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Psychomotor Phenomena, Functional Brain Organization, and the Mind-Body Relationship: *Do We Need a "Philosophy of the Brain"?*

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Abstract: Psychomotor phenomena such as catatonia or Parkinson's disease are shown to be paradigmatic examples of functional brain organization and mind-brain relationship. First psycho-motor relationships in both diseases are described on a phenomenological level, emphasizing motor similarities and mental differences. The next section, relying on various results in recent neuroimaging and on the concept of functional systems, elucidates various principles of functional brain organization (parallel-distributed, serial-hierachical, context-dependence, functional knots, functional circuitry) by means of psychological and physiological alterations in both diseases. The final section discusses the neurophilosophical implications of functional brain organization for the question of the mind-brain relationship. The ontological neutrality of the different ways of description of mental states (phenomenal, psychological, functional, physiological) is pointed out. Furthermore the various kinds of potential fallacies (conditional, ontological, epistemological), which should be avoided, are discussed. It is concluded that for a deeper understanding of the mind-brain relationship, further elaboration and definition of the terms *brain* and *brain function* with the consecutive development of a "philosophy of the brain" is warranted.

Keywords: psychomotor phenomena, functional brain systems, mind-brain relationship, ontological and epistemological fallacies

Introduction

As new techniques for the investigation of the brain emerge and more knowledge about functional brain organization is obtained, classical brain localizationist approaches, as well as historical philosophical mind-brain theories (for example, Descartes's dualism), become more and more questionable. Previous brain models, mostly relying on Descartes's mind-body dualism, which either separate mental states from brain states or reduce the former to the **[End Page 199]** latter, turn out to be insufficient in the light of recent neurophysiological and neuropsychiatric findings. These inadequacies may be attributed to both neuroscientific and philosophical reasons (Volkow 1991). The neuroscientific reasons have to do in particular with methodological problems concerning functional brain organization and the possibility of separating physical from mental states with current neuroimaging techniques. The philosophical reasons relate to the inadequacy of a model that attempts to construct a direct one-to-one relation between specific biological processes and particular mental states without consideration of functional brain organization itself.

Psychomotor phenomena such as catatonia and Parkinson's disease may serve as a bridge between neuroscientifc and philosophical problems because on the one hand they reveal principles of functional brain organization in an exemplaric way, whereas on the other they can show possible empirical modes of mind-brain relationships. The focus in the present paper will thus be on the elucidation of principles of functional brain organization and its neurophilosophical implications for the question of the mind-brain relationship. Mental states in both diseases will be described phenomenologically, psychologically, and physiologically by means of which various principles of functional brain organization and their alterations in catatonia and Parkinson's disease are revealed. Finally ontological and epistemological problems of the mind-brain relationship are discussed, relying on functional brain organization as elucidated above by pointing out the need for a further elaboration and definition of the terms *brain* and *brain function*.

Catatonia and Parkinson's Disease as Psychomotor Phenomena

Catatonia was first described by Kahlbaum in 1874 as a disease displaying psychological, i.e., affective and cognitive, as well as motor alterations. As in Parkinson's disease, catatonic patients suffer from akinesia and rigidity. Unlike Parkinsonian patients, they may also show motor features such as posturing, *flexibilitas cerea,* stereotypies, and grimacing, as well as behavioral abnormalities such as staring, echolalia/praxia, positivisms, negativisms, and automatic obedience (Gelenberg 1976, Lohr 1987, Rogers 1992, Northoff 1997). These symptoms are often interpreted as disorders of the will (Andreasen 1982, Kraepelin 1904) which is empirically supported by findings of positive correlations between hypokinetic symptoms and schizophrenic negative symptoms, as well as between hyperkinetic symptoms and formal thought disorder (Lund et al. 1991, McKenna et al. 1991, Northoff et al. 1995). Furthermore, catatonic patients often do show extremely intense and uncontrollable states of anxiety, which, in 50 to 60 percent of all patients, can be relieved by lorazepam (Northoff et al. 1995) or amantadine (Northoff et al. 1997). Some authors consecutively regard catatonia as a reaction to extreme emotional stress and a functional analogue to the immobilization reflex in animals (Perkins 1982, Magrinat 1983).

In spite of motor similarities, subjective experience of akinesia differs significantly between catatonic and Parkinsonian patients (Northoff et al. 1998). Akinetic Parkinsonian patients primarily complain about motor restrictions such as starting problems and stiffness and are consecutively fully aware of their motor disturbances. Catatonic patients, in contrast, often even do not realize their akinetic state while experiencing predominantly extremely intense anxieties and/or ambivalences (Northoff et al. 1997). They are not aware of their movement disturbances while being fully aware (or even hyperaware) of their emotional disturbances. Though showing similar motor states with akinesia, both kinds of patients subjectively experience different mental states as a "What is it like to be in an akinetic state?" Hence different mental states can go along with similar movements (i.e., akinesia) so that, considering catatonia and Parkinson's disease, it is impossible to argue for a one-to-one relationship between mental and motor states because otherwise subjective experiences in catatonic and Parkinsonian akinesia would not differ. **[End Page 200]**

Psychomotor Phenomena and Principles of Functional Brain Organization

In the following section, various principles of functional brain organization are shown relying on phenomenal, psychological, and physiological descriptions of mental states in catatonia and Parkinson's disease. Phenomenal descriptions rely on the subjective experience as the "What is it like?" of mental states, whereas psychological descriptions point out psychological functions that are assumed to be involved in the generation of mental states. Physiological descriptions point out the anatomo-physiologic properties (as, for example, anatomical areas) which are sought to be involved in the generation of mental states. The term *functional* is defined by the interactions between the internal world of the brain and the external world of the environment, as well as by the corresponding interactions between different brain areas (Luria 1966, 1973; Northoff 1997).

