

## **Glossary**

### **Access consciousness**

The concept of access consciousness describes the ability to access the contents of consciousness and to thereby become aware of them as contents of consciousness.

### **Agency**

The experience that it is I, rather than some other person, that causes action and movement. I, my self, am the agent of the lines I am currently writing here on my laptop. Neurally, regions such as the premotor cortex and the motor cortex have been associated with agency; these are regions that are implicated in generating movement and action in general.

### **Awareness**

Awareness is a kind of inner perception or thought. If taken to be an inner perception, like an inner monitoring, it must be conceived of as a higher-order perception that complements the original lower-order perception.

### **Brain (different concepts)**

The brain is a subject of cognition which concerns the brain that contributes to our perception and cognition and hence to our acquisition of knowledge about the world including its various objects like bodies and brains. Among those objects may also be brains which are then considered as objects, i.e. brain as object. The brain as functioning is the brain as it functions independent of our observation of it; this is supposed to reflect the brain as subject of cognition (concept at the border between metaphysical, empirical and epistemological domains). We have access to the brain though only via our observation in third-person perspective which concerns the brain as observed (concept within the empirical domain).

### **Brain (Intrinsic Activity)**

Spontaneous brain activity and contrast it with the stimulus-induced or task-related activity. The concept of a resting state signifies the absence of any specific extrinsic stimuli, i.e. stimuli from outside the brain. As for instance when a person closes his eyes, he does not receive any extrinsic stimuli and is therefore supposed to be in a resting state.

### **Consciousness (phenomenal, access, unconscious, nonconscious)**

Consciousness is a multifaceted phenomenon that includes empirical, phenomenal, conceptual and epistemological (and metaphysical) dimensions. Conceptually, different forms of consciousness can be distinguished: phenomenal consciousness describes the 'what it is like' and thus the subjective experience itself. Meanwhile 'access consciousness' concerns the awareness of the contents in consciousness. Finally, the concept of consciousness in general must be distinguished from the concept of the unconscious. In the unconscious, contents are not conscious, though they can become potentially conscious. This distinguishes the concept of the unconscious from the nonconscious, where the contents are neither conscious, nor have the possibility of ever becoming conscious. What about the phenomenal characterization of consciousness – its first-person-based experiential features? Philosophers like Thomas Nagel assume the phenomenal-qualitative character of conscious states, the 'what it is like', to be central for consciousness. Besides the 'what it is like', consciousness may be characterized by other phenomenal features. These include unity as well as spatial and temporal continuity. In addition, consciousness can be characterized by self-perspectival and intentional organization and, most importantly, by subjective access and first-person perspective. These issues raise questions about appropriate methodological strategies for linking the first-person-based phenomenal features of consciousness to the third-person-based neuronal features of the brain. Hence, special methodological strategies like first-person neuroscience and the unified field model may be required to investigate the neural basis of consciousness.

### **Cognitive Functions**

Cognitive functions concern, for instance, processes like attention, working memory (e.g. short-term memory), episodic memory as long-term memory, and executive functions, e.g. the elaboration of goals and plans for subsequent action and behavior. In contrast to sensory functions, Fodor and others no longer assume modularity in the case of cognitive functions. Why? Because cognitive functions no longer rely on one particular input like visual stimuli. Instead, cognitive functions are based on and require multiple inputs from different sources, like different sensory inputs, motor inputs, inputs from emotional

functions, etc. Therefore, unlike sensory and motor functions, which are often assumed to be encapsulated, cognitive functions do not show any sign of encapsulation.

### **Dualism (substance, property, epiphenomenalism)**

The position that mental phenomena are, in some respects, non-physical, or that the mind and body are not identical. Thus, it encompasses a set of views about the relationship between mind and matter, and is contrasted with other positions, such as physicalism, in the mind–body problem.

Property dualism asserts that an ontological distinction lies in the differences between properties of mind and matter, and that consciousness is ontologically irreducible to neurobiology and physics. It asserts that when matter is organized in the appropriate way (i.e., in the way that living human bodies are organized), mental properties emerge. Hence, it is a sub-branch of emergent materialism.

Epiphenomenalism is a form of Property Dualism, in which it is asserted that one or more mental states do not have any influence on physical states (both ontologically and causally irreducible). It asserts that while material causes give rise to sensations, volitions, ideas, etc., such mental phenomena themselves cause nothing further: they are causal dead-ends. This can be contrasted to interactionism, on the other hand, in which mental causes can produce material effects, and vice-versa.

### **Electroencephalography (EEG)**

EEG is the recording of electrical activity along the scalp. EEG measures voltage fluctuations resulting from ionic current flows within the neurons of the brain. In clinical contexts, EEG refers to the recording of the brain's spontaneous electrical activity over a short period of time, usually 20–40 minutes, as recorded from multiple electrodes placed on the scalp. Diagnostic applications generally focus on the spectral content of EEG, that is, the type of neural oscillations that can be observed in EEG signals. EEG is most often used to diagnose epilepsy, which causes obvious abnormalities in EEG readings. It is also used to diagnose sleep disorders, coma, encephalopathies, and brain death. EEG used to be a first-line method of diagnosis for tumors, stroke and other focal brain disorders, but this use has decreased with the advent of high-resolution anatomical imaging techniques such as MRI and CT. Despite limited spatial resolution, EEG continues to be a valuable tool for research and diagnosis, especially when millisecond-range temporal resolution (not possible with CT or MRI) is required. Derivatives of the EEG technique include evoked potentials (EP), which involves

averaging the EEG activity time-locked to the presentation of a stimulus of some sort (visual, somatosensory, or auditory). Event-related potentials (ERPs) refer to averaged EEG responses that are time-locked to more complex processing of stimuli; this technique is used in cognitive science, cognitive psychology, and psychophysiological research.

### **Eliminativism (Eliminative materialism)**

Eliminative materialism is the radical claim that our ordinary, common-sense understanding of the mind is deeply wrong and that some or all of the mental states posited by common-sense do not actually exist. Descartes famously challenged much of what we take for granted, but he insisted that, for the most part, we can be confident about the content of our own minds. Eliminative materialists go further than Descartes on this point, since they challenge the existence of various mental states that Descartes took for granted.

### **Embodied Self (embedded, social self)**

The self may be considered as intrinsically linked to the body. This is called embodied self. Furthermore, since it is based on selfreference, our self may also be intrinsically linked to the environment. This is called the embedded and social self. Our self cannot consequently be regarded as an entity located somewhere in the brain and isolated from both body and environment. Instead our self seems to be intrinsically social, as suggested by the advocates of the concept of a social self.

### **Emergentism (emergent properties)**

A property of a system is said to be emergent if it is in some sense more than the "sum" of the properties of the system's parts. An emergent property is said to be dependent on some more basic properties (and their relationships and configuration), so that it can have no separate existence. However, a degree of independence is also asserted of emergent properties, so that they are not identical to, or reducible to, or predictable from, or deducible from their bases. The different ways in which the independence requirement can be satisfied, lead to variant types of emergence.

