Mind in Science

Silvia Gáliková

Edition Cognitive Studies

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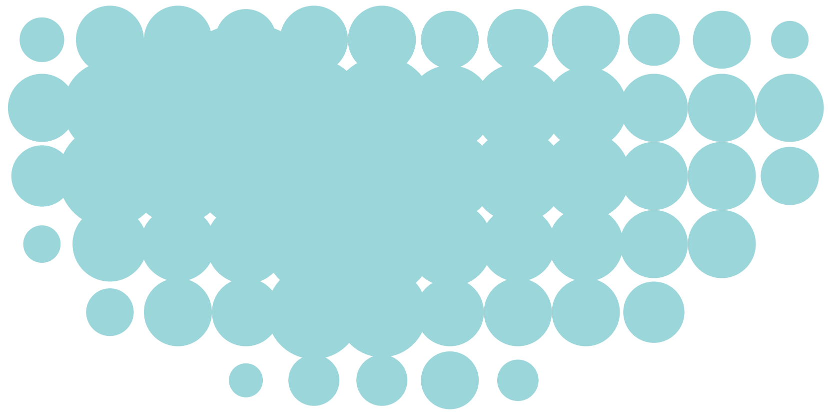

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Introduction

Philosophers, scientists and laymen as well seem to agree that the nature of mind has been problem for millenia. What kind of problem do we have in mind? Well, it is our own mind, indeed. In everyday life there seem to be no serious problem when speaking about inner experience, desires or feelings. We know that they do not exist *literally* „inside our heads“ as mental entities analogous to physical entities or events. Nevertheless, it is evident that thoughts, feelings, hopes are as real as rainbows, suffering or a smile on a childs‘ face. Status of mental states in theory and philosophy in particular, is not so straightforward. Scholars disagree on the explanandum (subject of inquiry), the nature of a theoretical starting point, so they propose often contradictory hypotheses on the „same“ phenomenon in question. States of mind have been attributed to states, creatures, Martians, dolphins, computers, trees, systems etc. Consequently, the complementarity of used methods is highly questionable as well as the expectations of a proposed theory of mind. Prevailing conflict between everyday life, experience, language and theoretical study of the nature of mind deepened and acquired a *schizmatic* character. In the text that follows I intend to point out two conflicting aspects of the theoretical chaos in contemporary mind studies. Firstly, it is a philosophers‘ permanent ignoration of the natural character of states of mind which secondly, ends in confused ideas about the relationship between philosophical and scientific study of mind. As demonstrated in experimental research and medical practise, man‘s mental life is open to experimental research, to a variety of clinical, empirical and theoretical methods. Naturalness of mental states goes hand in hand with reductive strategies and scientific explanation. Empirical research weighs heavily in determining the outcome — the nature of the phenomenon in question. And than it is not surprising that questions arise, such as: What is the proper approach or methodology to pursue in constructing a "science of the mind"? Should a science of conscious intelligence actively seek continuity with the network of established natural sciences (physics, chemistry, biology, and so on)? Or should it claim a discontinuous autonomy on grounds of some unique feature? In the following chapters I intend to demonstrate how empirical research bears on the philosophical issues and vice versa. From the first chapter I emphasize the intertwined character of studying problems of mind and the nature of physical states and processes. Revealing the nature of subjective experience is traditionally acquainted with the old philosophical mind–body problem. In chapter VI, I am concerned with the question What are we talking about when talking about inner mental states and processes? Is it just a conceptual or terminological or/and a broader empirical and practical problem (chapter V, VII)? Finally, I do *hope that* inspite of the introductory nature of the text it will inspire students and everyone willing to know and understand more about their own mind and of course the minds of others.

Bratislava, May 2012 S.G.

I. History of mind study

Key words: *psyché, trepanning, mental illness, asylum, natural*

Who is the subect of mental states? Do minds „live" after the death of the body? Where is the seat of soul? What is the relation between reason and emotions? Can machines (computers) think? Why are people „gifted" with conscious experience? Do we have free will? What is the sense of human life? These questions permanently follow origin and evolution of men. They also express a number of implicit and explicit problems concerned with the study and explanation of human thoughts, percpetions, feelings, longings etc. Health, disease, individual experience, treatment and mind go together. Study of mind disorders played always a significant role in explaining experience and behaviour of people. Attempts to treat mental illness date back as early as 5000 BCE as evidenced by the discovery of trephined skulls in regions that were home to ancient world cultures. Early man widely believed that mental illness was the result of supernatural phenomena such as spiritual or demonic possession, sorcery, the evil eye, or an angry deity and so responded with equally mystical, and sometimes brutal, treatments. Trephining (also referred to as trepanning) first occurred in Neolithic times. During this procedure, a hole, or trephine, was chipped into the skull using crude stone instruments. It was believed that through this opening the evil spirit(s), thought to be inhabiting one's head and causing their psychopathology, would be released and the individual would be cured. Some who underwent this procedure survived and may have lived for many years afterward as trephined skulls of primitive humans show signs of healing. Pressure on the brain may have also incidentally been relieved. This procedure endured through the centuries to treat various ailments such as skull fractures and migraines as well as mental illness, albeit with more sophisticated tools such as skull saws and drills developed solely for this purpose.

In ancient Mesopotamia, priest–doctors treated the mentally ill with magico–religious rituals as mental pathology was believed to mask demonic possession. Exorcisms, incantations, prayer, atonement, and other various mystical rituals were used to drive out the evil spirit. Other means attempted to appeal to the spirit with more human devices — threats, bribery, punishment, and sometimes submission, were hoped to be an effective cure. Hebrews believed that all illness was inflicted upon humans by God as punishment for committing sin, and even demons that were thought to cause some illnesses were attributed to God's wrath. Yet, God was also seen as the ultimate healer and, generally, Hebrew physicians were priests who had special ways of appealing to the higher power in order to cure sickness. Along the same spiritual lines, ancient Persians attributed illness to demons and believed that good health could be achieved through proper precautions to prevent and protect one from diseases. These included adequate hygiene and purity of the mind and body achieved through good deeds and thoughts. Ancient Egyptians seem to be the most forward–thinking in their treatment of mental illness as they recommended that those afflicted with mental pathology engage in recreational activities such as concerts, dances, and painting in order to relieve symptoms and achieve some sense of normalcy. The Egyptians were also very advanced in terms of medicine, surgery, and knowledge of the human body. Two papyri dating back to the sixteenth century BCE, the Edwin Smith papyrus and the Ebers papyrus, document early treatment of wounds, surgical operations, and identifies, very likely for the first time, the brain as the site of

mental functions. These papyri also show that, despite innovative thinking about disease, magic and incantations were used to treat illnesses that were of unknown origin, often thought to be caused by supernatural forces such as demons or disgruntled divine beings. Ancient Egyptians also shared the early Greek belief that hysteria in women, now known as Conversion Disorder, was caused by a "wandering uterus," and so used fumigation of the vagina to lure the organ back into proper position. In all of these ancient civilizations, mental illness was attributed to some supernatural force, generally a displeased deity. Most illness, particularly mental illness, was thought to be afflicted upon an individual or group of peoples as punishment for their trespasses. In addition to the widespread use of exorcism and prayer, music was used a therapy to affect emotion, and the singing of charms and spells was performed in Babylonia, Assyria, the Mediterranean–Near East, and Egypt in hopes of achieving a cure. Beliefs about mental illness and proper treatments were altered, and in some cases advanced, by early European thinkers. Between the 5th and 3rd centuries BCE, Greek physician Hippocrates denied the long–held belief that mental illness was caused by supernatural forces and instead proposed that it stemmed from natural occurrences in the human body, particularly pathology in the brain. Hippocrates, and later the Roman physician Galen, introduced the concept of the four essential fluids of the human body—blood, phlegm, bile, and black bile—the combinations of which produced the unique personalities of individuals. Through the Middles Ages, mental illness was believed to result from an imbalance of these humors. In order to bring the body back into equilibrium, patients were given emetics, laxatives, and were bled using leeches or cupping. Specific purges included a concoction developed by Ptolemy called Hiera Logadii, which combined aloes, black hellebore, and colocynth and was believed to cleanse one of melancholy. Confectio Hamech was another laxative developed by the Arabs that contained myrobalans, rhubarb, and senna. Later, tobacco imported from America was popularly used to induce vomiting. Other treatments to affect the humors consisted of extracting blood from the forehead or tapping the cephalic, saphenous, and/or hemorroidal veins to draw corrupted humors away from the brain. In addition to purging and bloodletting (also known as phlebotomy), customized diets were recommended. For example, "raving madmen" were told to follow diets that were "cooling and diluting," consisting of salad greens, barley water, and milk, and avoid wine and red meat. Custody and care of the mentally ill were generally left to the individual's family, although some outside intervention occurred.

The first mental hospital was established in 792 CE Baghdad and was soon followed by others in Aleppo and Damascus—mass establishment of asylums and institutionalization took place much later, though. The mentally ill in the custody of family were widely abused and restrained, particularly in Christian Europe. Due to the shame and stigma attached to mental illness, many hid their mentally ill family members in cellars, caged them in pigpens, or put them under the control of servants. Others were abandoned by their families and left to a life of begging and vagrancy. The social stigma attached to mental illness was, and to some extent still is, pronounced in countries that have strong ties to family honor and a reliance on marriages to create alliances and relieve families of burdensome daughters. In China, the mentally ill were concealed by their families for fear that the community would believe that the affliction was the result of immoral behavior by the individual and/or their relatives. The mentally ill were also thought to have "bad fate" that would negatively influence anyone who associated with the disturbed individual, scaring away potential suitors and leading to the idea that mental illness was contagious. Historically in Greece, "a mentally ill (family) member implies a hereditary, disabling condition in the bloodline and threatens (the family's) identity as an honorable unit," therefore treatment of the mentally ill in these cultures meant a life of hidden confinement or abandonment by one's family. Mentally ill vagrants were left alone to wander the

streets so long as they did not cause any social disorder. Those who were deemed dangerous or unmanageable, both in family homes or on the streets, were given over to police and thrown in jails or dungeons, sometimes for life. Particularly in Europe during the Middle Ages, beatings were administered to the mentally ill who acted out as punishment for the disturbances their behavior caused and as a means of "teaching" individuals out of their illnesses. Others who were considered nuisances were flogged out of town. Through the Middle Ages and until the mass establishment of asylums, treatments for mental illness were offered by humanistic physicians, medical astrologers, apothecaries, and folk or traditional healers. Aside from secular exorcisms, prayers, charms, amulets, and other mystical treatments were available.