Parallel and Distributed

Simple movements like extension of the right index finger leads, as shown in PET-studies, to significant activation of various brain areas such as supplementary motor area (SMA) bilaterally, left primary sensorimotor cortex, anterior cingulate, lateral premotor cortex bilaterally, insular cortex bilaterally, left thalamus, left putamen, parietal area 40 bilaterally and right dorsolateral prefrontal cortex (DLPFC) relative to rest (Deiber et al. 1991, Frith et al. 1991, Playford et al. 1992, Jahanshahi et al. 1995). Electrophysiologically it has been shown that the *Bereitschaftspotential* (BP)--an electrical alteration shortly before the execution of movements probably reflecting their process of internal initation in SMA and motor cortex--is modulated by inputs from the prefrontal and superior parietal regions suggesting close relationships between planning, initiation, and visual control of movements (Singh et al. 1993). Thus even simple movements, such as finger extension, cannot be fully explained by cortical motor functions alone. Instead, movements should be rather regarded as complex behavioral acts involving various psychological functions (i.e., cognitive, attention, visual, constructive, etc.) which may be subserved by distinct brain areas (Bernstein 1966). Brain areas such as DLPFC, medial and lateral premotor areas, parietal cortex, anterior cingulate and SMA are simultaneously and/or successively activated in the process of the generation of movements (Deiber et al. 1991, Jahanshahi et al. 1995). Hence movements are not generated in isolation from psychological functions but rather as integral part of a particular behavioral act where both movements and psychological functions are closely integrated into each other. Generation of movements thus presupposes a parallel and distributed functional organization within the neural network providing an integrated "volitional action system" (Jahanshahi et al. 1995) as the respective "functional system" for complex behavioral acts. According to such a functional organization with simultaneous and successive involvement of anatomically distant areas, one may speak of a "functional cerebral space" (Kinsbourne and Hicks 1978) where "functional closeness" replaces physical geometric distances as the primary functional organizational principle for the interconnections between different anatomical structures (Goldstein 1963).

Such a functional organization with complex neural networks in the generation of movements is further underlined by consideration of physiological and psychological alterations in catatonia and Parkinson's disease. Parkinsonian patients show psychological deficits in executive functions which are responsible for the planning and execution of action, i.e., behavioral acts, whereas catatonic patients show deficits in visuo-spatial and attentional functions (Northoff et al. 1998). Physiologically, Parkinsonian patients show decreased activity in the Supplementary Motor Area

(SMA) that can be reversed by apomorphine (Rascol et al. 1992), a dopamine agonist increasing the decreased level of dopamine in Parkinson's disease, deep brain stimulation in subthalamic nucleus (Limousin et al. 1997) and pallidotomy (Grafton et al. 1995), whereas thalatomy rather decreases activation in motor and premotor cortex (Boecker et al. 1998). Catatonia in contrast cannot be characterized by deficits in the dopaminergic **[End Page 201]** system, as it is the case in Parkinson's disease (see above), but rather by alterations in the inhibitory GABA-ergic system, i.e., the GABA-A receptors in the motor cortex (Northoff et al. 1998) which, in addition, may also account for dramatic therapeutic efficacy of the GABA-A agonist lorazepam in catatonic patients (Northoff et al. 1995).

In summary, catatonia and Parkinson's disease can be characterized by distinct psychological and physiological alterations that, in both diseases, apparently lead to similar motor disturbances, i.e., to akinesia. Hence brain function seems to be organized not according to separate non-overlapping modules, each responsible for one particular function (as, for example, the generation of movements) with specific psychological and physiological mechanisms, but rather in complex parallel and distributed neural networks with multiple and overlapping functional interactions such that, as in catatonia and Parkinson's disease, distinct psychological and physiological disturbances could lead to similar motor symptoms.

Serial and Hierarchical

Clinically, Parkinsonian and catatonic patients show deficits solely of the internal initiation of movements whereas externally initiated movements are fully functioning (Northoff et al. 1995, Jahanshahi et al. 1995): In healthy controls, internal initiation of movements differs significantly from external initiation with regard to *Bereitschaftspotential* (higher amplitude of late and peak BP in self-initiated movements) and activation of right DLPFC in PET (no activation in externally initiated movements). Parkinsonian patients differed significantly from healthy controls only in self-initiated movements (lower amplitude of early and peak BP, lower activation of SMA, anterior cingulate and DLPFC in PET) but not in externally triggered movements (Playford et al. 1992, Jahanshahi et al. 1995). Similarly to Parkinson's disease, catatonic patients show clinical signs of a deficit of internal initiation (Northoff et al. 1995) as well as correlative electrophysiological (alteration of BP) and functional (hypoactivation of SMA) alterations (Northoff et al. 1998, Eckert et al. 1997). Consecutively catatonia and Parkinson's disease show psychological similarities with regard to the internal initiation of movements that could presumably account for similarities in motor symptoms.

It can be concluded that more complex processes such as internal initiation involve more and "higher" cortical regions than less complex tasks like the external initiation of movements. The respective functional system seems therefore to be organized according to the complexity of the respective task so that functional brain organization shows serial and hierarchical aspects. More complex behavioral acts superimpose on less complex actions, the former using partially the neural structures of the latter as well as creating new connections between "old" and "new" neural structures (Alexandrow and Jarviletho 1993), thus establishing a new level of complexity in the organization of neural networks.