Emergent properties are novel properties that supposedly arise out of the interactions among the physical properties. How exactly such non-physical

properties can arise from the interactions among the physical properties remains unclear at this time. This position is referred to as 'emergence' or 'emergentism'

## **Emotional Contagion**

Emotional contagion is the tendency for two individuals to emotionally converge. One view developed by Elaine Hatfield et al. is that this can be done through automatic mimicry and synchronization of one's expressions, vocalizations, postures and movements with those of another person. When people unconsciously mimic their companions' expressions of emotion, they come to feel reflections of their partner's emotions. Emotions can be shared across individuals in many different ways both implicitly or explicitly. For instance, conscious reasoning, analysis and imagination have all been found to contribute to the phenomenon. Emotional contagion is important to personal relationships because it fosters emotional synchrony between individuals. A broader definition of the phenomenon was suggested by Schoenewolf: "a process in which a person or group influences the emotions or behavior of another person or group through the conscious or unconscious induction of emotion states and behavioral attitudes."

## **Empathy**

Empathy has many different definitions that encompass a broad range of emotional states, such as caring for other people and having a desire to help them; experiencing emotions that match another person's emotions; discerning what another person is thinking or feeling; and making less distinct the differences between the self and the other. Since empathy involves understanding the emotional states of other people, the way it is characterized is derivative of the way emotions themselves are characterized. If, for example, emotions are taken to be centrally characterized by bodily feelings, then grasping the bodily feelings of another will be central to empathy. On the other hand, if emotions are more centrally characterized by a combination of beliefs and desires, then grasping these beliefs and desires will be more essential to empathy. The ability to imagine oneself as another person is a sophisticated imaginative process. However, the basic capacity to recognize emotions is probably innate and may be achieved unconsciously. Yet it can be trained and achieved with various degrees of intensity or accuracy.

## **Encoding (Neural Coding)**

Neural coding is a neuroscience-related field concerned with characterizing the relationship between the stimulus and the individual or ensemble neuronal responses and the relationship among the electrical activity of the neurons in the ensemble. Based on the theory that sensory and other information is represented in the brain by networks of neurons, it is thought that neurons can encode both digital and analog information. The link between stimulus and response can be studied from two opposite points of view. Neural encoding refers to the map from stimulus to response. The main focus is to understand how neurons respond to a wide variety of stimuli, and to construct models that attempt to predict responses to other stimuli. Neural decoding refers to the reverse map, from response to stimulus, and the challenge is to reconstruct a stimulus, or certain aspects of that stimulus, from the spike sequences it evokes.

## **Epistemology**

Defined narrowly, epistemology is the study of knowledge and justified belief. As the study of knowledge, epistemology is concerned with the following questions: What are the necessary and sufficient conditions of knowledge? What are its sources? What is its structure, and what are its limits? As the study of justified belief, epistemology aims to answer questions such as: How we are to understand the concept of justification? What makes justified beliefs justified? Is justification internal or external to one's own mind? Understood more broadly, epistemology is about issues having to do with the creation and dissemination of knowledge in particular areas of inquiry. This article will provide a systematic overview of the problems that the questions above raise and focus in some depth on issues relating to the structure and the limits of knowledge and justification.

## **Explanatory Gap**

The explanatory gap is a term introduced by philosopher Joseph Levine for the difficulty that physicalist theories of mind have in explaining how physical properties give rise to the way things feel when they are experienced. In the 1983 paper in which he first used the term, he used as an example the sentence, "Pain is the firing of C fibers", pointing out that while it might be valid in a physiological sense, it does not help us to understand how pain feels.

## **First Person Perspective (Third Person Perspective)**

Perhaps the most important duality in the philosophy of mind is that between the first-person and third-person views of mental events. Some might say that the

fundamental duality is that between mind and brain or between subjective and objective - but all of these reduce to the first-person/third-person duality. The first-person view of the mental encompasses phenomena which seem to resist any explanation from the third person. Such phenomena include some famous philosophical bugbears: subjective experience, qualia, consciousness, and even mental content. The distinguishing mark of the first-person view is the air of mystery which surrounds it. If it was not for the direct *experience* which all of us have of the first-person, it would seem a ridiculous concept. But it throws up too many problems to be neatly packaged away in the kind of third-person explanation which suffices for everything else in the scientific world.

The third-person view, by contrast, poses no deep metaphysical difficulties. The difficulties here, while not to be underestimated, are in a sense merely technical. From the third-person view, the human brain is (in principle at least) perfectly understandable. It is after all only a physical system - a tremendously complex one, without doubt, but a physical system nevertheless - which like all other such systems, is constituted at the bottom line by microscopic physical parts, obeying the laws of physics. Its behaviour would be totally analyzable and predictable if one had a detailed knowledge of physical principles. From the third person, there is no room for any mystery.

## **Folk Psychology**

The concept of folk psychology has played a significant role in philosophy of mind and cognitive science over the last half century. However, even a cursory examination of the literature reveals that there are at least three distinct senses in which the term “folk psychology” is used. (1) Sometimes “folk psychology” is used to refer to a particular set of cognitive capacities which include—but are not exhausted by—the capacities to predict and explain behavior. (2) The term “folk psychology” is also used to refer to a theory of behavior represented in the brain. According to many philosophers and cognitive scientists, the set of cognitive capacities identified above are underpinned by folk psychology in this second sense. (3) The final sense of “folk psychology” is closely associated with the work of David Lewis. On this view, folk psychology is a psychological theory constituted by the platitudes about the mind that ordinary people are inclined to endorse.

## **Free Will**

Free will is a philosophical term for a particular sort of capacity of rational agents to choose a course of action from among various alternatives. Which sort is the free will sort is what all the fuss is about. (And what a fuss it has been:

philosophers have debated this question for over two millennia, and just about every major philosopher has had something to say about it.) Most philosophers suppose that the concept of free will is very closely connected to the concept of moral responsibility. Acting with free will, on such views, is just to satisfy the metaphysical requirement on being responsible for one's action. But the significance of free will is not exhausted by its connection to moral responsibility. Free will also appears to be a condition on desert for one's accomplishments (why sustained effort and creative work are praiseworthy); on the autonomy and dignity of persons; and on the value we accord to love and friendship.

## **Functional Magnetic Resonance Imaging (fMRI)**

Functional magnetic resonance imaging, or fMRI, is a technique for measuring brain activity. It works by detecting the changes in blood oxygenation and flow that occur in response to neural activity – when a brain area is more active it consumes more oxygen and to meet this increased demand blood flow increases to the active area. fMRI can be used to produce activation maps showing which parts of the brain are involved in a particular mental process. The development of FMRI in the 1990s, generally credited to Seiji Ogawa and Ken Kwong, is the latest in long line of innovations, including positron emission tomography (PET) and near infrared spectroscopy (NIRS), which use blood flow and oxygen metabolism to infer brain activity. As a brain imaging technique FMRI has several significant advantages:

1. It is non-invasive and doesn't involve radiation, making it safe for the subject.
2. It has excellent spatial and good temporal resolution.
3. It is easy for the experimenter to use.