In the 17th century, astral talismans were popular and were easily made using brass or tin emblems with astrological signs etched into them and cast at astrologically significant times. These were worn around the neck of the afflicted while they recited prayers. Also worn around the neck were scraps of Latin liturgy wrapped in paper, bundled with a leaf of mugwort or St. John's Wort and tied with taffeta. Amulets were also used, supplemented by prayers and charms, to soothe troubled minds, prevent mystical infection, and protect against witches and evil spirits. Sedatives during the 17th century consisted of opium grains, unguents, and laudanum to "ease the torment" of mental illness. Replacement of the picture of evil spirits and demons by psychopathology (study of the origin, development, and manifestations of mental or behavioral disorders) took centuries. Many believed, even as late as the sixteenth and seventeenth centuries that the bizarre behavior associated with mental illness could only be an act of the devil himself. To remedy this, many individuals suffering from mental illness were tortured in an attempt to drive out the demon. Most people know of the witch trials where many women were brutally murdered due to a false belief of possession. When the torturous methods failed to return the person to sanity, they were typically deemed eternally possessed and were executed. By the eighteenth century we began to look at mental illness differently. It was during this time period that „madness“ began to be seen as an illness beyond the control of the person rather than the act of a demon. Because of this, thousands of people confined to dungeons of daily torture were released to asylums where medical forms of treatment began to be investigated. Despite the expansion of scientific research, Copernican revolution in the understanding of the universe, progress in anatomy and physiology Renaissance is characterized by a number of conflicting trends. Dramatic examples of Renaissance demonology were ominous “witch–hunts” which were initiated in 1484 in a papal bull of Pope Innocent VIII. and instructed the Inquisition to exterminate witchcraft as heresy followed by three hundred years of ruthless persecution of people who as a result of torture confessed to anything. The term “witch” was backed and mentally ill as well as non–conformist and schismatics. If the doctor was unable to find the cause of the disease or if the patient medication did not help, it was considered that the disease is caused by the devil.

In the Middle Ages also a form of hysteria in which sick spoke in confusion, insulted God or suffered from hallucinations was labelled obsession. “Treatment” consisted of either expelling the demon or killing him by hanging (England) or burning (Germany). A Dutch doctor Weyer, one of the few in the 16th century, spoke publicly against the persecution of witches. He claimed that many prisoners are ill as a “flying ointment”, which was allegedly used by witches, contains drugs. Absorbing substances in the body provoked hallucinations and visions. Even to the widely criticized “dualist” René Descartes (1596–1650) medicine was the key to understanding the world of nature. Linking philosophy and medicine resonates well in emphasizing the importance of love which is deemed useful for health. The regularity of the pulse, gentle heat that we feel in the heart, better functioning of digestion, it all combines love, as opposed to hate, with goodness and joy. Descartes‘ attempt to explain the origin of life and functioning of the human

body without any intervention of (Aristotelian) respiration function of souls paved the way to modern science and thinking. In the following centuries explanation of the respiratory mechanisms, circulatory, neural activity and the nature of disease research played a key role. Since the second half of the 18th century exploration of mind marked the debate and controversy about the localization of mental states to specific areas of the brain. The initiator of the era of cortical localization was a German anatomist F. Gall (1757–1828) known as the representative of phrenology, the idea of the division of the cortex into specific functional areas (love, friendship, memories, languages etc.). In the second half of the 19th century in Germany thanks to W. Wundt (1832–1920) first experimental laboratory was established and constituted a separate science of the soul — psychology. Along with Helmholtz, Wheatstone he establishes psychology as an experimental science whose primary method of examining psychological states was *introspection*. Wundt influenced by German idealism characterized psychology as opposed to natural science as exploring “the content of experience in its immediate certainty”. The problem of introspection as an objective method of emerging discipline led to the transformation of science of “the soul” for science of “behaviour”.

The founder of behaviourism J. B. Watson (1878–1958) defined the object of psychological research as examining objective, i.e. externally observable phenomena. In the early 20th century in opposition to the atomistic behaviourism in psychology a movement Gestalt (of German configuration, shape) arose. Representatives of the Gestalt movement (W. Kohler, K. Koffka, M. Wertheimer) stressed the importance of quality as a whole standing over individual elements and parts. The most significant breakthrough in exploring the nature of the human mind was undoubtedly brought in by *Darwin’s evolution theory*. At present, the theory of evolution has become one of the basic theories explaining the origin, evolution and function of various states of the human mind. Darwin and his followers laid the foundations for examining the human psyche as a natural phenomenon subjected to experimental and theoretical research. Since 20 century a number of revolutionary „turns“ appeared in the study of mind. The *lingusitic* turn, *cognitive science* turn and what can be called a *brain research* turn all contributed immensely to a better understanding of human mind. Supposedly mysterious inner subjective life of people has become a relevant scientific explanandum. Strict (ontological) dichotomies between philosophy and science, mind and body (brain) conscious and unconscious states, reason and emotions were abandoned. Furthermore, limitations of introspective approach and a new model of man as a rational free agent has emerged. New methods, findings, strategies and theories on the functioning of specific mental states will be the subject matter of the following chapter.

Suggested readings

Fialová, L, Kouba, P., Špaček, M. (ed.): *Medicína v kontextu západního myšlení.* Praha: Galén, 2008.

Gáliková, S.: *Psyché — od animálnych duchov k neurotransmiterom.* Bratislava, Veda, 2007.

Porter, S.: *Madness: A Short History.* Oxford: Oxford University Press, 2002.

II. Neural coding and modelling

Key words: *vector, spike, artificial neuronal networks, reccurent network, coding*

Nervous system faciliates the communication and feedback of organism with the environment. Inseparable part of this „dialogue“ is a mutual communication between neurons. Consider a network composed of simple, connected neuron–like units. The bottom units may be thought of as sensory units, as they are stimulated by the environment outside the system. Each of these bottom units emits an output through its own “axon”, an output whose strength is a function of the unit's level of stimulation. The axon divides into a number of terminal branches, and a copy of that output signal is conveyed to each and every unit at the second level. These are called the hidden units, and the bottom units make a variety of “synaptic connections” with each of them. Each connection has a certain strength or weight, as it is commonly called. You can see already that the bottom half of the system is just another vector–to–vector transformer, much like the neural matrices discussed in the previous section. If we stimulate the bottom units, the set of activity levels we induce (the input vector) will be conveyed upward toward the hidden units. On the way, it gets transformed by various influences: by the output function of the bottom cells, by whatever pattern of weights resides in the many synapses, and by the summing activity within each of the hidden units. The result is a set or pattern of stimulation levels across the hidden units — another vector. That stimulation vector in the hidden units serves in turn as the input vector to the top half of the system. The axons from the hidden units make synaptic connections, of various weights, with the units at the topmost level. These are the output units, and the overall set of stimulation levels finally induced in them is what constitutes the output vector. The upper half of the network is thus just another vector–to– vector transformer. Following this general pattern of interconnectivity, it is possible to construct a network with any desired number of input units, hidden units, and output units, depending on the size of the vectors that need processing. And we can begin to see the point of having a two–tiered arrangement if we consider what such a network can do when confronted with a real problem. The crucial point to remember is that we can modify the synaptic weights in the overall system, so as to implement whatever vector–to–vector transformation we want.

Churchland gives a following sample problem. We are the command crew of a submarine, whose mission will take it into the shallow waters of an enemy harbor, a harbor whose bottom is sprinkled with explosive mines. We need to avoid these mines, and we can at least detect them with our sonar system, which sends out a pulse of sound and then listens for the returning echo in case the pulse bounces off some solid object lying on the bottom. Unfortunately, a sizeable rock also returns a sonar echo, an echo that is indistinguishable to the casual ear from a genuine mine echo. This is frustrating, because the target harbor is also well sprinkled with largish rocks. The situation is further complicated by the fact that mines come in various shapes and lie in various orientations relative to the arriving sonar pulse. And so do rocks. So the echoes returning from each type of object also display considerable variation within each class. On the face of it, the situation looks hopelessly confused. How might we prepare ourselves to distinguish the explosive mine echoes from the benign rock echoes, so that we may undertake our mission in confidence? As follows. We first assemble, on recording tape, a large set of sonar echoes from what

we know to be genuine mines of various types and in various positions. These are mines that we have deliberately laid out, for test purposes, on the bottom of our own coastal waters. We do the same for rocks of various kinds, and of course we keep careful track of which echoes are which. We end up with, say, fifty samples of each. Than it shows how much sound energy the given echo contains at each of the various sound frequencies that make it up. It is a way of quantifying the overall character of any given echo. Let us bring a neural network into the picture. This network is organized on the same lines as the simple network, with 13 input units, 7 hidden units, 2 output units, and a total of 105 synaptic connections. The activity levels of each unit vary between zero and one. It is also important to take into account that the synaptic weights of the system can be adjusted to whatever values are needed. But that is just we do not know yet. So at the beginning of the experiment, the connections are given randomly distributed weights. We take a mine echo from our store of samples, and we use the frequency analyzer to sample its energy levels at 13 different frequencies. This gives us the input vector, which has 13 elements. We then enter this vector into the network by stimulating each of the 13 input units by an appropriate amount. This vector is propagated swiftly forward through the two–stage network, and it produces a two–element output vector in the output units. What we would like the network to produce is the vector (1,0), which is our conventional output vector coding for a mine. But given the random weights, that correct output would be a miracle. Scientists have to calculate, by simple subtraction, the difference between the vector we got and the vector we wanted. And they use a special mathematical rule, called the generalized delta rule, to calculate small changes for the weights of the system. The idea is to modify those weights that were most responsible for the network's erroneous output. The weights are then adjusted accordingly. The system is then given another sample echo—perhaps of a rock this time—and hope for an output vector of (0,1), which is our conventional output vector coding for a rock. Again the amount of the error and reapply has to be calculated. And so forth. After repeating this procedure for thousands, perhaps tens of thousands, of times — a conventional computer, whose memory contains recorded samples, to serve as the teacher and do all the work is going to be programmed. This is called training up the network. The result is that the set of weights gradually relaxes into a final configuration where the system gives a (1,0) output vector when and only when the input vector is of a mine; and it gives a (0,1) output vector (or close to it) when and only when the input vector is of a rock. The first remarkable fact in all of this is that there is a configuration of synaptic weights that allows the system to distinguish fairly reliably between mine echoes and rock echoes. Such a configuration exists because it turns out that there is after all a rough internal pattern or abstract organization that is characteristic of mine echoes as opposed to rock echoes. And the trained network has managed to lock onto that rough pattern. If, after training up the network, one examine's the activity vectors of the hidden units for each of the two kinds of stimulation, one find's that such vectors form two entirely disjoint classes. Any "rock–like" vector falls into a large but quite distinct subvolume of that abstract space. What the hidden units are doing in a trained network is successfully to code some fairly abstract structural features of mine echoes, features they all have, or all approximate, despite their superficial diversity. And it does the same for rock echoes. It does all this by finding a set of weights that produces disjoint classes of coding vectors for each. Given success of this sort at the level of the hidden units, what the right–hand half of the trained network does is just transform any hidden–unit mine–like vector into something close to a (1,0) vector at the output level, and any hidden–unit rock–like vector into something close to a (0,1) vector at the output level. In short, the network learns to distinguish between the two subvolumes of the hidden–unit vector space. Vectors close to the center of either volume — these are the "prototypical" examples of each type of vector — produce a clear

verdict at the output level. The network's "guess" at a rock is thus not very confident. But it may be fairly reliable even so.