"Functional Knots" between Psychological and Motor Function

The Supplementary Motor Area (SMA) shows an anterior and a posterior part. The anterior part of SMA is anatomically closely related to the anterior cingulate and functionally thought to be especially responsible for cognitive aspects such as the selection of movements, whereas its posterior part is anatomically and functionally associated with the motor cortex and the execution of movements (Grafton 1994). Such a functional distinction between motor and rather cognitive functions within the SMA itself is supported by PET-findings of significantly increased activation of SMA during complex (sequential finger opposition) movements compared to simple (tapping) ones with less cognitive involvement (Roland et al. 1980).

Considering Parkinsonian and catatonic patients, the distinction between anterior SMA and posterior SMA may be crucial for a possible explanation of the above described differences in their subjective experiences: Both show a deficit of self-initiated movements with akinesia closely related with hypoactivation of SMA (see above). In contrast to motor similarities, their subjective experiences differ significantly: Parkinsonian patients **[End Page 202]** primarily complain about motor deficits and catatonic patients experience intense anxieties or strong ambivalences. Thus it could be speculated that down-regulation of SMA in Parkinsonism and catatonia may be related to distinct parts of SMA and therefore be of different origin. Nigrostriatal deficiency in Parkinson's disease leads to down-regulation of the "motor-loop" with consecutive hypoactivation of posterior, i.e., "motor" parts of SMA. In contrast, down-regulation of SMA in catatonia may rather be caused by (or related to) alterations in prefrontal cortical areas involved in the generation of emotions. Such an assumption is strongly supported by findings of deficits in orbitofrontal cortical activation and consecutive alterations in orbitofrontal-premotor (SMA)/motor cortical "functional connectivity" under emotional-motor stimulation in catatonic patients (Northoff et al. 1998) that may account for abnormal transformation between emotions and movements, as well as for subjective experiences in catatonic patients (Northoff 1997).

Furthermore, similar to idiopathic dystonia (Cereballos-Baumann et al. 1995), the relation between the anterior and posterior part of SMA may be unbalanced in catatonia, which would account for the often observed dystonic-like hyperkinetic movements in catatonic patients. Hence the SMA may play a crucial role in the transformation of cognitive and emotional contents into movements such that the SMA may be considered as a *functional knot* in the terms of Luria (Luria 1973, 31). Taking the functional importance of cognitive/emotional-motor transformational processes and their respective "functional knots" into account, neither the distinct aspects (emotional, cognitive, motor) of behavioral acts nor the respective underlying anatomical structures in the brain could be adequately accounted for independently of each other. Therefore "functional knots," as well as, more generally speaking, "functional connectivity" between distinct neural structures (within the functional systems) and between different "functional systems," should be investigated in order to get insight into the mechanisms of functional brain organization. Similar to functional brain organization (see above), "functional knots" and "functional connectivity" as constitutive parts of "functional configuration" may thus be highly dependent on the interaction between brain and world. Consecutively anatomo-physiologic properties of the brain can neither be considered independently from the respective brain function nor from the environment, so that they may be regarded only as neccessary but not sufficient conditions for functional brain organization and the generation of mental states.

"Functional Circuitry" between Psychological and Motor Functions

There are different cortico-striato-pallido-thalamo-cortical loops (motor, oculomotor, orbitofrontal, dorsolateral prefrontal, lateral prefrontal, and anterior congulate loops) processing distinct kinds of emotional, cognitive, and motor information (Alexander et al. 1990). Currently the functional relations between these different loops are still a matter of discussion (Parent et al. 1995). The "parallel processing" hypothesis assumes that motor, emotional, and cognitive informations of the cortex are processed largely independently from each other via these multiple, parallel, and segregated loops. The "information funneling" hypothesis, in contrast, assumes a "reception convergence" within the striatum and the pallidum such that motor, emotional, and cognitive cortical inputs would flow together (Parent et al. 1995). Even though it is still not clear yet whether these different "loops" process either in a parallel or convergent way, it is clear that emotional, cognitive, and motor information processing is organized in functional circuits that may be considered as one important principle of functional brain organization.

In Parkinson's disease it has been demonstrated quite well that the "motor loop" (SMA/motor cortex**-->**Striatum**-->**Pallidum**-->**Thalamus**-->** SMA/motor cortex) is dysfunctional due to deficient nigrostriatal dopamine (Alexander et al. 1990). Various therapeutic measures like apomorhine, pallidotomy, thalamotomy, subthalamic deep brain stimulation reinstall function of this "motor loop" by influencing different relay stations within this "motor loop" (Rascol et al. 1992, Boecker et al. 1998, Limousin et al. 1997, Grafton **[End Page 203]** et al. 1995), all leading consecutively to reversal of akinesia and Parkinsonian motor symptoms. Thus the "motor loop" may be functionally altered in the same way by different measures aiming at distinct anatomical structures (or transmitters) within this "motor loop." Findings in catatonia rather suggest alterations in the "orbitofrontal cortical loop" since emotional-motor stimulation showed reduced activation in orbitofrontal cortex with altered "functional connectivity" between orbitofrontal and motor cortex (Northoff et al. 1998). Thus although the "motor loop" itself may be intact in catatonia, cortical motor function may be altered either via altered "functional connectivity" between orbitofrontal and motor cortex or via basal ganglia involvement within the "orbitofrontal loop."