The attractions of FMRI have made it a popular tool for imaging normal brain function – especially for psychologists. Over the last decade it has provided new insight to the investigation of how memories are formed, language, pain, learning and emotion to name but a few areas of research. FMRI is also being applied in clinical and commercial settings.

## **Global Workspace**

Global Workspace Theory is a simple cognitive architecture that has been developed to account qualitatively for a large set of matched pairs of conscious and unconscious processes. It was proposed by Bernard Baars (1988, 1997, 2002). Brain interpretations and computational simulations of GWT are the focus of current research. GWT resembles the concept of Working Memory, and is proposed to correspond to a "momentarily active, subjectively experienced"

event in working memory (WM) - the "inner domain in which we can rehearse telephone numbers to ourselves or in which we carry on the narrative of our lives. It is usually thought to include inner speech and visual imagery." (in Baars, 1997).

## **Hard Problem**

The hard problem of consciousness is the problem of explaining how and why we have qualia or phenomenal experiences — how sensations acquire characteristics, such as colours and tastes. David Chalmers, who introduced the term "hard problem" of consciousness, contrasts this with the "easy problems" of explaining the ability to discriminate, integrate information, report mental states, focus attention, etc. Easy problems are easy because all that is required for their solution is to specify a mechanism that can perform the function. That is, their proposed solutions, regardless of how complex or poorly understood they may be, can be entirely consistent with the modern materialistic conception of natural phenomena. Chalmers claims that the problem of experience is distinct from this set, and he argues that the problem of experience will "persist even when the performance of all the relevant functions is explained". The existence of a "hard problem" is controversial and has been disputed by some philosophers. Providing an answer to this question could lie in understanding the roles that physical processes play in creating consciousness and the extent to which these processes create our subjective qualities of experience.

Several questions about consciousness must be resolved in order to acquire a full understanding of it. These questions include, but are not limited to, whether being conscious could be wholly described in physical terms, such as the aggregation of neural processes in the brain. If consciousness *cannot* be explained exclusively by physical events, it must transcend the capabilities of physical systems and require an explanation of nonphysical means. For philosophers who assert that consciousness is nonphysical in nature, there remains a question about what outside of physical theory is required to explain consciousness.

## **Holism**

Any doctrine that emphasizes the priority of a whole over its parts is holism. Some suggest that such a definition owes its origins to a non-holistic view of language and places it in the reductivist camp. Alternately, a 'holistic' definition of holism denies the necessity of a division between the function of separate parts and the workings of the 'whole'. It suggests that the key recognizable characteristic of a concept of holism is a sense of the fundamental truth of any

particular experience. This exists in contradistinction to what is perceived as the reductivist reliance on inductive method as the key to verification of its concept of how the parts function within the whole.

In the philosophy of language this becomes the claim, called semantic holism, that the meaning of an individual word or sentence can only be understood in terms of its relations to a larger body of language, even a whole theory or a whole language. In the philosophy of mind, a mental state may be identified only in terms of its relations with others. This is often referred to as "content holism" or "holism of the mental". This notion involves the philosophies of such figures as Frege, Wittgenstein, and Quine.

## **Idealism**

Any view that stresses the central role of the ideal or the spiritual in the interpretation of experience is called idealism. It may hold that the world or reality exists essentially as spirit or consciousness, that abstractions and laws are more fundamental in reality than sensory things, or, at least, that whatever exists is known in dimensions that are chiefly mental-through and as ideas.

Thus, the two basic forms of idealism are metaphysical idealism, which asserts the ideality of reality, and epistemological idealism, which holds that in the knowledge process the mind can grasp only the psychic or that its objects are conditioned by their perceptibility. In its metaphysics, idealism is thus directly opposed to materialism, the view that the basic substance of the world is matter and that it is known primarily through and as material forms and processes. In its epistemology, it is opposed to realism, which holds that in human knowledge objects are grasped and seen as they really are-in their existence outside and independently of the mind.

## **Identity Theory**

One view of modern Materialism that asserts that mind and matter, however capable of being logically distinguished, are in actuality but different expressions of a single reality that is material. Strong emphasis is placed upon the empirical verification of such statements as: "Thought is reducible to motion in the brain." The double-aspect theory is similar to this, with one notable exception: reality is not material; it is either mental or neutral. The latter case is illustrated by an undulating line that is both concave and convex at the same time; each aspect is an integral, but only a partial, expression of the total reality.

## **Informed Consent**

In clinical practice, the doctrine of informed consent rose to dominance during the course of the 20th century. It replaced a medical ethos founded on trust in physicians' decisions—often on the assumption that “doctor knows best”—with an ethos that sought to put patients in charge of their own care. In medical research on human subjects, informed consent requirements gained prominence in reaction to abuses. One influential response to the cruelty of Nazi experiments was the Nuremberg Code of research ethics, which stipulated, “The voluntary consent of the human subject is absolutely essential” (Faden and Beauchamp 1986, 156). But why should we require informed consent when it comes at a cost to the individual's health? What is the content, the scope, and the status of that requirement? How does informed consent in bioethics, the focus of the present entry, relate to consent in sexual ethics, business ethics, and political philosophy?

## **Intentionality**

Generally, intentionality can be described as the directedness towards content. Intentionality as a hallmark of the structure of consciousness is that it is directed towards a particular object. The term ‘I’ is followed by a verb that stands in connection to an object. ‘I perceive the colorful brushstrokes in this painting’. ‘Perceive’ is the verb that describes a certain activity of the subject in relation to a particular object, the ‘painting’. The experience of the person is thus directed towards the ‘brushstrokes in the painting’; this directedness is described as intentionality, the directedness of consciousness towards a specific content. By means of intentionality, the respective content – the intentional content – becomes semantic content and thus meaningful. Hence, alongside subjectivity, intentionality is considered a main phenomenal feature of consciousness.

## **Intersubjectivity**

The ability of the self to relate to other selves is described by the concept of intersubjectivity in philosophy. Contemporarily, intersubjectivity is a major topic in both the analytic and Continental traditions of philosophy. Intersubjectivity is considered crucial, not only at the relational level, but also the epistemological and even metaphysical levels. For example, intersubjectivity is postulated as playing a role in establishing the truth of propositions, and constituting the so called “objectivity of objects.”

In the past 50 years, in consciousness studies, a central concern is the so called problem of other minds, which asks how is it that we can justify our belief that

people have minds very much like our own, and predict others mind-states and behavior, as our experience shows we often can. Contemporary philosophical theories of intersubjectivity will need to address the problem of other minds. In phenomenology, intersubjectivity plays an important role, and Edmund Husserl has written extensively about it.