A by–product of this procedure is the following. If the network is now presented with entirely new samples of rock echoes and mine echoes—samples it has never heard before—its output vectors will categorize them correctly straight off, and with an accuracy that is only negligibly lower than the accuracy now shown on the 100 samples on which it was originally trained. The new samples, novel though they are, also produce vectors at the level of the hidden units that fall into one of the two distinguishable subspaces. In short, the "knowledge" that the system has acquired generalizes reliably to new cases. Our system is finally ready to probe the enemy harbor. Let's say we feed it the threatening sonar returns, and its output vectors will tell us whether or not we are approaching a mine. What is interesting here is not the proposed military application of the device described. Existing naval technologies can already pick out a beer can on a sandy bottom, and even guess at the brand name, by using quite different principles of analysis. What is interesting, rather is that such a simple system can perform the sophisticated recognitional task described above. That a suitably adjusted network will do this job at all is the first marvel. The second marvel is that there exists a rule that will successfully shape the network into the necessary configuration of weights, even if it starts out in a random configuration. That rule makes the system learn from the 100 samples we provide it, plus the errors it produces. This process is called automated learning by the back–propagation of error, and it is relentlessly efficient. For it will often find order and structure, all by itself, where initially we see only chaos and confusion. This learning process is an instance of gradient descent, because the configuration of weights can be seen as sliding down a variable slope of ever–decreasing errors until it enters the narrow region of a lowest valley, at which the error messages get closer and closer to zero. With such small errors, the efficiency of further learning naturally goes down, but at that point the system has already reached a high level of reliability. Training up the network on the many sample echoes may take a couple of hours, but once the system is trained, it will yield up a verdict on any sample in an instant. Being a parallel system, the network transforms the many elements of the input vector all at the same time. Here at last we have the "perceptual" recognition of complex features on a time scale equal to, or better than, that of living creatures. The elements of cognition, as sketched in the preceding text, have a character unfamiliar to common sense. Perhaps we should expect that, as our theoretical understanding here increases, our very conception of the phenomena we are trying to explain will undergo significant revision as well. This is a common pattern throughout the history of science, and there is no reason why (cognitive) science should prove any exception. Principles of computer simulation have been recently tested by outstanding project — *Blue brain* — directed by H. Markram (2006). The main objective of the project is to model and simulate biological neurons (mainly cortical collumns) and other brain structures on a paralel supercomputer.

Suggested Readings

Churchland, P. M.: *Matter and Consciousness.* Cambridge: MIT Press, 1999.
Churchland, P. M.: *The Engine of Reason, the Seat of the Soul: A Philosophical Journey into the Brain*. Cambridge: MIT Press, 1995.
Kvasnička, V., Pospíchal, J., Farkaš, I.: Úvod do teórie neurónových sietí. Bratislava: Iris, 1997.
Markram H.: The Blue Brain Project. Nature Reviews Neuroscience, 2006, 7(2), 153–60.

III. Modular mind

Key words: *modul, innateness, poverty of stimulus argument, universal grammar, language acquisition device*

Since the beginning of the research on the nature of mind in cognitive science, the relationship between structure and functions of states of mind were an open question. It has been expressed in questions, such as: How does the system acquire informations? How does it distribute and save them? How do people (systems) remember? What are the basic mechanisms of problem solving? The idea of a modular nature of states of mind has become popular among philosophers and psychologists mainly since publishing the work *The Modularity of Mind* (1983) written by one of the most recognized cognitive scientist — Jerry Fodor. Fodor studied the relationship between language and mind and his view that language is a modular process has important implications for a theory of language acquisition. The term modular is used to indicate that the brain is seen, unlike older views such as behaviouristic view of learning and language learning, to be organized with many modules of cells for a particular ability (for instance, the visual module). These modules, according to Fodor (1983, 47), operate in isolation from other modules that they are not directly connected. The language module, if we are to follow Fodor's ideas, is one of such modules. This modular separateness has been termed as "*informational encapsulation*" by Fodor. To put it simply, each module is open to specific type of data. In other words, modules are *domain specific*.

This is another way of saying that conscious knowledge cannot penetrate your visual module or language module or any other subconscious module. Besides the two mentioned properties in Fodor's conpcetion more properties of modules play an imporatant role, such as: mandatory operation, limited central accessibility, fast processing, „shallow" outputs, fixed neural architecture, characteristic and specific breakdown patterns and characteristic ontogenetic pace and sequencing (Rybárová, 2001). Fodor's arguments are somewhat similar to that of Noam Chomsky also popular for the criticism of Skinnerian behaviourism and furthermore for the *universal grammar* hypothesis. Both views proposing a modular approach to language acquisition were totally different from the views of Piaget and Vygotsky who have laid the primary emphasis on the role of social or environmental factors in language development. Chomsky proposed a distinction between *I–Language* and *E–Language,* I–language refers to *internal language* which is contrasted with E–language — *external language*. I–Language is taken to be the object of study in linguistic theory, it is the mentally represented linguistic knowledge that a native speaker of a language has. E–Language encompasses all other notions of what a language is, for example that it is a body of knowledge or behavioural habits shared by a community. Chomsky considers E–Language as not a coherent concept and therefore he rejetcs its use in the study of innate linguistic knowledge. Chomsky is perhaps the best known and the most influential linguist of the second half of the Twentieth Century. He has made a number of strong claims about language: in particular, he suggests that language is an innate faculty — that is to say that we are born with a set of rules about language in our heads which he refers to as the *Universal Grammar*. The universal grammar is the basis upon which all human languages build. If a Martian linguist were to visit Earth, he would deduce from the evidence that there was only one language, with a number of local variants. Chomsky gives a number of reasons why this should be so. Among the most important of these reasons is the ease with

which children acquire their mother tongue. He claims that it would be little short of a miracle if children learnt their language in the same way that they learn mathematics or how to ride a bicycle. This, he says, is because children are exposed to very little correctly formed language. When people speak, they constantly interrupt themselves, change their minds, make slips of the tongue and so on. Yet children manage to learn their language all the same. Children do not simply copy the language that they hear around them. They deduce rules from it, which they can then use to produce sentences that they have never heard before. They do not learn a repertoire of phrases and sayings, as the behaviourists believe, but a grammar that generates an infinity of new sentences. Children are born, then, with the Universal Grammar wired into their brains. This grammar offers a certain limited number of possibilities — for example, over the word order of a typical sentence. When the child begins to listen to his parents, he will unconsciously recognise which kind of a language he is dealing with — and he will set his grammar to the correct one — this is known as "*setting the parameters*". It is as if the child were offered at birth a certain number of hypotheses, which he or she then matches with what is happening around him. He knows intuitively that there are some words that behave like verbs, and others like nouns, and that there is a limited set of possibilities as to their ordering within the phrase. This is not information that he is taught directly by the adults that surround him, but information that is given. It is as if the traveller were provided at the beginning of his journey with a compass and an astrolabe. This set of language learning tools, provided at birth, is referred to by Chomsky as the *Language Acquisition Device*. How did you learn to speak your native language? We often ask questions such as, do you remember when did you learned to tie your shoes, ride a bike, and eat with a fork. Sometimes we can remember because a parent helped us learn how to do these things. Now, since we always speak the language of our parents, they must have helped us learn to speak our first language. But do you remember when your mother taught you the past tense? When your father laid down the rules for passive sentences? We don't remember these important moments of our childhood because they never occurred. Our parents didn't teach us how to walk and they didn't teach us how to talk. Yet we learned from them. How can this be? Certainly there must have been a subtle, perhaps intuitive teaching process that neither our parents nor we were aware of. We begin by imitating what we hear our parents say as best we can, repeating random phrases. Our parents in subtle ways punish us for the childish speech errors we make (by not responding, correcting the error, etc.) and reward correct phrases. In fact, parents themselves make grammatical errors when they speak. Despite the fact that children don't know when their parents are speaking grammatically and when they are making errors, all children grow up knowing (if not always speaking) the language perfectly. So how do we learn to speak? Although *hitted* is not a word children hear adults utter, it is wrong for an interesting reason: the verb, in a sense, has the "right" ending on it for the past tense. In other words, the only way a child learning language could make such an error is that he or she is learning a rule that derives past tense verbs from verb stems. What the child has not mastered at this stage is the exceptions to the rule. By the time a child begins putting, for example, two words together, he or she has already mastered the basic rules of syntax and applies them correctly even in their erroneous speech. It takes the child a little longer to master the rules of morphology. The evidence then indicates that children do, in fact, absorb a massive number of sentences and phrases but rather than parrot them back, they abstract rules from them and create their own grammar which they then apply to create new utterances they have never heard before. Over the years from 2–7, when language is mastered, children constantly adjust their grammar until it matches that of the adult speaker population. This critical period between the ages of 2–7 suggests that (first) language learning, like walking, is an innate capacity of human beings triggered by a level

of development more than feedback from the environment. That is, so long as a child hears a language, any language, when they reach this critical period they will learn it perfectly. If this is true, any child not hearing language during this period not only should not learn to speak but also should not be able to learn to speak. But there is the case of pidgin "language". Pidgin can become a language — Creole. How does this happen? It's origin was connected with creolisation in Hawaii which took approximately one generation. The community of young children in Hawaii took the pidgin used by their parents — workers from China, Japan, Korea, Portugal, the Philippines and Puerto Rico — and created a language of their own. From the point of language acquisition children deprived of linguistic input, invented a rudimentary grammar not attributable only to the external factors. When children began to use a pidgin, they automatically enriched the vocabulary and the syntax — it became a full language almost as systematic and sophisticated as any natural human language. Moreover, the language contained rules not attributable to the languages forming the pidgin, out of which the creole was driven. As far as universal grammar is concerned, it has surely generated valuable predictions about the course of interlanguage and the influence of the first language. Also, it has provided invaluable information regarding second language teaching as to how second language teachers (or educational linguists) should present vocabulary items and how they should view grammar. Finally, even if the modularity theory of mind has been widely criticized it still has a number followers and is considered as a relevant concept and approach in a variety of domains.

Suggested readings

Carruthers, P.. The Architecture of the Mind. Oxford: Oxford University Press, 2006.
Fodor, J. A.: *The Modularity of Mind*. Cambridge: MIT Press, 1983.
Chomsky, N.: *Modular approaches to the study of the*
mind. San Diego: San Diego State University Press, 1984.
Rybárová, D.: Teória „ladenness" a modulárna teória mysle. In: Filosofický časopis, 2001, roč. 49, č.3, 373–379.

IV. Mind in experimental research

Key words: *out–of body experience, virtual self, disembodiment, self–image, rubber–hand illusion*

In this chapter I would like to introduce specific experiments connected with the questions of being aware of one's body and self. The problem of the nature of self is not only one of the oldest problems but also one that has been very difficult to treat and explain. To be *someone* and to experience oneself requires to „own" one's body, its parts and functions. From this it should be clear that self–image needs a body and scholars more often then previously use the concept of *embodiment* in order to emphasize this fact. Recently, neuroscientists managed to shed light on the subtle nature of self with the help of experiments based on disembodiment — the state of experiencing the absence of own body or/and its parts.