In addition "functional loops" can be characterized by "feedforward" and "feedback" connections that may regulate each other so that "functional circuitry" may be considered as self-referential. Such "self-referentiality" within "functional loops" may account psychologically for the process of internal monitoring that may be closely related to awareness/consciousness as well as to disturbances in schizophrenia (Frith 1992). It may consequently be hypothesized that lack of awareness of movements in catatonic patients could be closely related to alterations in "feedback connections" that however have not been investigated empirically yet.

In summary functional brain organization can be characterized by "functional circuitry" with various "functional loops" whose exact relationship to each other, i.e., their mode of processing, either parallel or convergent, remains unclear. Such "functional loops" may be disturbed or influenced in different relay stations, all leading consecutively to (more or less) similar symptoms/symptom reversals, as has been shown in Parkinson's disease. Within such "functional loops," "feedforward" and "feedback" connections can be distinguished that may be closely related to different kinds of symptoms respectively, and "feedback" connections in particular may account for the psychological processes of internal monitoring and awareness, which however has not yet been demonstrated empirically.

Context Dependence

The functional principle of "context dependence" points out the influence of sensory, emotional, environmental, etc., factors on topography and intensity of actual functional brain activity. It has been shown that the topography of the BP as a potential related with movements depends on the concomitant involvement of visual and tactile tasks. In visual-motor tasks the BP did not only appear in frontal cortex, as in isolated motor tasks, but in the occipital cortex as well whereas in tactile-motor tasks, contrary to the visual task, the somatosensory cortex showed a BP (Deecke et al. 1984). Even similar movements within different functional contexts (for example, playing a tone isolated or within a melody) may lead to distinct ways of neural activation as measured with BP (Kristeva 1984). Another example for the interaction between brain and world is pianists, who, having trained their fingers quite well almost all their life, showed different, i.e., enlarged, representations of fingers in cortical motor areas than non-pianists (Ebert et al. 1995).

The "context dependency" of brain function is also reflected in the startle reflex whose intensity is potentiated in association with negative emotions and decreased while inducing positive emotions (Lang et al. 1993). Thus relations between different neural structures within the respective functional system, as well as interrelations between different functional systems, will correspondingly vary with the respective relationship between the individual person and its environment, i.e., the internal function of the brain is strongly shaped by influences and stimuli from the external world of the environment. Brain function can therefore not be regarded independent of the environment, i.e., in social isolation, so that the actual functional brain organization is determined by means of the interaction between brain and world. Hence considering functional brain organization, one may speak of "functional configurations" of the neural network that, depending on the respective context, may show various *Gestalten* with different relations between "figure" and "background" (Goldstein 1963, S.12; Northoff 1995, S.81). **[End Page 204]**

The dependence of "functional configurations" on the external environment can be clearly observed symptomatically in Parkinson's disease and catatonia. Stressful situations can further alleviate Parkinsonian symptoms, whereas life-threatening situations (such as, for example, bombing in the Second World War) may reverse akinesia in such a way that patients are able to walk again. Catatonic symptoms are highly susceptible to influences by the environment as well. If a strong emotionally laden event occurs (such as, for example, a visit by a parent with whom the relationship is emotionally highly ambiguous), catatonic symptoms may reoccur even after they vanished completely (Northoff 1997). Functional brain organization in these different situations may thus be characterized by different "functional configurations" with distinct relations between "figure" and "background" depending on the respective environment situation and its meaning for the respective person. Catatonic patients experience strong and uncontrollable emotions in different environmental situations that may be considered the "figure," whereas motor alterations remain in the "background" of their subjective experience such that the patients "feel paralyzed by fear" (Northoff 1997). Such a relation between "figure" and "background" may be reflected in functional brain organizations by means of corresponding "functional configurations." Under emotional-motor stimulation, catatonic patients show strongly reduced prefrontal, i.e., orbitofrontal, cortical activity that is strongly involved in the generation of emotion (in collaboration with the reciprocally connected amygdala), with (probably secondary) alterations in "functional connectivity" between orbitofrontal and motor cortex, which may account for concomitant occurrence of emotional and motor alterations (Northoff et al. 1998). Parkinsonian patients in contrast show predominant motor symptoms as the "figure" that may be influenced by different environmental situations (see above). Consequently the main alterations can be found here in cortical and subcortical areas, the primary motor cortex, the

SMA, and the basal ganglia (Alexander et al. 1990, Playford et al. 1992, Jahanshahi et al. 1995), that are primarily involved in the generation and execution of movements. In summary catatonic and Parkinsonian symptoms are highly dependent on the respective environmental situation with different relations between "figure" and "background" respectively, i.e., there is "context dependency." Such different relations between "figure" and "background" are reflected in functional brain organization showing distinct "functional configurations" that may account for differences in mental states in both diseases.

A further example of "context dependency" is schizophrenic patients with delusions of alien control who believe their thoughts, movements, and actions to be those of external, or alien, entities. During the execution of voluntary movements, these patients showed hyperactivation in parietal and anterior cingulate cortex, areas that are closely associated with attentional functions (Spence et al. 1997). Consecutively attentional disturbances may lead to misattribution of internally generated thoughts, movements, and actions to external or alien entities as the cardinal features of delusions of alien control. Internal monitoring of movements and thoughts is thus highly dependent on attention that influences attributions and judgments about them and is reflected also in the respective physiological, i.e., pathophysiological, substrates.