## **Localization**

How can we empirically characterize the brain as a whole? One central issue is how the brain and its different regions and networks are related to the various functions, sensory, motor, affective and cognitive, as well as the different mental states. Can a particular function or a specific mental state be related to the neural activity in one particular region or network within the brain? Or is the respective function or mental state a result of the interplay between the different regions and networks in the brain? This touches upon the problem of localization of function in the brain. Can we localize different mental functions in different regions and networks in the brain? The question of the localization of mental functions has been discussed in both psychology and neuroscience. Psychology focuses on the scientific investigation of the mind and its different mental functions. This was later extended to cognitive functions, and resulted in the birth of cognitive psychology. There it was, and still is, much discussed whether different sensory functions as well as cognitive functions like working memory, attention, executive functions, etc. are processed by different units or not. Such units of processing are described as modules.

## **(Logical) Behaviorism**

Methodological behaviorism focuses on the empirical domain – on what is observable in third-person perspective. Behaviorism that focuses on the metaphysical domain is known as ‘logical behaviorism’. Logical behaviorism claims that it is a logical error to assume inner mental states. Instead, inner mental states are nothing but behavioral dispositions. According to this account, Descartes and other dualists committed a logical error when they confused behavior with inner mental states. How can we explain mental states in logical behaviorism? Mental states are nothing but behavioral dispositions. For example, I believe that it might rain today and this incites me to buy an umbrella, to wear my coat, and to walk beneath the shelter of the supermarket’s roof. Buying an umbrella, taking the coat, and walking beneath the roof are behaviors that result from the association between input stimuli and outputs as the behavioral response. The input stimulus ‘rain’ is associated with ‘umbrella’ and that in turn triggers the indicated line of subsequent associations. Mental states like the belief that I may get wet are not really needed here; everything can be accounted

for the linkage between rain as input and umbrella as output. Mental states are thus to be discarded and can be replaced by behavioral dispositions. The British philosopher Gilbert Ryle (1900–76) compared the assumption of a mind and its mental features to a 'ghost in the machine' of the body: the body as mere machine mediates the input–output relations and thus the association between stimulus and response. For that no inner mental states are needed. The 'ghost' does not have any kind of proper function. Logical behaviorism is a radical thesis because it eliminates all inner mental states. This might seem implausible, given our common sense intuition that mental states like free will and consciousness exist and impact our behavior. In this light, behaviorism seems counterintuitive to our experience.

### **Magnetoencephalography (MEG)**

MEG is a functional neuroimaging technique for mapping brain activity by recording magnetic fields produced by electrical currents occurring naturally in the brain, using very sensitive magnetometers. Arrays of SQUIDs (superconducting quantum interference devices) are currently the most common magnetometer, and SERF being investigated for future machines. Applications of MEG include basic research into perceptual and cognitive brain processes, localizing regions affected by pathology before surgical removal, determining the function of various parts of the brain, and neurofeedback. This can be applied in a clinical setting to find locations of abnormalities as well as experimental setting to simply measure brain activity.

### **Neuroscientific Methods (Differences)**

Unlike EEG, the new techniques of PET and fMRI do not measure electrical activity. Instead they measure metabolic, biochemical and neurovascular activity in the brain. While the exact neurophysiological mechanisms underlying the signals measured especially with fMRI remain undiscovered (see Logothetis, 2008), these new imaging techniques, especially fMRI, found widespread application among researchers, especially those interested in higher-order cognitive functions. What is the difference between PET and fMRI? PET uses radioactive substances to visualize glucose metabolism, cerebral blood flow, or specific receptors (entrance doors) of different biochemical substances (like the dopamine receptor, the serotonin receptor, etc.). This allows researchers to measure metabolic, vascular and biochemical activity in the brain. fMRI measures changes in the coupling between neural and vascular activity; how they are coupled and how that affects the neuronal activity remains unclear at this point in time. In addition to fMRI, researchers can also measure the concentration of biochemical substances like GABA and glutamate in specific

regions of the brain using magnetoresonance spectroscopy (MRS). What is the difference between PET/fMRI and EEG/MEG? The main difference between EEG (and the more recently developed MEG, the magnetoencephalogram) and fMRI and PET consists in their temporal and spatial resolution. EEG and MEG allow for an excellent temporal resolution of neural activity in the range of milliseconds, but its spatial resolution (the assignment of neural activity to particular regions in the brain) is rather low. Spatial resolution, in contrast, is much higher – within the range of mm – in techniques like fMRI and PET, which have low temporal resolution (within the range of seconds). These techniques offered for the first time online visualization of metabolic, vascular, neural and biochemical activity changes during the performance of higher-order cognitive functions. Not only did these techniques introduce a new methodology, they also made it possible to study phenomena that were previously beyond the scope of experimental investigation. The neural effects of cognitive functions like attention, working memory, etc. could now be visualized. These imaging techniques allow researchers to observe online the changes in neural activity during particular tasks or stimuli. The introduction of new technological tools once more opened up novel ways to investigate neurons – this time with regard to the macroscopic (regional basis) of neural activity.

### **Materialism (Physicalism)**

In contrast to mental approaches, purely physical approaches to the mind and the world were rare before the twentieth century. While the concept of materialism – which accounts for the world in terms of matter – can be traced back to ancient Greece, a purely materialistic account of the mind was almost unheard of. The term physicalism, which describes everything in the world (including the mind) as purely physical was not introduced into philosophy until the twentieth century when the Austrian philosophers Otto Neurath and Rudolf Carnap made such a claim. Today the terms materialism and physicalism are often used interchangeably. Following this precedent, I will do the same. Both materialism and physicalism describe the existence and reality of the world and the mind as consisting of nothing but pure physical matter. There is no room for non-physical and mental features in both the mind and the world. The world and our mind are understood as mere physical and materialistic entities. There is nothing else. This model denies the possibility of any kind of nonphysical features, including those that were traditionally associated with religious belief and a mind – like God. A materialistic-physicalistic view of world and mind reflects the increasing dominance and relevance of the sciences in our understanding of the world and of us. This dominance began with the scientific revolution and has continued throughout the centuries until the present day. In the twentieth century, for example, physics as a discipline was revolutionized, as was psychology.