German neuroscient Thomas Metzinger (2010) has proposed a thought provoking hypotheses on the „myth of the self". In his book *The Ego Tunnel* he appeals to the now–classic experiment known as the „*the rubber–hand illusion*". Participants of this experiment observed a rubber hand lying on the desk in front of them. At the same time their own corresponding hand has been concealed from their view by a screen. The visible rubber hand and the unseen hand were synchronously stroked with a probe. After a certain time (cca 60 seconds) the rubber–hand illusion emerges. Participants experienced the rubber hand as their own and they felt the repeated strokes in the rubber hand. They also felt a „virtual arm" — the connection from their sholder to the fake hand on the table in front of them. There have been more experiments which have simulated an experience of not only a part of the body but the body as a whole. This is the case of *out–of–body experience*. As the term suggests the phenomenon in question, often usually associated with near–death experiences, accounts for an experience during which people may suddenly have a sense of being outside their bodies, looking at themselves. What is overhelming and perhaps even suprising is that in contemporary neuroscience scientists are able to simulate his phenomenon using a rather simple technique. The experiment of creating an *out–of–body experience* was conducted by Dr. Olaf Blanke, a neuroscientist at the École Polytechnique Fédérale in Switzerland. During the experiment the test participant would wear *Virtual Reality* goggles while standing in an empty room. A camera located behind the participant projected an image — which appeared as if it were six feet in front of the participant — within the goggles. Dr. Blanke (2012) would then poke the participant's back for one minute with a stick, this action also being visible within the goggles. By varying the delay of the images shown in the goggles, Dr. Blanke was able to detect certain differences in the experience. When the poking was synchronous, tested people reportedly had a sense of being momentarily within the illusory body. When the pokes were not synchronous, this illusion did not occur. The experimental induction of out–of–body experiences outlines the unique method by which the illusion was created and also brings interesting implications for further study. An *out–of–body experience* occurs when a person who is awake sees their own body from a location outside the physical body. These experiences have been reported in clinical conditions where brain function is compromised, such as stroke, epilepsy and drug abuse. They have also been reported in association with traumatic experiences such as car accidents. Around one in ten people claim to have had an *out–of–body experience* at some time in their lives. In other experimental setting, the illusion worked by using head–mounted displays to enable participants to watch a live film recorded by two video cameras located behind their head. The image from the left video camera is presented on the left–eye display and the image from the right camera on the right–eye display. The participant sees these as one 'stereoscopic' (3D) image, so they see their own back displayed from the perspective of someone sitting behind them. The researcher then stood just beside the participant (in their view) and used two plastic rods to simultaneously touch the participant's actual chest out–of–view and the chest of the illusory body, moving this second rod towards where the illusory chest would be located, just below the camera's view. The participants confirmed that they had experienced sitting behind their physical body and looking at it from that location. As experimenters found out — "this was a bizarre, fascinating experience for the participants — it felt absolutely real for them and was not scary". To test the illusion further and provide objective evidence, an additional experiment has been performed. It was based on measurement of the participants' physiological response — specifically the level of perspiration on the skin — in a scenario where they felt the illusory body was threatened. Their bodily response strongly indicated that they thought the threat was real. Out–of–body experiences that have fascinated mankind for millennia have raised fundamental questions about the relationship between human consciousness and the body, and has been much discussed in theology, philosophy and psychology. Although *out–of–body experiences* have been reported in a number of clinical conditions, the neuroscientific basis of this phenomenon remains unclear. According to neuroscients, the invention of this illusion is important because it reveals the basic mechanism that produces the feeling of being inside the physical body. This represents a significant advance because the experience of one's own body as the centre of awareness is a fundamental aspect of self–consciousness. Discovering this means of inducing an *out–of–body* could also have industrial and other more sensitive applications. The experience of playing video

games could reach a whole new level, but it could go much beyond that. For example, a surgeon could perform remote surgery, by controlling their virtual self from a different location. The above mentioned illusion is fundamentally different from anything studyied and published previously. It is the first to involve a change in the perceived location of the self, relative to the physical body. It is also different from any virtual reality set–up because it examines what happens when you look at yourself, and there is also multisensory information that triggers the illusion. There has been no way of inducing an out–of–body experience in healthy people before, apart from unsubstantiated reports in occult literature. It is considered as a very exciting development, and has implications for a range of disciplines from neuroscience to theology.

The study of normal and impaired consciousness brought also an immense novelty in the study of human mind and consciousness. Experiments indicated that the experience of *conscious volitional activity* can occur: a) before the act, b) right after the act, c) during the act. I appeal to the experimental research of D. M. Wegner (2002) on mutual relations between thinking, experiencing, timing and feeling responsibility of performed action. Person may feel conscious will in action he has not anticipated (confabulation of intentions) or he does not feel responsibility for performed action („allien–hand syndrom"). Besides that, when actions are caused unconsciously people tend to explain their behaviour in terms of mysterious forces (automatisms) or just „make up" stories (cognitive dissonance). Experimental findings demonstrate also as fundamental the *timing* problem in the supposed mental causality chain (Gray, 2004). Several experiments bring evidence for the delay of conscious states in a variety of modalities (motor action, language, thought). Automatic neuronal activity (ongoing objective time) preceeds reports of subjects (subjective time) about the *experienced will* to perform a motor activity (Libet, Wegner). In the following text I argue towards a profound asymetry between experienced introspective access to one's „inner world" and a theoretically adequate explanation of the nature of experience itself. In theory, similarly as in everyday experience, the concept of consioussness has been used in a variety of meanings. I refer to the concept of consciousness in the sense of *subjectively experienced* (inner) life. In spite of much controveries over the concept of consciousness philosophers seem to agree that experienced inner states are inseparable from the explanation of consciousness. However, we can define several concepts that refer to consciousness as the experienced subjective life, for example: a) phenomenal consciousness, subjective experience as such, necessarily involving „qualia" or the qualitative character of experience; b) states and contents of consciousness which refer to the background state that allows specific contents of experience to appear in our minds; c) structure of phenomenal consciousness with clearest experiences in the center of consciousness; d) reflective consciousness, where we formulate conscious thoughts about other experiences and thoughts; e) self–awareness, through which we „communicate" experiences to ourselves and others; f) unconscious information which could become conscious; g) zombies, a metaphor for complex, intelligent behavioral systems that operate in total absence of consciousness (Revonsuo, 2010, 96). Heterogenity of „definitions" of consciousness makes it hard to identify usages of the concept which are less confused and useful for the scientific understanding of consciousness. Unsuprisingly, differences in definitions of consciousness lead to contrary perspectives in investigating the nature and function of conscious states. It can be said that the widespread ambiguity of usage of consciouseness is also due to the complexity of the phenomenon itself. For Metzinger the so called „subtle body", independent of of the real physical body is a by product of the brain or in other words, it is a product of brain's own self–model. Interpretations *out–of–body experiences, near–death experiences, automatisms* etc. have been traditionally affected by men's inclination for the unknown, mysterious and supranatural. Due to a kind of fear or ignorance „explanations" of similar phenomena

have been associated with the *paranormal* — that which transcends possibility and aims of science. As recent experimental and theoretical study suggests, however, scientific research and explanation is being no less fascinating. On the cotrary, I think it finally brings into light the capacity of human's mind to know and to understand itself.

Suggested readings

Blanke, O.: Multisensory brain mechanisms of bodily self consciousness. *Nature Reviews Neuroscience*: 2012, 13, 556–571.
Damasio, A.: *The Feeling of What Happens*. London, William Heinemann, 1999.
Metzinger, T.: *The Ego Tunnel*. New York: Basic Books, 2010.
Wegner, D.: *The Illusion of Conscious Will*. Cambridge: MIT Press, 2002.

V. Porcelain souls

Key words: *blindsight*, *mindblindness*, *agnosia*, *autism*, *phantom limbs*

Explaining healthy and disturbed minds constitutes a intertwined complex system. In order to study and understand the nature of our minds — a significant role and importance has been played by the analysis of various mental disorders and diseases. In the text of this chapter I will mention specific syndroms which have shed light on our mental states and behaviour. First syndrom is known under the name of *blindsight* — a specific kind of disordered seeing with normal eyes. Some patients with damage to the primary visual cortex claim to be completely blind in the affected part of the visual field yet their behaviour is influenced by what appears there. This paradoxical finding — given the name *blindsight* by Larry Weiskrantz — was first noticed by E. Poppel and his colleagues at the Massachusetts Institute of Technology, who asked brain–damaged patients to move their eyes in the direction of a spot of light that was flashed briefly in the blind part of their visual fields. Although the patients were sure that they saw nothing they tended to move their eyes in the right direction. The following year a similar, though much more striking, result was reported by Larry Weiskrantz, Elizabeth Warrington and their colleagues in London. They studied a 34–year–old man, DB, who had lost most of his right primary visual cortex in an operation to remove a tumour, and, as a result, was blind in the left visual field except for a crescent of