In summary functional brain organization is shaped and determined by functional interactions between different functions, as, for example, between emotions, cognitions, and attentions, on the one hand, and movements on the other that, in turn, reflect the interactions between the internal world of the brain and the external world of the environment. Such a "context dependence" of functional brain organization on functional interactions and the external environment is reflected in the "functional configuration" (and psychological and physiological states) that may account for the respective mental state, i.e., the corresponding subjective experience.

Overlapping Functional Substrates of Mental and Motor Processes

Mental activity such as imagination of movements has shown in PET-studies activation of **[End Page 205]** anterior cingulum, medial and lateral premotor areas bilaterally, ventral operculum premotor areas and superior-inferior parts of parietal areas (Stephan et al. 1995, Crammond 1997, Jeannerod 1997, Mellet et al. 1998), whereas execution of movements leads, in addition, to activation of left primary sensorimotor cortex with adjacent parts of dorsal premotor and rostral superior parietal cortex. Furthermore studies with transcranial magnetic stimulation demonstrated that motor imagination leads to enhanced cortical excitability of the lateral rostral precentral gyrus as part of the motor cortex with no muscle activity measured by EMG, whereas execution of movements increases both cortical excitability and muscle activity (Stephan et al. 1995). Consequently the authors consider motor imagination as a special subset of motor behavior, activating overlapping functional substrates with the exclusion of certain parts of the motor cortex specifically responsible for activation of muscles (Stephan et al. 1995, Crammond 1997). In addition, it has been shown that imagined movements obey the same physical laws and are tied to the same physiological constraints as are real, i.e., executed, movements (Crammond 1997, Jeannerod 1997, Mellet et al. 1998).

Similar findings of overlapping anatomical structures in distinct aspects of motor functions have been made also in motor learning. As shown in neuroimaging studies motor learning apparently takes places in motor areas such as SMA, motor cortex, and cerebellum (Grafton 1995); i.e., the distinct aspects (i.e., execution, learning, imagination) of one particular function (i.e., motor function) seem to be related to and processed in overlapping anatomical structures.

Consequently, mental states, as for example motor imagination or motor learning, do not activate separate anatomical structures but rather overlapping and partially similar anatomical areas as the actual execution of movements. Hence functional brain organization cannot be characterized by separate modules for mental and nonmental motor functions but rather by anatomical and functional overlappings between mental and nonmental aspects within motor functions so that, from an empirical point of view, mental and nonmental motor functions cannot be entirely separated from each other within functional brain organization.

Such an anatomical and functional overlapping between mental and nonmental motor functions is also reflected symptomatically. Parkinsonian patients showed deficits in motor imagination similar to those in motor execution: Actual and imagined movements showed similar time delays, a similar asymmetry between right and left side (only on the right side but not on the left since hemiParkinsonian patients were investigated), and similar improvements/deteriorations in on/off phases (i.e., with/without effect of medication) (Jeannerod 1997; 123-25), whereas no general deficits in motor imagination (but only those related to deficits in execution of movements) were detected. Motor imagination in catatonic patients has not been investigated yet. However, following accounts of subjectve experiences of catatonic patients, where they say that "I could have performed movements but I preferred not to move since it made no sense at all" (Northoff 1997, Northoff et al. 1998), one might assume that motor imagination would show no deficits, since their alterations in motor execution seem to be, at least partially, voluntarily controlled by their mental states. Such an assumption is however somewhat speculative and has to remain open until further empirical investigation.

In summary functional brain organization can be characterized by overlapping anatomical and functional substrates for mental and nonmental aspects of motor function so that alterations in nonmental functions may consequently lead to corresponding alterations in mental states (and probably vice versa as well?). Furthermore functional brain organization itself, i.e., from the point of view of the brain itself, mental and nonmental states are organized as distinct, dependent, and integrated aspects of one particular behavioral, i.e., motor, function than as different, separate, and independent functions.

Functional Brain Organization and the Mind-Brain Relationship

Catatonia and Parkinson's disease as neuropsychiatric diseases show clinically similar motor **[End Page 206]** symptoms but distinct accompanying mental states; i.e., subjective experience of akinesia differed between both kinds of patients. In order to further understand the possibility of such a dissociation between mental and motor state, we investigated principles of functional brain organization. Description of functional brain organization revealed functional principles such as "functional knots," "functional systems," "functional circuits," "functional cerebral space," "functional configurations," etc., where mental and nonmental functions are closely related to each other. We thus showed that psychomotor phenomena are functionally not primarily organized according to the distinction between mental and nonmental states but rather with regard to behavioral, emotional, and cognitive acts where mental and nonmental states are integrated into each other. Hence mental and nonmental states appear no longer as different (ontological) entities but rather as distinct functional aspects of functional brain organization.

Presupposing such an integration of mental and nonmental states within functional brain organization, the following conclusions with regard to the mind-brain relationship can be drawn (see also Northoff 1997). The philosophical arguments will be discussed briefly and are described in a more formal way with their respective premises (P) and conclusions (C). The purpose of this section is only to indicate potential neurophilosophical implications of functional brain organization; it is impossible within the scope of this discussion to examine each implication extensively.