## **Mental Representation**

The notion of a “mental representation” is, arguably, in the first instance a theoretical construct of cognitive science. As such, it is a basic concept of the Computational Theory of Mind, according to which cognitive states and processes are constituted by the occurrence, transformation and storage (in the mind/brain) of information-bearing structures (representations) of one kind or another. However, on the assumption that a representation is an object with semantic properties (content, reference, truth-conditions, truth-value, etc.), a mental representation may be more broadly construed as a mental object with semantic properties. As such, mental representations (and the states and processes that involve them) need not be understood only in computational terms. On this broader construal, mental representation is a philosophical topic with roots in antiquity and a rich history and literature predating the recent “cognitive revolution,” and which continues to be of interest in pure philosophy. Though most contemporary philosophers of mind acknowledge the relevance and importance of cognitive science, they vary in their degree of engagement with its literature, methods and results; and there remain, for many, issues concerning the representational properties of the mind that can be addressed independently of the computational hypothesis. Though the term ‘Representational Theory of Mind’ is sometimes used almost interchangeably with ‘Computational Theory of Mind’, I will use it here to refer to any theory that postulates the existence of semantically evaluable mental objects, including philosophy's stock in trade mentalia — thoughts, concepts, percepts, ideas, impressions, notions, rules, schemas, images, phantasms, etc. — as well as the various sorts of “subpersonal” representations postulated by cognitive science. Representational theories may thus be contrasted with theories, such as those of Baker (1995), Collins (1987), Dennett (1987), Gibson (1966, 1979), Reid (1764/1997), Stich (1983) and Thau (2002), which deny the existence of such things.

## **Mind (Concept)**

According to Plato, the soul can be characterized by both bodily and mental aspects. Bodily aspects concern sensorimotor functions of the body, while its mental aspects refer to cognitive functions that Plato considered necessary for accessing the form as supernatural entity. However, Plato's student Aristotle (384–322 BC) disagreed with his teacher. While he learned much from Plato, Aristotle did not always agree with him. Aristotle did not believe in characterizing forms as supernatural entities. While Aristotle believed in form, he did not ‘locate’ it as supernatural, as outside of the physical, natural world. According to Aristotle, form is part of our natural world. How does Aristotle determine the form

as part of our natural world? Is the form as material as the body? There has been much debate about Aristotle's concept of form and whether it can be interpreted either mentally or physically (see for instance Nussbaum and Rorty, 1992). While we cannot discuss this debate here, what is clear is that the form cannot be identified with the material, physical, substrate of the body. This implies that the existence and reality of the form itself must be characterized metaphysically in a different way when compared to the body: since the body is material and physical, the form must be described as immaterial and nonphysical, (i.e. mental), in order for it to be properly distinguished from the material and physical body. How do Plato's and Aristotle's accounts relate to each other with regard to their mind-body theories? Plato suggested dualism between natural and supernatural parts of the soul. The natural part consists of the body, whereas the supernatural part must be 'located' outside the body. Plato's dualism resurfaces in Aristotle, though in a different way. There is no longer dualism between natural and supernatural, between body and universe. Instead, the dualism is shifted into the body itself that is considered dualistic and thus a composite by itself consisting of content/substrate and form/structure. The dualism is here no longer between the natural body and a supernatural non-body, but rather between form and content within the body itself. Taken together, we can already see two kinds of dualism in Ancient Greece. One kind describes the dualism between supernatural and natural entities which extends beyond the natural world including our bodies. In contrast, the other kind refers to the dualism of form and content within the body itself as a natural entity. We will see below that both positions resurface in some way or other in later philosophers' assumptions about the mind-brain problem. We will now move on to shed some light on the concept of the mind in medieval philosophy.

## **Mirror Neurons**

Mirror neurons are a type of brain cell that fires when you do an action, and also when you simply watch someone else doing the same action. For example, when you are grabbing a cup of coffee, Motor Neuron A (which also happens to be a Mirror Neuron) fires to tell your hand to reach out and grip the handle of the cup. When you watch your friend pick up his own cup of coffee, Motor Neuron A also fires as if you were also picking up his cup of coffee, even if your hand is not moving at all.

## **Mysterianism**

The view known as mysterianism holds that even though there is nothing supernatural about how consciousness arises from neural activity, the human brain is simply not equipped to understand it. The reason we find the mind-brain

problem so baffling, the argument goes, is that humans did not evolve sufficient cognitive abilities to solve it, just as armadillos did not evolve the ability to understand arithmetic. This argument has been advocated by philosophers such as Colin McGinn and cognitive scientists such as Steven Pinker.

## **Naturalism**

The term 'naturalism' has no very precise meaning in contemporary philosophy. Its current usage derives from debates in America in the first half of the last century. The self-proclaimed 'naturalists' from that period include: John Dewey, Ernest Nagel, Sidney Hook and Roy Wood Sellars. These philosophers aimed to ally philosophy more closely with science. They urged that reality is exhausted by nature, containing nothing 'supernatural', and that the scientific method should be used to investigate all areas of reality, including the 'human spirit' (Krikorian 1944, Kim 2003). So understood, 'naturalism' is not a particularly informative term as applied to contemporary philosophers. The great majority of contemporary philosophers would happily accept naturalism as just characterized—that is, they would both reject 'supernatural' entities, and allow that science is a possible route (if not necessarily the only one) to important truths about the 'human spirit'. In particular, on the question of whether philosophy can manage with scientific methods alone.

## **Neural correlates of consciousness (NCC) and Neural Predispositions of Consciousness (NPC)**

Consciousness is a multifaceted phenomenon that includes empirical, phenomenal, conceptual and epistemological (and metaphysical) dimensions. We therefore discussed the concept of consciousness in different ways. In the first chapter we presented arguments against the physical and ultimately neuroscientific explanation of consciousness. These included various arguments that pointed out phenomenal, epistemic, logical and explanatory features of consciousness that seem to resist any explanation in the brain's neuronal states. By developing these arguments, philosophy has put forward the required criteria that a neuroscientific explanation of consciousness should meet. After discussing the philosophical issues in Chapter 13, we turned to the current neuroscientific findings in Chapter 14. More specifically, we discussed the current neuroscientific hypotheses for the neural correlates of consciousness (NCC), the sufficient neural conditions for consciousness. This was followed by a discussion about how the various NCC hypotheses relate to the different arguments as discussed in Chapter 13 in this part. This led us to conclude that the current NCC do not really fulfill the required criteria and reveal major shortcomings. In Chapter 14, we discussed some alternative options presented by findings in current

neuroscience. Instead of focusing mainly on stimulus-induced activity, we shifted our focus to the brain's intrinsic activity – its resting state activity. Rather than deciphering the sufficient neural conditions of actual consciousness, the NCC, the intrinsic activity might provide the necessary conditions for possible consciousness, which we described as neural predispositions of consciousness (NPC). While we currently lack detailed knowledge about the structure and organization of the brain's intrinsic activity, the search for the NPC may nevertheless provide a good starting point. Why, because it promises to fulfill the criteria established by the various philosophical arguments in a more coherent way than the NCC.