vision in the left upper quadrant. They started by using the procedure of Poppel and his colleagues, but the results were only just significant. They then asked DB to point to where he guessed the flash occurred, and found him surprisingly accurate. In later experiments, when asked to guess between alternatives, he could distinguish between a vertical and a horizontal line (97 per cent accuracy for an exposure of 100 milliseconds), and between a circle and a cross (90 per cent accuracy). He could tell whether a circular patch of parallel lines was oriented with the lines horizontal or not, provided the deviation from horizontal was at least 10°. It was even possible to measure his visual acuity by seeing whether he could detect the presence of bars in a grating. This extraordinary performance was not accompanied by any visual sensation. If by chance the stimulus extended beyond the blind area, DB immediately reported it, but otherwise he denied having any visual experience. In some parts of the blind field he claimed to have 110 sensation of any kind; in other parts he said there was no sensation of vision but there were sensations of, for example, "smoothness" or "jaggedness" in the discrimination of a circle and a cross. Experiments with other patients with blindsight have shown similar results; some are even able to distinguish between light of different wavelengths, though without any sensation of colour. Attempts have been made to explain these findings, and others subsequently reported by other investigators, as the result of the scattering of light onto the seeing portion of the retina. Scattering of light certainly occurs but is unlikely to be the explanation because the position of a stimulus falling on the blind spot in the blind half–field could not be "guessed" by DB, though he could guess the position of the same stimulus in other parts of the blind field. It is significant, too, that he could guess the position of black stimuli on a white ground and could distinguish between a uniform field and a coarse grating of the same average brightness; both abilities are difficult to explain on the basis of scattered light. Blindsight seems very strange because it is impossible to imagine getting visual information and at the same time being unable to see. But whatever seems contraintuitive to our common–sense, we have to accept that discriminating information acquired through vision yet not being conscious of the visual features providing the information is a real phenomenon. Another example of disordered seeing with normal eyes has been described by Louis Verrey, an ophthalmologist from Neuchatel. He described an unfortunate sixty–year–old woman, Mme R., who, while busy in her garden two years earlier, had suffered a violent attack of giddiness, headache and vomiting. Ever since, her sight had been affected in a remarkable way: in the right half of her visual field she had lost all sense of colour — everything appeared in shades of grey; in the left half, colours were entirely normal. Nearly two days after the original attack, Mme R. had a severe stroke and died within a few years. Examination of her brain showed long–standing damage in the lowest part of the left occipital lobe. Complete loss of sight in one half of the visual field following damage to the occipital lobe on the opposite side is, as we have seen, not uncommon. What was odd about Mme R. was not the restriction of the visual loss to one half of the field of view, but the restriction to just one aspect of vision — colour. Similar clinical observations had been made before, in Germany and in England, but the significant thing about Verry's work was that, for the first time, it linked the loss of colour sense to damage in a particular small area of the occipital lobe. If localized brain damage could cause loss of the sense of colour alone, could damage in different locations cause selective losses of other aspects of vision — the ability to recognize shape or individual objects or movement or to see things as three–dimensional? Ten years before Verry's paper, physiologist Hermann Munk had reported some strange observations to the Physiological Society of Berlin. A dog who had had parts of both occipital lobes removed, and had then had several days to recover from the operation, seemed to be entirely normal except for a peculiar disturbance of vision. The dog could certainly see — he roamed freely indoors and in the garden, avoiding obstacles, crawling under a stool, stepping over people's feet or the bodies of other animals — yet he no longer seemed to recognize people or dogs with whom he had been friendly, he no longer responded to a threatening gesture and, most remarkably, even when he was thirsty he ignored his water bucket, and when he was hungry he paid no attention to his food bowl unless the food could be smelt. Munk called the condition mind–blindness (Seelenblindheit in German), and supposed that it resulted from a loss of visual memory. Following Munk's experiments, what looked like a similar mind–blindness was noted in several patients, one of whom, described by Hermann Wilbrand, showed a feature that necessitated a slight change in Munk's hypothesis. Wilbrand's patient, a highly intelligent, sixty–four–year–old German woman, showed convincing mind–blindness — though she could see the butcher's cart coming down the street and the objects in her own display cabinet, they seemed unfamiliar and she could not recognize them. But she had not lost her visual memory. She could not recognize a pencil by sight, but when one was put into her hands while her eyes were shut she had no difficulty in visualizing it; the smell of paraffin evoked the visual image of her lamp. It seemed that her visual memory was intact and that her failure to recognize objects was the result of a failure to make associations between current perceptions and the memories of past perceptions. It has been suggested that *mind–blindness* could be of two kinds. It could, as in Wilbrandt's patient, be the result of a failure to relate current perceptions to past experience — this Lissauer called associative mind–blindness–but it could also, he said, be the result of a failure to form adequate current perceptions. To regard recognition as a two–stage process is certainly an oversimplification, but Lissauer's subdivision proved useful clinically and is still used by neuropsychologists who work with patients. As a further example of associative mind–blindness, Lissauer described an eighty–year–old salesman who, following a few days' illness, was incapable of finding his way outside his own room, and had great difficulty in choosing the right clothes when dressing or the right cutlery when eating. On one occasion he put the wrong end of the spoon into his soup; on another he put his hand into a cup of coffee. He was found to have lost the right half of the visual field in both eyes, but vision in the left half of the field was adequate, and loss of the right half could not account for his disabilities. He was unable to identify the most common objects by sight, confusing an umbrella with a leafy plant, a coloured apple with a portrait of a lady, an onion with a candle, and a clothes brush with a cat. But he was not generally confused and he identified objects promptly and correctly as soon as he could touch and feel them. He could match strands of wool of different colours accurately, but often named the colour incorrectly. Because he could copy simple drawings of objects, and could draw the actual objects, though laboriously and clumsily, Lissauer concluded that his disability was not in forming visual perceptions but in associating them with previous experience. In 1891 S. Freud introduced the term agnosia (from the Greek for "*without knowledge*") to indicate an inability to recognize objects normally, despite normal working of the sense organs and the nerves to the brain. Agnosia applies not only to vision — people sometimes speak of auditory or olfactory agnosia, or a kind of agnosia in which the patient has normal senses of touch and pressure but cannot determine the shape of objects by feeling them — but it is used mostly in connection with disturbances of the visual system, and it has completely replaced the term mind–blindness. In the century since Freud introduced the term, a vast literature on visual agnosia has developed, but all I want to do here is to talk about a small number of cases, chosen because in each of them the patient has a particular kind of disability — often more than one — and such disabilities throw light on the way visual information must be handled in the visual parts of our brains. The various kinds of visual agnosia differ in the class of perceptions that cause problems, and also in whether the agnosia is the result of a failure to form adequate perceptions or a failure to recognize what is perceived. In 1988, DF, a thirty–four–year–old

Scotswoman, holding a private pilot's licence and working in northern Italy as a freelance commercial translator, collapsed and lost consciousness from carbon monoxide poisoning while taking a shower at her home. She was admitted to hospital in deep coma, and when she recovered consciousness was found to be blind. After about ten days her vision gradually returned, though she had a number of residual problems, and six months after the accident she still had a very poor perception of the shape or orientation of objects in front of her. The peculiar nature of her disability became clear from a series of tests done by Melvyn Goodale, David Milner and their colleagues, about fifteen months after the accident. To test her ability to detect orientation, she was seated in front of a large slot in an upright disc, given a card to hold, and asked to turn it so that its orientation matched that of the slot. She did this very badly, even failing to distinguish between vertical and horizontal. On the other hand, when she was asked to "post" the card through the slot, she did this as well as normal subjects. What is more, analysis of a video recording showed that, like the normal subjects, she began to orient the card correctly even as it was being raised from the starting position. Posting a card through a slot is a more natural activity than orienting a card to match the orientation of a slot, and you might wonder whether DF simply failed to understand what she was being asked to do in the tests in which she performed so badly. This explanation is made unlikely by a further test in which she was asked to shut her eyes and to orient the card to match the orientation of an imaginary slot at O°, 450 or 90° from the vertical. This she did as accurately as normal subjects. Since, in the orientation experiment with the real slot, she had failed, in a task she performed easily with the imaginary slot, it seems that information about orientation obtained by looking at the real slot was not available to her for purposes that involved conscious thought — though her ability to "post" the card through the real slot showed that it was available to her for the direct visual control of movement. The term *mind–blindness* has been reintroduced to refer to the apparent inability of autistic children to appreciate that other people have minds (Baron–Cohen, 1995). *Autism* is a highly variable neurodevelopmental disorder that first appears during infancy or childhood, and generally follows a steady course without remission. It is distinguished not by a single symptom, but by a characteristic triad of symptoms: impairments in social interaction, communication and restricted interests and repetitive behavior. One of the widespread example — a case study on autism — is that of Temple Grandin (2010) which has been diagnosed autism at the age of three and her disability meant that she developed her skill of visual thinking more than regular people do. Recently, Grandin is a designer of livestock handling facilities and a Professor of Animal Science at Colorado State University. She has designed facilities (curved chute and race systems) for cattle that are used worldwide. She has also developed an objective scoring system for assessing handling of cattle and pigs at meat plants. This scoring system is being used by many large corporations to improve animal welfare. She wrote many articles and books about her own inner experience and the ways people with autism perceive and feel the outside world. *Phantom limb syndrome* is another curious syndrom in which individuals perceive various kinds of sensations, including pain, in a limb that has been amputated. Patients with this condition experience the limb as if it were still attached to their body as the brain continues to receive messages from nerves that originally carried impulses from the missing limb. One of the first cases of this syndrom involved a fifteen year old girl who lost a leg to cancer. Starting the day after surgery she was asked to keep a log for 28 days detailing any experiences that she had with phantom limb sensations. She experienced a number of phantom limb episodes. The experience included the following sequence. On the first day after surgery she felt sensations akin to itching and tingling that occurred in the area where her toes had been. There was the feeling that her toes were asleep. The phantom sensations were not constant in duration, but rather occurred

rather sporadically throughout the day for periods of10 to 15 minutes each time. She also felt pain in the amputated part of her leg. The pain was not as severe as some other cases of phantom pain after amputation, and was reduced with the administration of codeine. On the second day she reported that it felt like her entire foot was asleep. The sensations lasted about as long as the ones on the previous day and were relieved when she massaged her other non–amputated foot! This would be an example of cortical remapping. The phantom sensations continued to migrate throughout the „leg“ until the tenth day, when it felt as if the entire amputated part was asleep, tingling, and „itchy“. The sensations only lasted about 10–15 minutes, sporadically throughout the day. After the tenth day the sensations started to disappear and by day 26 the phantom sensations lasted only a couple of seconds and there was no itchy sensation. Highly recognized neuroscientist Vilayanur S. Ramachandran (1998) invented a phantom limb painbox — a box with two mirrors in the, in which patients feel they still have a limb after having it amputated. In a mirror box the patient places the good limb into one side, and the stump into the other. The patient then looks into the mirror on the side with good limb and makes „mirror symmetric“ movements, as a symphony conductor might, or as we do when we clap our hands. Because the subject is seeing the reflected image of the good hand moving, it appears as if the phantom limb is also moving. Through the use of this artificial visual feedback it becomes possible for the patient to „move“ the phantom limb, and to unclench it from potentially painful positions. It is more than evident, that the analogy between our souls and porcelain works. As demonstrated in a variety of case studies, souls can become heavily disrupted or broken during man's life. Knowledge and empathy could be of much help for those who are able to “accommodate” their impairment into everyday life and even to encourage others, as demonstrated in the case of Temple. Neurologist Oliver Sacks (1995) described the tale of Grandin and many other cases of neurological diseases which, according to him, inspite of being abnormal for our way of thinking, may also develop virtues and beauties of their own.

Suggested readings

Baron–Cohen, S.: *Mindblindness: an Essay on Autism and Theory of Mind.* Cambridge, MA: MIT Press, 1995.

Fialová, L, Kouba, P., Špaček, M. (ed.): *Medicína v kontextu západního myšlení.* Praha, Galén, 2008.

Grandin, T.: *Making Animals Happy.* London: Bloomsbook, 2010.

Ramachandran, V. S., Blakeslee, S.: *Phantoms in the Brain.* New York: Quill, 1998.