Description of Mental States: "Ontological Neutrality"

Mental states can be described in different ways. They can be described with regard to personal experience, i.e., phenomenologically and psychologically, as well as with regard to brain function, i.e., functionally and physiologically (see also Karlsson and Kamppinnen 1995). The phenomenological description points out the subjective experience by the person itself, i.e., the "What is it like?" to experience such a situation. Consequently, the phenomenological description is closely related to the "First-Person Perspective," whereas the psychological descriptions of mental states can be made from the "Third-Person Perspective." The psychological description focuses on psychological functions such as attention, working memory, etc., which are assumed or presumed to be involved in the generation of mental states.

With regard to the brain, mental states can be described as functionally and physiologically analogous to the person, presupposing a particular "brain perspective," a concept that will be further discussed below. The functional description points out the specific functional mechanisms ("functional knots," "functional circuitry," etc.), i.e., the kind of interaction between different brain areas as well as between brain and world which are sought to be involved in the generation of particular mental states. The physiological description points out the physiological mechanisms involved in the generation of mental states such as anatomical areas, electrophysiological mechanisms, etc.

In summary, mental states can be described with regard to personal experience and brain function. Personal experience can be described either phenomenologically or psychologically, whereas brain function can be described functionally and physiologically. Such different ways of describing mental states remain ontologically neutral with regard to the mind-brain relationship since they do not presuppose any ontological (mental and/or nonmental) entities so that the ontological nature of the relationship between the different ways of description, as, for example, between phenomenal and physiological descriptions, remains open. Hence our assumption of ontological neutrality can be considered as an epistemic statement rather than as an ontological assumption by its own presupposing a certain kind of ontological mind-brain theory (as, for example, dualism or monism).

> (P1) Mental states can be described with regard to personal experience (phenomenal, psychological) and brain function (functional, physiological).
>
> (P2) Different ways of description do not necessarily presuppose different ontological entities (but rather distinct perspectives from which the description can be made; see below). **[End Page 207]**
>
> (C) The different ways of describing mental states thus remain ontologically neutral

since they do not necessarily assume preassumptions about (mental and/or nonmental) ontological entities.

The phenomenological description showed that catatonic patients, unlike those with Parkinson's disease, are not aware of their movement disturbances so that they do not subjectively experience a specific "What is it like to be akinetic?" but rather, despite showing akinesia and posturing, they experience "normal" i.e., non-akinetic movements. The psychological description showed deficiencies in executive function in Parkinson's disease probably closely related to the occurrence of akinesia (and the respective subjective experiences as well), whereas in catatonia attentional and visuo-spatial functions are altered both of which may be involved in the generation of posturing (and probably of non-awareness of posturing as well) (Northoff et al. 1998). The functional description in catatonia revealed that principles of functional brain organization like "functional knots," "functional circuitry," and "context dependence" were altered in different ways in Parkinson's disease and catatonia, showing different "functional configurations" respectively. The physiological description showed alterations in basal ganglia, SMA/motor cortex, and dopamine in Parkinson's disease, whereas in catatonia the orbitofrontal and GABA were mostly affected (see above). Such psychological, functional, and physiological differences may account for differences in mental states, i.e., for phenomenal differences between catatonic and Parkinsonian patients.

Mental States and Anatomo-Physiologic Properties: "Conditional Fallacy"

Functional brain organization could be characterized by "functional systems" with distinct "functional configurations" depending on the interactions between the various brain areas as well as by those between brain and world (which is reflected in "context dependency") by means of which mental states are (probably) generated. Anatomo-physiologic properties are part of the internal world of the brain by which means it is capable of interacting with the external environment. Anatomo-physiologic properties can thus be regarded as a necessary (natural; i.e., not logical) condition for the generation of mental states (in human subjects). Can anatomo-physiologic properties be considered also as a sufficient condition by themselves for the generation of mental states?

Principles of functional brain organization showed that anatomo-physiologic properties are necessary for the organization of brain function since, as shown in Parkinson's disease and catatonia, their alterations lead to alterations in brain function. However, it was not the deficit of certain anatomo-physiologic properties by themselves that generated catatonic and Parkinsonic (mental and nonmental) symptoms but rather the alterations in functional brain organization (as, for example, in "functional knots" and "functional circuitry") as induced by the anatomo-physiologic deficits. Consequently anatomo-physiologic properties can only be regarded as a necessary but not sufficient condition for the generation of mental states. Instead of anatomo-physiologic properties, specific "functional configurations" may thus be regarded as a sufficient (natural) condition for the generation of mental states (in the human subject) (whether "functional configurations" may also be considered as a sufficient condition in the logical sense may be a matter of further philosophical discussion). Hence a complete reduction/redefinition of mental states to anatomo-physiologic brain properties would be wrong and should therefore be considered as a confusion between necessary and sufficient conditions of mental states; i.e., a "conditional fallacy."

> (P1) Mental states can be characterized by particular ways of functional brain organization with specific "functional configurations" that may thus be regarded as a sufficient condition for the generation of mental states.
>
> (P2) Brain function is determined by "functional configurations" arising out of interactions between different brain areas as well as interactions between brain and world, both kinds of interactions requiring anatomo-physiological properties as a necessary but not sufficient (natural) condition.
>
> (C) Mental states can thus neither be (completely) reduced to nor (fully) redefined by anatomo-physiologic brain properties since otherwise one would confuse **[End Page 208]** necessary and sufficient (natural) conditions for the generation of mental states that may be regarded as a "conditional fallacy."