## **Neuroethics**

Recent progress in neuroscience has led to various questions that touch upon ethical issues and to the emergence of a novel field, neuroethics. Neuroethics can broadly and preliminarily be defined by the drawing of relationships between neuroscientific observations and ethical concepts. Adina Roskies (2002) distinguished between the ethics of neuroscience and the neuroscience of ethics. The ethics of neuroscience deals with ethical problems in neuroscience. This includes issues like validity of informed consent in psychiatric patients, enhancement of cognitive functions by neuroscientific interventions and coincidental findings in neuroimaging. This may be subsumed under the concept of 'practical neuroethics'. Meanwhile, the 'neuroscience of ethics' investigates the psychological and neural mechanisms that may possibly underlie ethical concepts like informed consent, moral judgment, free will, etc. There is, however, no sharp distinction between the neuroscience of ethics and the ethics of neuroscience. Consider the example of informed consent. How valid is the informed consent of patients whose cognitive and emotional capacities are altered or deteriorated by the nature of their very disorder as in, for instance, dementia or schizophrenia? This is an issue in the domain of the ethics of neuroscience. At the same time, it requires empirical investigations of those cognitive and neural functions that are implicated in giving valid informed consent which, in turn, falls more into the domain of the neuroscience of ethics (Northoff *et al.*, 2010a, 2010b). Another example where the neuroscience of ethics and the ethics of neuroscience converge is in the recent discussion about moral judgment. What is moral judgment and how does it affect our ethical decisions in current neuroscience? This question falls into the ethics of neuroscience. At the same time, many imaging studies have been conducted to investigate the neural basis of moral judgment, and how they differ from non-moral but emotional judgments. This falls within the domain of the neuroscience of ethics. The topic of brain function enhancement is a highly discussed subject. Because of its rapid development, neuroscience develops novel tools and drugs to modulate brain activity and its various cognitive functions, not only in the diseased brain, but also in the healthy brain. Does this lead to changes in our self and personal identity?

And what are the ethical boundaries of such enhancement? We may, for instance, use pharmacological drugs to enhance our memory and attention skills and to improve our job performance. Finally, one may also raise a more methodological issue. How can we make the translation between ethical concepts, including their normative dimension, and the descriptive dimension of neuroscientific concepts and findings? We need predefined rules and valid methodological strategies for linking ethical concepts and neuroscientific findings. These conceptual and methodological issues may be subsumed under the umbrella of theoretical neuroethics as distinguished from a more empirical neuroethics.

## **Neural Causation**

Neuroscience demonstrates that neural activity in specific regions of the brain often accompanies specific mental states. In addition, as observed in neurological and psychiatric patients, lesions in specific regions of the brain lead to changes in mental states. This suggests that mental states might be dependent on the brain's neuronal states and that their assumed independence as based on their differences is incorrect. How are mental states dependent on the brain and its neuronal states? In other words, how does the brain and its neuronal states generate and cause mental states? This is called 'physical (or neuronal) causation'. However, we also have to consider the reverse position: how can mental states cause physical states? For example, we might experience a mental state like the wish to move, and then we do indeed perform the respective physical movement. This suggests that mental states can cause my physical states and thus my behavior. This is called 'mental causation' in current philosophy of mind.

## **Neurophenomenology**

M. Merleau-Ponty who considered the body and its brain-based sensorimotor function to be central for consciousness. In this model, consciousness was considered necessarily dependent on the body. This is called 'embodiment' More recent neuroscientists like Francisco Varela (1946–2001) and philosophers like Evan Thompson (1962–) consider embodiment central for the constitution of consciousness. Moreover, Varela and Thompson suggested the direct linkage of first-person accounts of experience (and its phenomenal features like subjectivity and intentionality) to third-person-based observation of neuronal states in the brain. This led them to coin the term 'neurophenomenology', which mainly describes a research strategy that links first- and third-person perspectives and thus the experience of contents in consciousness and observation of the brain's neuronal mechanisms. What is the difference between the

neurophenomenological approach and the reductive approach to neurophilosophy? Unlike in reductive neurophilosophy, neurophenomenology takes the phenomenal features of experience, like subjectivity, intentionality and the sense of self, seriously, and does not eliminate them by declaring them as illusory. Instead, the phenomenal features are taken as a starting point and thus as a template for the subsequent observational-experimental investigation of the brain. How does this stand in relation to reductive neurophilosophy? Reductive neurophilosophy ultimately eliminates the first-person perspective and its phenomenal features in favor of the third-person perspective and a purely neuronal account. This is different from neurophenomenology. Neurophenomenology aims to link both first and third-person perspectives as well as phenomenal and neuronal features. As such, neurophenomenology can be considered a first step toward the future development of a non-reductive neurophilosophy that includes phenomenal features in a nonreductive way. Moreover, neurophenomenology presupposes a brain-based rather than brain-reductive stance in that it includes the body in its account of the mind.

### **Neurophilosophy (non-reductive)**

Instead of focusing on neural correlates with their complete reduction of mental to neural features, one may rather search for the neural predispositions and how the brain is related to body and environment. This ultimately leads to what I describe as 'non-reductive neurophilosophy'. What is non-reductive neurophilosophy? Put in a nutshell, non-reductive neurophilosophy considers the brain as relevant to philosophy but, unlike its reductive sibling, does not completely and exclusively reduce philosophy in general and mental features in particular to the brain and its neural features. Instead of reducing mental to neural features, non-reductive neurophilosophy targets the relation of the brain's neural features to the vegetative features of the body and the social features of the environment. In addition to its distinction from reductive neurophilosophy, non-reductive neurophilosophy also needs to be distinguished from both philosophy and neuroscience. In contrast to philosophy, non-reductive neurophilosophy explicitly considers the relevance of the brain for philosophical questions including the mind-brain problem and issues that go beyond the question of the mind. Hence, rather than reducing the mind-brain problem and other philosophical issues to the mind, non-reductive neurophilosophy points out the relevance of the brain for these various issues without though reducing them to the brain either (as its reductive sibling). Non-reductive neurophilosophy thus pursues what I will later call a brain-based rather than brain-reductive approach. How about neuroscience? Neuroscience focuses on the brain and aims to reveal the various neural mechanisms that operate in the inside of the brain. This is different in non-reductive neurophilosophy. Here the focus is not so much on the inside of the brain itself but rather on how the brain's neural features relate and link the brain to the outside of the brain, the body and the environment. Hence,

non-reductive neurophilosophy puts the brain and its neural features into its respective bodily and social contexts and focuses on those linkages.

## **Panpsychism**

Panpsychism is the doctrine that mind is a fundamental feature of the world which exists throughout the universe. In this entry, we focus on panpsychism as it has been discussed and developed in Western philosophy. Unsurprisingly, each of the key terms, “mind”, “fundamental” and “throughout the universe” is subject to a variety of interpretations by panpsychists, leading to a range of possible philosophical positions. For example, an important distinction is that between conscious and unconscious mental states, and appeal to it allows a panpsychism which asserts the ubiquity of the mental while denying that consciousness is similarly widespread. Interpretations of “fundamental” range from the inexplicability of mentality in other, and non-mentalistic, terms to the idealist view that in some sense everything that exists is, and is only, a mental entity. And, although the omnipresence of the mental would seem to be the hallmark feature of panpsychism, there have been versions of the doctrine that make mind a relatively rare and exceptional feature of the universe. Against the backdrop of our immense scientific knowledge of the physical world, and the corresponding widespread desire to explain everything ultimately in physical terms, panpsychism has come to seem an implausible view. Nonetheless, the doctrine retains some attractive and interesting features. The recalcitrance of the mind, and especially consciousness, to fit smoothly into the scientific picture recommends our consideration of them.