VI. Folk psychology and the language of mind

Key words: *eliminative materialism, folk psychology, reduction, theory theory, mindreading*

In this chapter I will be concerned with the relation between the way we talk and speak about our inner feelings, thoughts and beliefs and the theoretically sound approach explaining their very nature. There are at least three distinct senses in which the term "folk psychology" is used: 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. 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. 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 ordinary people are inclined to endorse. To reduce terminological ambiguity, throughout this entry the term "mindreading" will be used to refer to that set of cognitive capacities which include (but is not exhausted by) the capacities to predict and explain behavior. "Folk psychology" will be used only in the second and third senses identified above. When separate names are required to avoid confusion, the second sense of "folk psychology" will be called the *mindreading* approach to folk psychology and the third sense the *platitude* approach to folk psychology. Stephen Stich called the mindreading sense of folk psychology the *internal* sense, and the platitude sense the *external* sense. However, the current labels are more informative. It's not clear who introduced the term "folk psychology" into the philosophy of mind. It gained wide usage during the 1980s and is rarely used outside philosophy. The phrase "commonsense psychology" is sometimes used by philosophers synonymously with "folk psychology", although the former term seems to be dying out. Psychologists rarely use "folk psychology", preferring the phrase "theory of mind" (or sometimes "naïve psychology"). Just as there is ambiguity in the use of "folk psychology", "theory of mind" is used to refer both to mindreading and to the theory hypothesized to underpin mindreading. There is an important set of human cognitive capacities first noticed by social psychologists and philosophers in the middle of last century. The members of this set of cognitive capacities are almost always assumed to be closely related, perhaps in virtue of their being produced by a single underlying cognitive mechanism. To a first approximation the set consists of a) the capacity to predict human behavior in a wide range of circumstances; b) the capacity to attribute mental states to humans; c) the capacity to explain the behavior of humans in terms of their possessing mental states. The second and third capacities are clearly related: explaining the behavior of humans in terms of their mental states involves attributing mental states to them. But we should not assume without further investigation that all mental state attributions take the form of explanations of behavior. The characterization of mindreading given above is too restrictive. In addition to attributing mental states and predicting and explaining behavior, there is a wide range of closely related activities. To begin with, we not only seek to predict and explain people's behavior, we also seek to predict and explain their mental states. In addition, we speculate about, discuss, recall and evaluate both people's mental states and their behavior. We also speculate about, discuss, recall and evaluate people's dispositions to behave in certain ways and to have certain

mental states; that is, we consider their character traits. It may be that these additional activities are grounded in the three capacities mentioned above, but we cannot simply assume that they are. Throughout this entry the term "mindreading" is used in a wide sense to include all of these activities. As characterized above, mindreading is a human capacity directed at humans. But in two ways this is overly exclusive. First, we attribute mental states to non–human animals and to non–animal systems such as machines and the weather. It's not uncommon to hear people say that their dog *wants* a bone, or that the chess program is *thinking* about its next move. We do not have to accept every such attribution at face value; plausibly, some of this talk is metaphorical. Nevertheless, there seem to exist plenty of examples of non–metaphorical attributions of mental states to non–humans.

Consequently, we must be careful not to characterize mindreading in a way which makes it *definitional* that only humans can be the objects of mindreading. The second way in which the characterization of mindreading offered above is overly focused on humans is that it remains an open question whether some non–human primates can predict the behavior of their conspecifics. Consequently, we should avoid characterizing the mindreading capacities in a way that makes it analytic that non–human animals lack those capacities. One way to avoid the risk of over–emphasizing human capacities when characterizing mindreading is to begin with the human capacities and then let the empirical chips fall where they may. For example, it may turn out that some non–human primates can predict the behavior of their conspecifics, and that there are significant similarities (including neurological similarities) between the human capacity to predict the behavior of others and that of the non–human primate. In that case we should widen the characterization of mindreading given above so that it is not exclusively focused on human capacities. Similarly, it may turn out that precisely the same cognitive mechanisms are engaged when humans attribute mental states to their conspecifics and when they attribute mental states to animals and machines. In that case we should widen the characterization of mindreading to allow that animals and machines can be the objects of mindreading. Defining the precise extension of "mindreading" by stipulation from the armchair is not likely to be fruitful. A final comment on mindreading is in order. The characterization of mindreading given here is compatible with the existence of first person mindreading. But it may turn out that we deploy quite distinct mechanisms when we predict or explain our own behavior, or attribute mental states to ourselves, than when we predict or explain other's behavior, or attribute mental states to them. However, this is not an issue which can be settled here. How is mindreading achieved? One popular theory, often called the *"theory–theory"*, holds that when we mindread we access and utilize a theory of human behavior represented in our brains. The posited theory of human behavior is commonly called "folk psychology". On this view, mindreading is essentially an exercise in theoretical reasoning. When we predict behavior, for example, we utilize folk psychology to reason from representations of the target's past and present circumstances and behavior (including verbal behavior), to representations of the target's future behavior. Chomsky's claim that understanding and producing grammatical sentences involves a representation of the grammar of the relevant language is frequently offered as analogy. The claim that folk psychology is represented "in the head" raises a range of important empirical questions. These questions are extensively interrelated, with research in one area very often having significant consequences for research in other areas. We can ask about the way in which folk psychology is *represented* in the brain. Is it represented in a language–like medium (Fodor, 1975) or is it represented in a connectionist network (Churchland 1995)? And what about the *implementation* of folk psychology in the brain? A wide range of brain areas have been correlated with mindreading. We can ask about the *content* of folk psychology. What states and properties does it quantify over, and what regularities does

in postulate? Further questions include the *structure* of folk psychology. Is it a "proto–scientific" theory with a structure akin to that of scientific theories, or does it take some other form? And finally, what is the *status* of folk psychology? Might it be, as Paul Churchland (1981) famously proposed, radically false? Other unsolved problems include the following: a) the *development* of folk psychology in young children, b) the *natural history* of folk psychology — its existence in our evolutionary relatives, c) questions of *universality* — to what extent the development of folk psychology, and the mature competence, vary from culture to culture etc. In addition to the issues just outlined, there is a further empirical question with which theory–theorists have been engaged. Is it the case that mindreading is in fact underpinned by a theory of human psychology? Is mindreading really a theoretical activity? A variety of philosophers and psychologists have argued that it is not, or have at least argued that there is more to mindreading than theorizing. According to simulation theory, mindreading involves a kind of mental projection in which we temporarily adopt the target's perspective. And according to intentional systems theory, mindreading is achieved by adopting a particular stance towards a system such as another human being.

A debate between empiricists and nativists quickly emerged, strongly reminiscent of the empiricism versus nativism debate about the development of grammar. One of the most important defenders of empiricism about folk psychology is the developmental psychologist Alison Gopnik. A. Gopnik and her co–workers (Gopnik et. al., 1999) begin with a bold empirical conjecture—that the cognitive mechanisms which drive the child's development of folk psychology are exactly those mechanisms which drive the adult scientist's development of scientific theories. This view has been dubbed the "child as little scientist view". Gopnik argues that when scientists are confronted by an anomaly they are initially inclined to dismiss it as noise or some other form of aberration. If the anomaly cannot easily be handled in this fashion, ad hoc conjectures are added to the original theory to deal with it. If counterevidence continues to accumulate, new theories are developed which are unencumbered by the growing excrescence of ad hoc conjectures. Very often, though, the new theory is applied only to the more recalcitrant anomalies. Finally, the new theory is applied across the domain and becomes very widely accepted. Gopnik argues that the pattern of scientific progress just sketched is recapitulated in the child‘s acquisition of folk psychology, thus supporting her claim that the mechanisms used by the child to acquire folk psychology are the same as those used by the adult to make scientific discoveries. Gopnik‘s view is open to a number of objections. To begin with, it is not at all clear that the pattern of scientific progress Gopnik identifies is universal. For example, the history of geological science seems to provide an example where two competing research programs—vulcanism and neptunism—merged into a single, widely accepted paradigm. If Gopnik‘s historical claims are mistaken then the pattern of conceptual development she observes in young children does not support the claim that the child deploys the same mechanisms as the adult scientist. Second, it has been argued that Gopnik‘s view is at odds with the apparent universality of the development of folk psychology: the vast majority of children pass through similar developmental stages to arrive at the same theory of human psychology, and do so on a common developmental timetable. Surely individual child–scientists beavering away in isolation would pass through different developmental stages to arrive at divergent theories of human psychology, and do so on distinct developmental timetables (Carruthers, 1996). The claim that there is a universal developmental time table for the acquisition of folk psychology has not gone unopposed. Some author‘s have argued for the existence of considerable cross–cultural variation in the development of mindreading. *Nativists* take the existence of a near–universal competence arrived at via a near–universal developmental pathway as evidence that the development of folk psychology is very strongly influenced by the child‘s genes: the species–wide developmental pattern is explained by our species–wide genetic inheritance. They also offer a poverty of stimulus argument to the same conclusion. Children as young five are highly competent mindreaders and so must possess an extensive array of psychological concepts and a rich body of information about human psychology. They could not, though, have acquired those concepts and that information from their environment—their environment simply does not provide sufficient learning opportunities. Consequently, a considerable amount of folk psychology must be innate. A great deal of work is required, however, to sustain an argument of this nature. The proponent of any poverty of stimulus argument must demonstrate that the stimulus is impoverished relative to the mature competence. That in turn requires measuring the information content of the environment and comparing it with the information demands of the competence. In the case of folk psychology, we lack an accurate measure of the information demands of the competence because crucial questions about the nature of mature mindreading remain unresolved. It seems that the following thought of Ludwig Wittgenstein on the confusion concerning the problem in question (1953) will persist for a long time: *„While I was speaking to him I did not know what was going on in his head". In saying this, one is not thinking of brain–processes, but of thought processes. The picture should be taken seriously. We should really like to see in his head. And yet we only mean what elsewhere we should mean by saying: we should like to know what he is thinking. I want to say: we have this vivid picture — and that use, apparently contradicting the picture, which expresses the psychical".*

References

Carruthers, P.: The Architecture of the Mind. Oxford: Oxford University Press, 2006.

Churchland, P. M.: *The Engine of Reason, The Seat of the Soul*. Cambridge: MIT Press, 1995.

Gáliková, S., Gál, E.: Antológia filozofie mysle. Bratislava: Kalligram, 2003.

