Grawe 2002), as well as in systemic family therapy. In a similar approach, I have described depression as a psychophysiological *desynchronization* (Fuchs 2001): a perceived backlog or gap between one's expectations and achievements, or a loss that the individual is unable to cope with, are perceived as a loss of synchronicity and connection with important others. This perception of the personal situation is translated by the brain into a neurobiochemical pattern associated with depressed mood. On the biological level, depression implies an uncoupling of rhythmic physiological (e.g. endocrine) processes normally synchronized with each other and with the environment. In the course of this biological desynchronization, a prolonged stress response of the hypothalamic–pituitary–adrenal axis and other endocrine systems ensues, which in turn increases anxiety and depressed mood. The causal pathway thus goes from the "mind" or the subjective experience of the situation, to the brain and body, and then back to the mind. Psychosocial and physiological desynchronization trigger and influence each other. Thus the subjective reactions to the disorder become intertwined with the disorder itself. Psychosocial and physiological desynchronization influence each other.

As we can see, subjective experience is more than a mere by-product of an underlying "real" or "brain depression." Depressed mood, perceived insufficiency or distorted thinking are not just accidental or epiphenomenal symptoms whose only importance is to give cause to consult a psychiatrist. Depression, on the contrary, is triggered by the subjective perception of meaningful, mainly interpersonal situations, and it is also to a high degree kept up or worsened by negative feeling, thinking and interacting with others.

In a similar way, schizophrenia may be regarded, from an ecological point of view, as a circular process, implying neuropsychological and biochemical dysfunctions on the one hand and psychosocial alienation on the other. Basic cognitive and self-disturbances in the prodromal phase (Klosterkötter 1988; Klosterkötter et al. 2001; Parnas 2000) lead the patient to withdraw from situations that overburden his intentional and emotional capacities. The loss of social attunement to the world of common life results in an increasing dissolution of commonsense meanings and *Gestalt* perceptions. Finally, the process of alienation culminates in a psychotic crisis in which the lost intersubjective meanings are replaced by the private and isolated world of delusions (Fuchs 2007). These rigid, concrete schemas of perceiving and thinking (which nevertheless serve adaptive purposes as well) correlate with neurobiochemical alterations in the brain which can be treated by neuroleptic medication. Thus, there is a circular and reciprocal

influence of subjective, intersubjective and physiological factors on each other. Again, the brain both reflects *and* causes alterations in the relationships with the body, the self and the world.

Finally, an ecological concept of mental illness also suggests a pluralistic understanding of treatment. The dualistic distinction between somatic therapies acting on the brain and psychological therapies having elusive, purely subjective effects is no longer tenable either. The circular interactions of self, body, brain and environment may be approached at various levels or turning-points, since any mode of treatment will be transformed by the brain and thus contribute to a holistic effect. On the one hand, beyond a certain point, the neurobiological and endocrine dysfunctions involved in, e.g. depression may be too advanced to be accessible to interventions on the psychological level. Pharmacological ("bottom–up") treatment may then enable the patient to re-engage in his relationships and thus will indirectly further his social well-being. On the other hand, as we have seen, psychotherapy not only changes the patient's implicit relational patterns, attitudes and behaviour, but also changes the functions and structures of his or her brain. In view of the limited effectiveness of medication, especially in chronic illness, it would be wrong to neglect these "top–down" options of treatment. Moreover, a merely biological view tends to isolate the individual patient and to make his illness seem separated from its interconnections with his environment.

The intentional and qualitative aspects of beliefs and emotions cannot be explained in terms of physical processes in the brain; nor can we do without new subjective and intersubjective experiences if we want to change the patient's maladaptive beliefs and dispositions that have lead to his illness and may lead to a relapse in the future. Such dispositions are only accessible to change by new and repeated *subjective experiences*, i.e. emotional, verbal and interpersonal processes of learning that stabilize new attractors of perception and behaviour in the brain. Only conscious experience is able to correct the corresponding dysfunctional patterns of neuronal activity. Since the brain is an historical organ, there will probably—and hopefully—never be a way to create new views of the self and the world by brain manipulation. Any social approach to psychiatry is based on a holistic, ecological view of life.

6 Conclusion

I have briefly outlined a systemic or ecological view of the mind and brain as embedded in the relation of an organism and its environment. There is no such thing as a brain by itself, unless it has been separated from the living organism through an autopsy. Its role may be seen in the mutual translation of single elements of a given situation into higher-order units that are experienced as meaningful wholes, and vice versa. Only subjectivity contains the *Gestalt*-like wholes that, for the organism, represent an integrated experience of reality. And it is only subjective experience that is capable of gradually changing the dysfunctional patterns of perception and behaviour which may lead to mental disorders.

A psychiatry of the brain, if adequately understood, would have to become a "systemic" or "ecological psychiatry" (Fuchs 2005). Psychiatry needs an "ecology of the brain" in order to better grasp the interconnection of psychological, social and pharmacological approaches adequate for its subject. In the end, this subject is not the brain, but rather the mentally ill patient.

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