## **Parallelism**

Also called psychophysical parallelism (meaning that mind and body are parallel) is a form of dualism which denies any interaction between mind and body. Parallelism is a difficult position to hold, since it does little to account for the fact that the brain and mind seem to regularly interact, and that changes in one appear to affect the other. If the two are separate substances in a dualist view, then the idea that there is no causality between them, yet obvious changes in both simultaneously, seems counter-intuitive. For this reason it is not a commonly held belief, but merely a presentation of the third possibility, the others being two-way interaction (as in interactionism) and one-way interaction, as in most forms of physicalism. Although Leibniz was a monist, believing that only one true substance exists, he presented a form of parallelism in his theory of mind. Leibniz states that although they are of the same substance, the distinction between mind and body is a useful one for the purposes of understanding and explanation. He held that they are not causally related, but that they follow the

same path which has been previously arranged by God. Leibniz's theory is known as pre-established harmony.

## **Phenomenology**

Your own experience is accessible only to you in first-person perspective – by yourself, but not by others and who can only have a third-person perspective of you. What does our experience in first-person perspective and its specific features tell us about consciousness in general? This is the central question that the German philosopher, Edmund Husserl (1859–1938), asked himself. Husserl's ultimate aim was to establish philosophy as strict science with a clearly defined methodology. He argued for the need to abstain from any beliefs, preemptions and speculations and instead was in favor of focusing on experience itself and thus on consciousness. He believed that this focus would reveal the things themselves – phenomena – as they are by themselves independent of our preconceptions (hence the name 'phenomenology' for this approach). By focusing on consciousness itself and what appears to us in it, Husserl shifted the focus of philosophy from metaphysical and epistemological questions to the study of consciousness and how things appear to us in our experience. As such he was interested in the study of phenomena, or the appearance of things in consciousness. For this he is remembered as the founder of the novel philosophical field at the beginning of the twentieth century called 'phenomenology'. The term phenomenology refers to the study of phenomena that describes the appearance of things in consciousness as they are by themselves, independent of our preconceptions and presuppositions about their existence and reality. In other words, phenomenology aims to focus on the phenomena themselves as they appear in our consciousness independent of their metaphysical characterization, i.e., their presupposed existence and reality.

## **Philosophy of Brain**

How does the distinction between domain and discipline apply to the brain? Usually, the brain is considered only in the empirical domain that methodologically has been associated with observation in third-person perspective. The empirical domain is the domain of science, including neuroscience. Philosophy, in contrast, is concerned more with the metaphysical domain, the domain of existence and reality, and the epistemological domain, the domain of knowledge. Most importantly, these domains have been associated traditionally with the rational-argumentative and more recently the conceptual-logical method of investigation. This may change once the brain is shifted into the context of philosophy. Shifting the brain into the context of philosophy will enable us to consider the brain in both the metaphysical and epistemological domains,

as well as in the empirical domain. We can then determine the concept of the brain, metaphysically and epistemologically. In short, one may want to develop what can be called a 'philosophy of brain' as distinguished from both philosophy of mind and neuroscience of mind. The concept of philosophy of brain describes investigation of the brain and how it can be defined and conceptualized in different domains, metaphysical, epistemological and empirical, as well as how we can (and cannot) relate the different definitions in the different domains to each other (see Chapters 7, 8, 11 and 12 for details). Philosophy of brain has to be compared with and distinguished from philosophy of mind. Unlike philosophy of mind, philosophy of brain focuses on the brain rather than the mind. Similar to philosophy of mind, philosophy of brain discusses different kinds of concepts and definitions (though with regard to the brain) in traditionally philosophical domains like metaphysical and epistemological and extends them to the empirical domain. Accordingly, philosophy of brain and philosophy of mind share, in part, the domains, while they differ in their subject matter, brain versus mind. How does philosophy of brain stand in relation to neuroscience of mind (i.e. affective, cognitive and social neuroscience; see Chapter 3) in particular and neuroscience in general? Unlike neuroscience of mind in particular and neuroscience in general, philosophy of brain is not restricted to the empirical domain but includes metaphysical and epistemological domains. Similar to neuroscience, philosophy focuses on the brain as its main content or subject matter of investigation. However, unlike neuroscience, philosophy of brain applies a multitude of different methods to the investigation of the concept of the brain by for instance combining observational-experimental and conceptual-logical strategies (see Chapters 2 and 4).

## **Philosophy of Mind**

Philosophy of mind is the branch of philosophy that focuses on the nature and features of the mind. The nature of the mind concerns the existence and reality of the mind. Is the mind as real and existent as Descartes assumed? Or is the mind an illusion or category mistake as suggested by Ryle? The mind and its various mental features, for example, consciousness, free will, etc., are the central focus of this branch of philosophy. What is the mind? And how does the mind stand in relationship to the body? How are the existence and reality of the mind and the body related to each other? This question reflects what is described as the mind–body problem. Since the brain seems to be particularly closely related to the mind and its mental features, the mind–body problem has often been condensed as the mind–brain problem. The mind–brain problem is a metaphysical problem that raises the question: how are the existence and reality of the mind and its mental features related to those of the brain and its various neuronal states? Different solutions ranging from metaphysical dualism (as in Descartes) to metaphysical monism have been suggested. Different options include: (i) the mind is traced back to the body leading to what is called physicalism (which in

turn can describe different relationships leading from identity through reduction to elimination of the mind with the body; see Chapter 6 for details), (ii) the body is reduced to the mind resulting in idealism, or (iii) both mind and body are traced back to a third entity as described in neutral monism. The different solutions of the mind–brain problem will be discussed in detail in Part II. What is the mind–brain problem about? It is about the existence and reality of the mind and the brain and how they are related to each other. Since questions of existence and reality are dealt with in metaphysics, the mind–brain problem can be situated in the metaphysical domain. How does philosophy of mind investigate the mind? This question is one of methodological strategy. Developed in the Anglo-American tradition with its emphasis on language during the twentieth century, philosophy of mind initially strongly relied on the analysis of concepts and sentences (i.e. linguistic analysis). More recently, this methodology has been complemented by considering empirical findings about the brain from neuroscience, and thus joins conceptual, linguistic and empirical methods. What this looks like and how it works will be discussed in further detail (see Chapters 2 and 4 in this Part). In sum, philosophy of mind focuses on the existence and reality of the mind and its mental features thus presupposing the metaphysical domain. The mind–brain problem as a metaphysical problem is consequently at the very core of philosophy of mind. Methodologically, philosophy of mind strongly relies on conceptual and linguistic analysis which more recently has been complemented by empirical findings from neuroscience (see especially Parts IV and V on consciousness and self).