VII. Cognitive enhancement, problems and perspectives

Key words: *cognitive enhancement, neuroplasticity, brain jogging, neuroethics, neuroimplants*

Recent advances in brain sciences have dramatically improved our understanding of human mind and behaviour. Neuroimaging technologies enable us to locate brain abnormalities, identify identify the function of a particular part of the brain which in turn helps to explain psychological and behavioural changes in individual cases. Diagnostic and therapeutic importance of new imaging methods in medicine, namely in neurology and psychiatry is remarkable. Besides therapeutic importance the impact of brain scans is closely related to questions concerning moral and legal responsibility in legal decision making. It has been suggested, for example, that „if we could read the minds of others we could determine whether someone is telling the truth". A guilty person is expected to be nervous, so presumably, corresponding changes occurring in her/his autonomic nervous systems could be detected. Reliability of the method of „lie detection" depends on clarifying what it means to lie as well as knowing what are we searching for, what is the relation between neurobiological data, phenomenal states and our actions. Problems concerning ethics of neuromanipulation, brain enhancements, subject's privacy, neuronal foundations of moral behaviour became a subject matter of a new discipline — *neuroethics*. As neuroscience gives us unprecedented ways to understand better the human mind and to predict, influence, and even control it — new ethical issues are arising. They lead us beyond the boundaries of bioethics into the philosophy of mind, psychology, theology, law, and neuroscience itself. It is this larger set of issues that has attracted so many new and established scholars to the area and earned it a name — neuroethics. Although the more familiar bioethical issues are important and invariably acquire interesting new twists when manifest in the context of neuroscience, it is the relatively newer neuroethical issues that are most in need of explication. What, specifically, do people need to know to understand these issues? First of all, what is required is the basic knowledge of neuroscience. Without the fundamentals about neurotransmission, the neural bases of emotional memory and personality, principles of brain imaging, the neuropsychology of responsible behavior, work on imaging mind in the damaged brain, the efoort to understand mind functioning would do in vain. When, from one side, the grasp of neuroscience is an essential component of understanding neuroethics, then, from the other side, an appreciation of the ethical issues is the other. By "ethical" issues we mean a full range of concerns regarding the impact of neuroscience on the individual human person and on society as a whole, including the moral, legal, and policy implications of that impact. Whereas neuroscience is largely a matter of fact, the ethical implications of neuroscience can be seen very differently by different people. In the text of this chapter I will ust mention few familiar bioethical issues of neuroethics. Although the brain is central to these issues, from an ethical perspective its role is not substantially different from that played by other organ systems in analogous situations. These issues are no less interesting and important for having underlying commonalities with other issues in bioethics. The development of predictive tests for incurable neurodegenerative diseases raises a variety of ethical concerns. For example, brain imaging has enabled researchers to better understand vulnerability to Alzheimer's disease, mechanisms of disease onset, and treatment response. Positron emission tomography (PET) scanning, in particular, measures relevant brain function more sensitively than conventional behavioral tests of clinical dementia research. PET research has revealed neuroimaging correlates of incipient Alzheimer's disease, which in some cases may herald the clinical onset several years in advance. With the enthusiastic backing of PET scanner manufacturers, the medical community has been encouraged to consider using this method as a diagnostic test in the differential diagnosis of patients already showing signs of cognitive decline. The main ethical concerns are privacy rights and quality of life (what are the effects on patient well–being of knowing versus not knowing?). These are common to genetic and neuroimaging — based prediction. Another important ethical issue raised by neuroscience is the safety of some of its newly developed research methods. One such method is for example, transcranial magnetic stimulation (TMS), which alters brain function using powerful magnetic fields. It is noninvasive in the sense that the magnet remains outside the head, but the magnetic fields pass through the skull and other tissue and induce electrical currents in cortical tissue. For some applications, a single pulse (onset followed by offset of magnetic field) is used, but more commonly repetitive pulses are used (rTMS). The effects of TMS vary according to where the field is focused, its strength, and its pulse frequency and can either increase or decrease cortical activity near the stimulation site as well as in other brain regions to which the stimulated area projects. The ability to target specific brain areas for temporary activation or deactivation makes TMS a valuable research tool, and cognitive neuroscientists have embraced it. The impressive ability of TMS to bring about scientifically informative brain changes raises the question: What other kinds of brain changes does it cause? Concern about the side effects of TMS, especially rTMS, has accompanied its use from the start. We now know that high–frequency, high–intensity rTMS can provoke seizures, even in people with no seizure history, although guidelines developed in the 1990s have succeeded in eliminating this phenomenon. TMS also shows promise as a treatment modality for a variety of neuropsychiatric illnesses and was approved in 2008 by the U.S. Food and Drug Administration (FDA) for the treatment of depression in specific kinds of patients. Brain stimulation with TMS and with implanted devices are among the most promising new therapeutic modalities, which lends urgency to questions of clinical trial design and the approval process for devices. Safety, efficacy, and regulatory controls on brain stimulation are neuroethical issues, as they concern the way in which society manages advances in clinical neuroscience, but their ethical, legal, and social dimensions do not differ substantially from those in the evaluation and regulation of other biotechnologies.

A more widely used application of magnetism in neuroscience is functional magnetic resonance imaging (fMRI) — a workhorse of cognitive neuroscience research since the 1990s, thanks to its ability to measure brain activity with a useful degree of spatial and temporal resolution, without the need for radioactive tracers or injected contrast media. Current research involves placing the human subject in a magnetic field of strength 1.5 or 3 tesla, and all indications are that this is safe. Until recently, technical limitations prevented the use of stronger fields; they could be created only across spaces too small to accommodate a human head. However, it is now possible to scan humans at 7 tesla and higher. Strong static magnetic fields can affect blood pressure, cardiac function, and neural activity. In addition to static fields, image acquisition with MRI involves exposure to varying magnetic fields and radiofrequency fields, which pose risks that range from activation of nerves and muscles to heating of tissue. Subjects in high–field scanners sometimes report seeing lights as a result of induced currents in their retinas and/or optic nerves. Although safety studies have suggested that such effects are benign, little is known about the long–term effects of these newer and more powerful scanning protocols. As with TMS, high–field MRI raises important questions about the risks to which we put human research subjects. How thoroughly should such methods be tested for safety before they are used in research with humans? Who should decide? These are important ethical questions that must be addressed as researchers push the envelope of brain fMRI. However, they are not substantially different from questions regarding the safety of new methods for studying any other part of the body. Although high–field scanning is mainly of interest in the study of brain function, the ethical issues it poses are not fundamentally different from those surrounding any new scientific method that has potential risks and benefits and that is used in the study of any organ system. Another bioethical issue that arises in connection with fMRI concerns brain abnormalities found by chance in the course of research scanning. fMRI studies generally include a nonfunctional scan of brain structure to enable localization of the brain activity revealed by fMRI relative to the anatomy of each research subject. The structural scans are of sufficient sensitivity and resolution that anatomic abnormalities and signs of disease will often show up. This raises the question of what researchers should do with these incidental findings. There is currently no universally accepted procedure for dealing with incidental findings from research scans (Illes, 2006).

Of course, the ethical issues raised by incidental findings from brain scans are not fundamentally different from those that would be raised by imaging other organ systems. One of the most relevant legal precedents does not come from imaging at all but from testing of blood lead levels. The issues just reviewed are the most commonly discussed "classic" bioethical issues of neuroethics, but they are not the only ones. Most bioethical issues have some intersection with neuroscience. For example, stem cell therapy has been the focus of much discussion in bioethics, and therapeutic targets include neurologic diseases such as Alzheimer's and Parkinson's diseases (Svoboda te al., 2006). Future genetic technologies for selecting or altering the traits of a child are likely to include mental traits such as intelligence and personality, which are functions of the brain, as well as other physical traits. Issues of drug industry marketing, regulation, and safety are nowhere more relevant than with drugs for neuropsychiatric illness, as the chronic nature of such illnesses make treatments more profitable and questions of longterm safety more pressing. In contrast with the issues reviewed, some neuroethical issues arise specifically because the brain is the organ of the mind. Neuroscience is giving us new, and in some instances very powerful, ways to understand people and to control their behavior. One set of such issues emerges from recently developed technologies for monitoring and manipulating the brain. It remains to be seen how these developments will intersect with our strongly held beliefs about the value of privacy, freedom, fairness, and responsibility. One of the main tasks of neuroethics is to assess the likely impact of neuroscience on these and other moral and cultural ideals. This requires a realistic understanding of the capabilities of neuroscience as well as an awareness of the ways in which society already compromises one ideal for the sake of another (e.g., trading freedom for safety). In addition to concerns about safety and distributive justice, neuropsychological enhancement raises profound questions about human effort and just deserts and personal identity. Other new ethical issues arising from the application of neurotechnology include those posed by fMRI and other brain imaging methods. The main concern in these cases is not with safety or incidental findings but with privacy of thought. Unlike imaging other bodily organs, imaging the brain reveals information about the mind. Researchers have found imaging correlates of individual differences in personality and intelligence, which can be applied outside the research laboratory; for example, by employers and marketers. fMRI and other methods are being adapted for lie detection and behavior prediction, which has attracted attention from the intelligence and criminal justice communities. These trends raise new questions about whether, when, and how to ensure the privacy of one's own mind. Of course, to the extent that functional neuroimaging is not up to the task of reliably delivering such information and at present it is not another problem arises: The hightech aura of brain images leads many people to accept them uncritically. The danger is that people will be judged based on wrong information about their personalities, abilities, truthfulness, or behavioral dispositions. Some of the most profound ethical challenges from neuroscience come not from new technologies but from new understandings. Neuroscience is calling our age–old understanding of the human person into question. In place of the folk psychology with which we have traditionally understood ourselves and each other, neuroscience is offering us increasingly detailed physical mechanisms. Personality, self–control, responsibility, consciousness, and even states of transcendent spiritual experience have become subjects of study in cognitive neuroscience. Much as the natural sciences became the dominant way of understanding the world in the eighteenth century, so neuroscience may be responsible for a kind of second enlightenment in the twenty–first century, naturalizing our understanding of humanity and transforming the way we think about ourselves. Such a transformation could help bring about a more understanding and humane society, as people's behavior is seen as part of the larger picture of causal forces surrounding them and acting through them. But it could also reduce us to machines in each other's eyes, mere clockwork devoid of moral agency and moral value. Although many people believe that, in principle, human behavior is the physical result of a causally determined chain of biophysical events, most of us also put that aside when making moral judgments. We do not say, "But he had no choice, the laws of physics made him do it!" However, as the neuroscience of decision making and impulse control begins to offer a more detailed and specific account of the physical processes leading to irresponsible or criminal behavior, the amoral deterministic viewpoint will probably gain a stronger hold on our intuitions. Whereas the laws of physics are a little too vague and general to displace the concept of personal responsibility in our minds, our moral judgments might well be moved by a demonstration of subtle damage to prefrontal inhibitory mechanisms wrought by, for example, past drug abuse

or childhood neglect. This has already happened to an extent with the disease model of drug abuse. Our intuitive understanding of persons includes the idea that they have an essence that persists over time. The changes wrought by normal development and life experience are understood as elaborations on a foundational personal identity that is constant throughout life. We also have the intuition that persons are categorically either alive or dead. Furthermore, most people also believe that persons have a nonmaterial component such as a spirit or soul. Yet none of these beliefs fit with the idea that a person is his or her brain. As physical objects, brains can and do change in countless ways in response to injury, disease, drugs, and, less commonly but no less realistically, implants, grafts, and other surgical interventions. There is no principled limit to the ways in which a brain can physically change and thus no immutable core to the neural substrates of a person. How can this fact be squared with the notion of an enduring personal identity or essence? As for life and death, there exists a continuum of levels of function linking the brains of fully living beings and indisputably cold, dead corpses. Legal systems and religions have both grappled with the question of where to draw the line between us and those corpses, in part because any particular place is somewhat arbitrary. The standard medicolegal definition of death, which can apply to a warm, breathing body, seems counterintuitive to most. Finally, as neuroscience reveals progressively more about the physical mechanisms of personality, character, and even sense of spirituality, there is little about a human being left to attribute to an immaterial soul. Slovak philosopher working in the domain of bioethics P. Sýkora (2011) emphasizes the necessity of discussing the topic of cognitive enhancement not only on academical level but also in solving particular ethical and practical problems. He considers as one of the most urgent and controversal — genetic cognitive enhancement of a human being, which can lead to creation of a new posthuman biological species (Sýkora, 2011). It is, finally, an open question, to what extent the problem of cognitive enhancement relates to the ancient Greek idea about the harmony between physical and psychical beauty — *kalokagatia.* The frontiers of scientific discovery are defined as much by the tools available for observation as by conceptual innovation. In the 16th century, the Earth was considered the center of the solar system. It has been supported by simple observation from everyday experience. The Sun rose each morning in the East and slowly moved across the sky to set in the West. The invention of the telescope in 1608 changed astronomers' observational methods. With this new tool they suddenly found galactic entities that they could track as these entities moved across the night sky. Observations exposed geocentric theories as painfully wrong and within few years Galileo spoke out for heliocentric universe. In 21st century the picture of human mind as a mysterious or at least empirically undetectable entity is still prevailing. Everyday experience seems to support this. We are unable to „see" our thoughts and images as ongoing electro–chemical activity (or light as electro–magnetic radiation). In introspection we „observe" our inner states as if they were „something" transparent to us. In general, not only laymen but philosophers as well trust themselves in understanding the contents of their own minds and the minds of others. As I have examined in the preceeding text, new neuroimaging techniques radically changed neuroscientists' observational methods. Observations exposed dualistically oriented theories as inadequate. Together with scientists a number of philosophers realized that human mind is as natural as Sun or our planet Earth.