In Parkinson's disease, deficits in the basal ganglia, the motor cortex/posterior SMA, and dopamine are the necessary anatomo-physiologic conditions, whereas a particular "functional configuration" within the "motor loop" could be regarded as the sufficient condition for the generation of Parkinsonian symptoms. This is further underlined by the observation that, even if nigrostriatal dopamine is not substituted, Parkinsonian symptoms may nevertheless improve significantly after (partial) restoration of the "motor loop," as, for example, by means of thalamotomy or deep brain stimulation (see above). Alterations in the orbitofrontal cortex and GABA are apparently the neccessary anatomo-physiologic conditions in catatonia, whereas alterations in gaba-ergic orbitofrontal-motor cortical functional interactions, i.e., in "functional connectivity," may be considered as the respective "functional configuration" that could be sufficient for the generation of catatonic symptoms. Hence the examples of Parkinson's disease and catatonia show quite nicely that anatomo-pyhsiologic deficits by themselves cannot be regarded as a sufficient but only as necessary condition for the generation of catatonic and Parkinsonian mental and nonmental symptoms.

Ontological Mind-Brain Problem: "Ontological Fallacy"

Dualistic and monistic models of mind-brain relationship fail in their account of mental states either by eliminating mental states from the brain (as in dualism where separate mental and nonmental ontological entities are presupposed) or by reducing them to anatomical structures (as in materialistic monism where mental states are reduced to or identified with nonmental states). Taking into account that anatomo-physiologic brain properties can only regarded as necessary but not sufficient conditions for the generation of mental states (see above), mental states can neither be completely eliminated from the brain nor entirely reduced to anatomo-physiologic brain properties. Furthermore a psychophysical correlationist approach must necessarily fail as well since brain function is not organized according to the distinction between mental and nonmental states (see above) that, as presupposed in the correlationist approach, could be correlated with each other. Instead functional brain organization can be characterized by distinct "functional configurations" where both mental and nonmental states are specifically integrated into each other within one particular behavioral, emotional, or cognitive act (for example, mental imagination; see above). Consequently the functional organization of the brain itself; i.e., from the "point of view of the brain," remains ontologically neutral with regard to the distinction between mental and/or nonmental ontological entities. Mental and nonmental states may therefore no longer be regarded as separate (reducible [as in monism] or non-reducible [as in dualism]) ontological entities but rather as distinct kinds of ontologically neutral (see above) descriptions from different perspectives (phenomenal, functional, psychological, physiological; see above). Separate mental and nonmental ontological entities can thus neither be derived empirically from functional brain organization nor logically from the different kinds of descriptions of mental states (see above).

Due to these empirical and logical reasons for the impossibility of inferring separate mental and nonmental ontological entities, the question for the relationship between mental and nonmental states can thus no longer be considered as an ontological problem but rather as an epistemological one where one has to choose among different perspectives all describing the same "functional configuration" in different terms. The assumption of separate mental and nonmental ontological entities, as derived as an empirical or logical conclusion from either functional brain organization or the different kinds of descriptions, may thus be regarded as an "ontological fallacy."

> (P1) Brain function is not organized according to the distinction between mental and nonmental states but rather with regard to behavioral, emotional, or cognitive acts where mental and nonmental states are closely integrated into each other; i.e., functional brain organization itself remains ontologically neutral. **[End Page 209]**
>
> (P2) Mental states can be described in phenomenological, psychological, functional, and physiological terms that however do not necessarily presuppose different mental and nonmental ontological entities; i.e., the epistemological descriptions themselves remain ontologically neutral.
>
> (C) Neither empirically (i.e., from functional brain organization) nor logically (i.e., from epistemological descriptions) separate mental and nonmental ontological entities can be inferred so that such ontological assumptions, as for example in dualism or correlationist approaches, may be regarded as an "ontological fallacy."

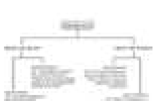
Epistemological Mind-Brain Problem: "Epistemological Fallacy"

Mental states can be described with regard to personal experience, i.e., phenomenologically and psychologically; and brain, i.e., functionally and physiologically, thereby remaining ontologically neutral (see above). However reasons for the possibility of such an epistemological variety remain unclear.

With regard to personal experience, mental states can either be described in subjective (experiential) terms ("What is it like for a person to experience a particular mental state?") "from within the person" in the "First-Person Perspective" or in objective (psychological) terms ("What do psychological functions do with regard to mental states?") "from without the person" in the "Third-Person Perspective." Consequently the "First-Person Perspective" accounts for the phenomenal description of mental states, whereas the "Third-Person Perspective" accounts for their psychological description. Describing mental states in exclusively psychological terms from the "Third-Person Perspective" would thus be inadequate since the phenomenal experience, as described in the "First-Person Perspective," would be eliminated so that a "Third-Person Perspective" description alone must be considered as insufficient for an adequate account of mental states.

With regard to brain function, mental states can be described either in functional or physiological terms. Similar to "first-person" and "third-person" descriptions of mental states with regard to subjective experience, functional and physiological descriptions point out distinct aspects of mental states with regard to brain function. Physiological terms describe anatomical, neurochemical, electrophysiological properties of the brain that can be measured and detected without fully understanding (their role in) functional brain organization, i.e., "from without the brain." In contrast functional descriptions point out the mechanisms and principles according to which brain function is organized so that detection of these principles of functional brain organization do necessarily presuppose a genuine understanding of brain function "from within the brain." Hence principles of functional brain organization can only be understood from "within the brain" as the "point of view of the brain" but neither "from without the brain" (see above) nor "from within the person" (the "First-Person Perspective" can detect only its own mental states but neither its anatomo-physiological properties nor its principles of functional brain organization) or "from without the person" (the "Third-Person Perspective" may be able to make improper functional and anatomo-physiogical statements about the brain but it can neither understand the "point of view of the brain", i.e., its functional principles, nor the proper i.e., corresponding anatomo-physiologic brain properties, since the person uses its own epistemological apparatus whose epistemological distinctions may not necessarily correspond to principles of functional and anatomo-physiologic brain organization).