## **Philosophy of Neuroscience**

How are different levels of explanation – ranging from the genetic, the cellular and the psychological level – related to each other? This question is central to neuroscience. As we recall from Part I, neuroscience originated in different disciplines, ranging from anatomy and physiology to clinical neurology and psychiatry. These different disciplines brought with them different methods that targeted different levels of explanation. The heterogeneity of different methods and levels in neuroscience is even further amplified and extended by recent developments in the field. Neuroscience, as discussed in Part I, has extended its investigatory reach into the territory of the social sciences and humanities, like anthropology, philosophy, theology, religion, politics, law, ethics, economy, etc. Many new disciplines are now characterized by the prefix ‘neuro’. This change brings along with it new levels of explanation. Some examples include: the cultural level as in neuroanthropology, the moral level as in neuroethics, the political-social levels as in social sciences and politics, the economical level as in neuroeconomics, the legal level as neurolaw, etc. How are all these different levels of explanation related to each other? The success of neuroscience, and its extension and outreach to other disciplines beyond itself, makes it even more important for us to understand the relations between these various levels of

explanation. For example, how are the genetic or regional levels of the brain's neural activity related to the social and economic levels of explanation? This is not only a question about different levels of explanation, but one about different disciplines like neuroscience, social science and economy. This issue will be discussed in the first part of this chapter. The question of the explanatory relationship between neuroscience and other disciplines does not concern the practice of neuroscience by itself; it is not about designing and conducting specific experiments that measure the various kinds of neuronal and psychological variables. Instead the debate surrounding the explanatory relationship between neuroscience and other disciplines is more a theoretical and methodological issue that is generally subsumed under the umbrella term 'philosophy of neuroscience'. The concept philosophy of neuroscience describes the discussion of theoretical, methodological and foundational issues in neuroscience. In this sense, the philosophy of neuroscience must be distinguished from neurophilosophy. Neurophilosophy is often considered as the application and relevance of neuroscientific data and studies to the investigation of originally philosophical questions (see Chapter 4 in Part I for different definitions). For instance, the question of consciousness has long been a topic dealt with in philosophy, but today it is also tackled in neuroscience. In neuroscience, it is manifest in the search for the neural correlates of consciousness (see Part IV for details). Both this chapter and the next focus not so much on neurophilosophy, but rather on methodological and theoretical issues in neuroscience and thus on the philosophy of neuroscience.

### **Positron emission tomography (PET)**

PET is a nuclear medicine, functional imaging technique that produces a three-dimensional image of functional processes in the body. The system detects pairs of gamma rays emitted indirectly by a positron-emitting radionuclide (tracer), which is introduced into the body on a biologically active molecule. Three-dimensional images of tracer concentration within the body are then constructed by computer analysis. In modern PET-CT scanners, three dimensional imaging is often accomplished with the aid of a CT X-ray scan performed on the patient during the same session, in the same machine. If the biologically active molecule chosen for PET is fludeoxyglucose (FDG), an analogue of glucose, the concentrations of tracer imaged will indicate tissue metabolic activity by virtue of the regional glucose uptake. Use of this tracer to explore the possibility of cancer metastasis (i.e., spreading to other sites) is the most common type of PET scan in standard medical care (90% of current scans). However, on a minority basis, many other radioactive tracers are used in PET to image the tissue concentration of many other types of molecules of interest.

## **Qualia**

Feelings and experiences vary widely. For example, I run my fingers over sandpaper, smell a skunk, feel a sharp pain in my finger, seem to see bright purple, become extremely angry. In each of these cases, I am the subject of a mental state with a very distinctive subjective character. There is something it is *like* for me to undergo each state, some phenomenology that it has. Philosophers often use the term 'qualia' (singular 'quale') to refer to the introspectively accessible, phenomenal aspects of our mental lives. In this broad sense of the term, it is difficult to deny that there are qualia. Disagreement typically centers on which mental states have qualia, whether qualia are intrinsic qualities of their bearers, and how qualia relate to the physical world both inside and outside the head. The status of qualia is hotly debated in philosophy largely because it is central to a proper understanding of the nature of consciousness. Qualia are at the very heart of the mind-body problem. The entry that follows is divided into ten sections. The first distinguishes various uses of the term 'qualia'. The second addresses the question of which mental states have qualia. The third section brings out some of the main arguments for the view that qualia are irreducible and non-physical. The remaining sections focus on functionalism and qualia, the explanatory gap, qualia and introspection, representational theories of qualia, qualia as intrinsic, nonrepresentational properties, relational theories of qualia and finally the issue of qualia and simple minds.

## **Theory of Mind**

How can we explain the cognition of other people's mental states? This is an empirical question that touches upon psychology where it is discussed under the heading of 'theory of mind'. The concept of theory of mind describes the ability to attribute mental states to other people and to explain and predict their behavior in terms of their intentions, beliefs and desires. Even though the other person's mental states are not directly observable, nor experienced by us, we nevertheless attribute them to the other person in order to explain and predict their behavior. How is an explanation and prediction of others' mental states possible, and what are the underlying mechanisms? There are two main competing theories in current psychology, theory-theory (TT) and simulation-theory (ST).

## **Zombies (Chalmers)**

David Chalmers introduced the concept of zombies into the debate about mind and brain. He argues that we can very well imagine a world without consciousness where the physical features remain the same as it is the case in

zombies. Let us describe the zombies in further detail. Zombies show exactly the same physical design and features as us. However, unlike humans, they do not show consciousness and thus have no mental states. If consciousness and mental states were purely physical, zombies should be impossible to even imagine. Since we can very well imagine and thus conceive of zombies as a logical possibility, consciousness and mental states cannot be physical. The fact that we can conceive zombies, who possess the absence of mental states in the presence of the same physical states, thus provides evidence in favor of dualism. What does the example of zombies imply for the relationship between mind and brain? Chalmers rejects any form of substance or property dualism where mental features are outside the natural world. This is called non-naturalistic dualism. He instead argues that there may be two kinds of features or properties within the natural world entailing a form of property dualism within the natural world itself. First, there are physical features as described by physics. And second, there are informational features that are accounted for by information theory. Both physical and informational features lie within the realm of the natural world and are thus subject to scientific examination. One can thus speak of naturalistic property dualism. The central point in Chalmers' property dualism is the assumption of informational features. How can we characterize informational features in further detail? And what is their relationship to consciousness? Chalmers argues that informational features account for consciousness in humans (and other animals) while they are not linked to physical features. This is supported by his example of the possibility of zombies who show similar physical features but lack the informational features. Consciousness remains consequently absent in zombies. These informational features complement the physical features. The dualism between the mental and the physical thus resurfaces here as property dualism between physical and informational features. By replacing mental features with informational features as the underlying existence and reality of consciousness, Chalmers shifts dualism into the natural world. One can thus speak of naturalistic property dualism as distinguished from the above described non-naturalistic forms of both substance and property dualism that only apply to the logical but not the natural world.