Suggested readings

Doidge, N.: *Váš mozek se dokáže změnit.* Brno: Computer Press, 2011.
Goldberg, E.: *Jak nás mozek civilizuje*. Praha: Karolinum, 2004.
Illes, J.: *Neuroethics.* Oxford: Oxford University Press, 2006.
Sýkora, P., Matějková, E.: Kognitívne vylepšovanie človeka, evolúcia a etika. In: Kelemen, J., Kvasnička, V., Pospíchal, J.(ed.): *Kognice a umělý život XI.* Opava: Selzská univerzita v Opavě, 2011, 255–268.

Bibliography

Andreansen, D.: *Brave New Brain*. Oxford: Oxford University Press, 2001.
Ashcraft, M., Radvansky, G.: *Cognition*. New York: Pearson, 2010.
Bartoš, A. a kol.: *Diagnostika poruch vědomí v klinické praxi.* Praha: Karolinum, 2004.
Baron–Cohen, S.: *Mindblindness: an Essay on Autism and Theory of Mind.* Cambridge, MA: MIT Press, 1995.
Bechtel, W., Graham, G.: *A Companion to Cognitive Science*. Oxford: Blackwell, 1999.
Blanke, O.: Multisensory brain mechanisms of bodily self
consciousness. *Nature Reviews Neuroscience,* 2012, 13: 556–571.
Brown, D.: *Magie a manipulace mysli.* Praha: Argo, 2007.
Carruthers, P.: The Architecture of the Mind. Oxford: Oxford University Press, 2006.
Descartes, R.: *Vášně duše.* Praha: Mladá fronta, 2002.
Damasio, A.: *Descartesův omyl.* Praha: Mladá fronta, 2000.
Damasio, A.: *The Feeling of What Happens.* London: William Heinemann, 1999.
Dennett, D.: *Consciousness Explained.* Boston: Little Brown, 1991.
Doidge, N.: *Váš mozek se dokáže změnit.* Brno: Computer Press, 2011.
Eysenck, M., Keane, M.: Kognitivní psychologie. Praha: Academia, 2008.
Fialová, L, Kouba, P., Špaček, M. (ed.): *Medicína v kontextu západního myšlení.* Praha, Galén, 2008.
Finger, S.: *Origins of Neuroscience*. Oxford: Oxford University Press, 2001.
Fodor, J. A.: *The modularity of mind.* Cambridge: MIT Press, 1983.
Gálik, D.: Jazyk a evolúcia: môže darvinovská teória evolúcie vysvetliť evolúciu jazyka?. V: Kelemen J, Nahodil P. *Kognice a umělý život XII.* Praha: Agentura Action M, 2012, 61–67.
Gáliková, S., Gál, E.: Antológia filozofie mysle. Bratislava: Kalligram, 2003.
Gáliková, S.: *Filozofia vedomia.* Trnava: Filozofická fakulta TU, 2013.
Gáliková, S.: Psyché: Od animálnych duchov k neurotransmiterom. Bratislava: Veda, 2007.
Gardner, H.: *The Mind's New Science: A History of the Cognitive Revolution.* New York: Basic Books, 1985.
Goldberg, E. *The Executive Brain.* Oxford: Oxford University Press, 2001.

Gopnik, A.: *The Scientist in the Crib.* New York: Harper Collins, 1999.
Gray, J.: *Consciousness: Creeping up on the Hard Problem.* Oxford: Oxford University Press, 2004.
Green, D. W.: *Cognitive Science: An Introduction.* Malden, MA: Blackwell, 1996.
Harnish, M. R.: *Minds, Brains, Computers: An Historical Introduction to the Foundations of Cognitive Science*. Oxford: Blackwell, 2002.
Fodor, J.: *Psychosemantics.* Cambridge: MIT Press, 1987.
Greenfield, S.: *The Private Life of the Brain.* London: Allen Lane, 2000.
Illes, J.: *Neuroethics.* Oxford: Oxford University Press, 2006.
Johnson–Laird, P.: A computational analysis of consciousness. In: *Cognition and Brain Theory,* 1983, No 6, 499–508.
Gazanniga, M., Ivry, R., Mangun, G.: *Cognitive Neuroscience: The Biology of the Mind.* New York: W.W. Norton, 2002.
Hacker, P., Bennett, M.: *Philosophical Foundations of Neuroscience.* Oxford: Blackwell, 2003.
Chomsky, N.: *Modular approaches to the study of the*
mind. San Diego: San Diego State University Press, 1984.
Chomsky, N.: *New Horizons in the Study of Language and*
Mind. Cambridge: Cambridge University Press, 2000.
Chomsky, N.: On the Nature, Use and Acquisition of Language. In: Goldman, A. (Ed.), *Readings in Philosophy and Cognitive Science,* 511–535. Cambridge: MIT Press, 1995.
Churchland, P. S., and Sejnowski, T.: Neural Representation
and Neural Computation. In: Neural Connections and Mental Computation, ed. Nadel, L. Cambridge, MA: The MIT Press, 1988.
Churchland, P. M.: *Matter and Consciousness.* Cambridge: MIT Press, 1999.
Churchland, P. M.: *The Engine of Reason, the Seat of the Soul: A Philosophical Journey into the Brain*. Cambridge: MIT Press, 1995.
Churchland, P. S.: Consciousness: The Transmutation of the Concept. In: *Pacific Philosophical Quarterly,* 1983, No 64, 86–94.
Churchland, P. S.: *Neurophilosophy.* Cambridge: MIT Press, 1986.
Churchland, P. S. (1997): The Hornswoggle problem. In: J. Shear: *Explaining Consciousness — The Hard Problem.* Cambridge : MIT Press, 37–44.
Kahneman, D.: *Myšlení rychlé a pomalé.* Brno: Jan Melvil, 2012.
Koukolík, F.: *Já: O vzťahu mozgu, vědomí a sebeuvědomování.* Praha: Karolinum, 2003.
Lakoff, G., Johnson, M.: *Metaphors we live by.* Chicago: Chicago University Press, 1980.
Leary, D. (ed.): *Metaphors in the History of Psychology.* Cambridge: Cambridge University Press, 1994.
Libet, B.: Do We Have Free Will? In: *Journal of Consciousness Studies*, 6, 1999, No. 8–9, 47–57.
Markram H.: The Blue Brain Project. Nature Reviews Neuroscience, 2006, 7(2): 153–60.

Metzinger, T.: *The Ego Tunnel*. New York: Basic Books, 2010.
Morton, A.: *Frames of Mind.* Oxford: Oxford University Press, 1980.
Murphy, D.: *Psychiatry in Scientific Image*. Cambridge, MA: MIT Press, 2006.
Noë, A., Thompson, E.: Are There Neural Correlates of Consciousness? In: *Journal of Consciousness Studies,* 2004, vol.11, No 1.
Pečeňák, J. a kol.: Kapitoly o schizofrénii. Osveta, Martin, 2005.
Petrů, M.: *Fyziologie mysli — Úvod do kognitivní vědy*. Olomouc: Triton, 2008.
Ortony, A. (ed.): *Metaphor and thought*. Cambridge: Cambridge University Press, 1996.
Piaget, J.: *The Language and the Thought of the Child.*
New York: Humanities Press, 1959.
Picha, M. (2005): *Chybějící qualia.* Brno: Masarykova Univerzita.
Raboch, J., Zvolský, P. et al.: Psychiatrie. Galen, Praha, 2001.
Ramachandran, V. S., Blakeslee, S.: *Phantoms in the Brain.* New York: Quill, 1998.
Rybárová, D. (2001): *Teória „ladenness“ a modulárna teória mysle.* In: Filosofický časopis, roč. 49, č.3, s. 373–379.
Rybár, J. a kol. (2002): *Filozofia a kognitívne vedy*. Bratislava, Iris.
Rybár, Ľ. Beňušková, V. Kvasnička (2002): *Kognitívne vedy*. Bratislava, Kalligram.
Rohde, E.: *Psyché.* London: Routledge, 2000.
Rorty, R.: Mind–body Identity, Privacy and Categories. In: *Review of Metaphysics,* 1965, No 19, 25–54.
Svoboda, M., (ed.), Češková, E.,Kučerová, H.: Psychopatologie a psychiatrie. Portál, Praha, 2006.
Sacks, O.: *Anthropologist on Mars.* ...:Vintage Books, 1995.
Searle, J.: *The Rediscovery of Mind.* Cambridge: MIT Press, 1992.
Soukup, V.: *Dějiny antropologie.* Praha: Karolinum, 2004.
Sternberg, R.: *Kognitivní Psychologie.* Praha: Portál, 2002.
Sýkora, P., Matějková, E.: Kognitívne vylepšovanie človeka, evolúcia a etika. In: Kelemen, J., Kvasnička, V., Pospíchal, J.(ed.): *Kognice a umělý život XI.* Opava, Selzská univerzita v Opavě, 2011, 255–268.
Thagard,: *Úvod do kognitivní vědy.* Praha: Portál, 2001.
Wegner, D.: *The Illusion of Conscious Will.* Cambridge: MIT Press, 2002.
Weiskrantz, L.: Some Contributions of Neuropsychology of Vision and Memory to the Problems of Consciousness. In: A. Marcel, A., Bisiach, E. (ed.): *Consciousness in Contemporary Science.* Oxford: Oxford University Press, 1989.
Wilkes, K.: „...“, Yishu, Duh, Um and consciousness. In: A. Marcel, B. Bisiach (eds.): *Consciousness in Contemporary Science.* Oxford: Clarendon Press, 1988, 16–41.
Wittgenstein, L.: *Philosophical Investigations.* Oxford: Basil Blackwell, 1953.

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