Consequently physiological and functional descriptions of mental states with regard to brain function presuppose different perspectives, "from within the brain" and "from without the brain." Analogous to the description of mental states with regard to the person, one may thus distinguish between a "First-Brain Perspective" and a "Third-Brain Perspective." The "First-Brain Perspective" describes the corresponding "functional configurations," i.e., the principles of functional organization "from within the brain" as the "What is it like for a brain to generate a particular functional state," whereas the "Third-Brain Perspective" describes the anatomo-physiologic properties **[End Page 210]** "from without the brain" as the "What do anatomo-physiologic properties do with regard to the function of the brain." Accounting for mental states exclusively by physiological descriptions from the "Third-Brain Perspective" would thus be insufficient since the principles of functional brain organization from the "First-Brain Perspective" as the "What is it like for a brain to generate a particular functional state" would be eliminated so that the description of mental states with regard to brain function would necessarily be insufficient. One may however be concerned with the (empirical) access to the "First-Brain Perspectives" since, unlike with regard to subjective experience in the ""First-Person Perspective," we apparently have no direct access to (and thus no direct knowledge of) anatomo-physiologic properties and functional mechanisms in the brain. For example, a Parkinsonian patient experiences his akinesia, but he has no knowledge on his own about his nigrostriatal dopamine and his "motor loop." Neural networks of brain function may give us at least a partial account of functional brain mechanisms by means of simulation of the "First-Brain Perspective," though then the question whether computers can have mental states immediately arises, and that would be a matter of discussion on its own.



In summary we have shown that the various epistemological descriptions of mental states presuppose different perspectives from which they can be made. Since mental states can be described with regard to personal experience and brain function, we subsequently distinguished a "Person Perspective" from a "Brain Perspective." Within each kind of perspective, we further distinguished between a "First-Person/Brain Perspective" and a "Third-Person/Brain Perspective" accounting for distinct kinds of description of mental states either "from within the person/brain" or "from without the person/brain" (see figure 1). In addition we argued that neither the psychological description from the "Third-Person Perspective" nor the physiological description from the "Third-Brain Perspective" can be considered by themselves as sufficient for an adequate description of mental states since then neither phenomenal experiences, as described in the "First-Person Perspective" nor functional brain mechanisms, as described in the "First-Brain Perspective", could be accounted for. Elimination (or complete reduction) of the "First-Person Perspective" and/or the "First-Brain Perspective" may thus be regarded as an "epistemological fallacy."

> (P1) Mental states can be described from the "First-Person/Brain Perspective," i.e., "from within the person/brain," as well as from the "Third-Person/Brain Perspective," i.e., "from without the person/brain," accounting for the distinct aspects of mental states respectively.
>
> (P2) Descriptions of mental states from the "Third-Person/Brain Perspective" alone, i.e., psychological and physiological descriptions, are insufficient since, due to the elimination of the "First-Person/Brain Perspective" descriptions, they can neither consider phenomenal experiences nor functional mechanisms.
>
> (C) Descriptions of mental states from the "First-Person/Brain Perspective" can neither be completely eliminated nor fully reduced to or identified with "Third-Person/Brain Perspective" descriptions since otherwise, describing distinct aspects of mental states respectively, description of mental states would be inadequate or insufficient. Elimination, reduction, or identification of "First-Person/Brain Perspective" descriptions to/with "Third-Person/Brain Perspective" descriptions may thus be regarded as an "epistemological fallacy."

Conclusions: "Philosophy of the Brain"

I have shown that two neuropsychiatric diseases, catatonia and Parkinson's disease, could be characterized by similar motor symptoms (i.e., akinesia) and different corresponding mental states (i.e., differences in subjective experience of akinesia). In order to further understand the generation of such a dissociation between mental and motor states, I discussed various principles of functional brain organization by means of psychological and physiological alterations in both diseases. In addition, relying on these principles of functional brain organization, I briefly indicated the respective neurophilosophical implications with regard to the mind-brain relationship. I pointed out ontological neutrality of the different kinds of descriptions of mental states (phenomenal, psychological, functional, physiological), as well as various kinds of fallacies (conditional, **[End Page 211]** ontological, epistemological) that, considering empirical data, should be avoided in the philosophical discussion.

It has been shown that consideration of empirical data about brain function may be helpful in and may contribute significantly to the philosophical discussion about the mind-brain relationship. Though illustrating its ideas often with empirical examples, the philosophical mind-brain discussion, however, lacks a clear and empirically realistic understanding of the brain and its principles of functional organization. Further elaboration and definition of the terms *brain* and *brain function*, as well as a discussion about the ontological and epistemological role of the brain, i.e., the development of a "philosophy of the brain," would thus be necessary to further advance a neurophilosophical account of the mind-brain relationship.

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Abbreviations and Terms

BP	= Bereitschafts of Readiness Potential
DLPFC	= Dorsolateral prefrontal cortex
EMG	= Electromyogram
PET	= Postron emission tomography
SMA	= Supplementary motor area
Striatum, putamen	= parts of the basal ganglia as subcortical structures
(P#)	= Premises
(C)	= Conclusions **[End Page 212]**

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