Mind And Consciousness

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Table Of Contents

Table Of Contents.....1
What Is Consciousness?.....2
Timeline: Ancient Views Of Mind.....4
Timeline: Medieval Views of Mind.....7
Timeline: 16th And 17th Centuries.....10
Timeline: 18th And 19th Centuries.....13
Timeline: Mind In The 20th Century.....16
The Human Brain.....21
The Inner Workings Of The Brain.....26
The Question Of Free Will.....31
Nonlocal Consciousness.....36

What Is Consciousness?

What is mind? What is consciousness? There seems to be no single answer that explains the phenomenon of mind. The contemporary views of philosophy, psychology, neuroscience, and cybernetics all come up with different interpretations of mind and consciousness.

It is a bit ironic that something we claim to possess is so hard to explain. Obviously mind cannot be an object of itself. Or can it? If we should one day understand the chemical and electrical processes in the brain completely, would this explain mind? Would this understanding account for all faculties including intelligence, consciousness, emotion, and volition?

On the following pages we will try to give some possible answers to this question. On the topic of consciousness, the British psychologist Stuart Sutherland once wrote: "Consciousness is a fascinating but elusive phenomenon; it is impossible to specify what it is, what it does, or why it evolved. Nothing worth reading has been written on it." - Hopefully this won't keep you from reading on.

Epistemology and psychology

The investigation of mind is closely related to the field of epistemology, the part of philosophy that deals with knowledge and whose principal question is: "What can we know?" Epistemology is not so much preoccupied with the process of accumulating knowledge, but with the validity of knowledge and how we can achieve certainty about it. It includes the branch of philosophy that the ancients called logic, which deals with language and thought. Bertrand Russell once remarked tellingly that the theory of knowledge is a product of doubt. Things seem to speak in favour of Russell's view – most philosophers find it easier to determine what we cannot know rather than what we can know. Perhaps the theory of knowledge should then be called "theory of ignorance."

The other question about knowledge is: "How do we know?" This question pertains to the mechanics of sensation, perception, cognition, memory, and physical brain processes. It also touches upon language and thought, but it takes a more scientific approach to these issues. The latter question is primarily asked by psychologists and neuroscientists, although philosophers recently took a renewed interest in the workings of the brain. Since both approaches are beneficial in their own way, we shall not limit ourselves to a particular one.

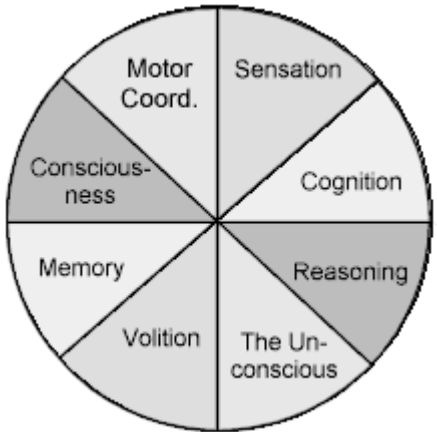
Defining mind

On the surface, the attempt to define mind seems superfluous, since it is so fundamental to us. However, the explicit verbalisation of an intuitive understanding of mind is fairly difficult, because it requires us to transform the subjective first-person experience into an objective third-person description.

The American Heritage Dictionary of the English Language defines mind as follows: "*The collective conscious and unconscious processes in a sentient organism that direct and influence mental and physical behaviour*." This definition attributes mind to sentient organisms and identifies it with processes that control behaviour.

According to the view of contemporary science, these are brain and nerve processes, cognition, motor, and sensory processes.

The faculties of mind



The scientific definition is in agreement with the physicalist view of mind that equates mental phenomena with neuronal activity. The definition is also in agreement with the functionalist view of psychology, which frequently divides mind into distinct faculties (as shown on the right) and then investigates those faculties individually. Some of these functions can be mapped to particular brain areas.

Dividing mind into faculties involves a great deal of abstraction, because in reality there are no clear boundaries between them. For example, the simple process of catching a ball involves sensation, cognition, and reasoning processes without there being a clear separation between the single actions of seeing the ball, calculating its speed and angle, and coordinating body movements.

Another more serious problem is that the scientific definition makes no reference to conscious experience and its subjective qualities. It is not easy to see how the experience of sensations and feelings could be part of the physical world. For example, how can emotions, such as love (affection, attraction) and hate (aversion, repulsion) which we seem to share with some animals, be described in terms of physical structures and processes?

Is the scientific definition viable in philosophy?

Perhaps it is necessary to ask whether science is capable of explaining mind at all.

Unfortunately the scientific definition falls short of one important quality: spirit. The scientific view is difficult to apply, for instance, in the context of sociology where we speak of the mental qualities of a group or population (the nation's mind, group mind, team spirit). It is also difficult to apply in the context of religion, where mind and spirit are associated with transcendental concepts such as the immortal soul, the world mind, the holy spirit, etc.

The materialist notion of mind is possibly too limited for a general philosophical discourse. It would be extremely difficult to discuss topics that involve metaphysical, ontological, and phenomenological accounts of mind. A purely materialist understanding of mind would simply evade these topics. More exotic fields of knowledge, such as theology, religion, and parapsychology do not harmonise with the scientific view of mind either. Hence, we shall postpone further attempts to define mind and as yet allow the largest possible meaning of the word, perhaps in the sense of the German word “Geist”, which means both mind and spirit.

Philosophy Of Mind

The philosophy of mind is the branch of philosophy that deals with mind and consciousness. It falls outside the four classical branches, metaphysics, epistemology, ethics, and aesthetics, but it relates especially to the first two. The ancients did not see it as a separate discipline, although the systematic investigation of certain aspects of mind began with the study of reason in Plato and Aristotle. During the middle ages, the philosophy of mind lingered within the confines of Christian epistemology. Important theoretical advances began to take shape only in the 17th century with Descartes and Hobbes. The philosophy of mind flourished during the late 18th and 19th century (Hegel, Darwin, Wundt, James) just before it spawned psychology, while the philosophical currents of the time flowed into the schools of phenomenology and existentialism. Psychology has ruled the field for some time during the 20th century, however, the philosophy of mind experienced a small renaissance lately due to the appearance of computer technology and other new disciplines such as cybernetics and the neurosciences. These developments brought up the question whether a machine can emulate mind and whether it can become conscious.

The following pages contain a historical abstract in the timeline section. Additional sections that discuss philosophy of mind, psychology, and neuroscience in some more detail are currently in preparation.

Timeline: Ancient Views Of Mind

550 BC - Pythagoras - the mathematical mind.

Pythagoras (582-500 BC) suggested that matter and mind are mystically connected. Logic, numbers, spirit, and soul were expressions of the same reality. He thought the soul to be immortal and wandering on a path of transmigration from one body to another. The Pythagoreans had a geometrical conception of the world. They believed that mind is attuned to the processes of nature, in particular to the laws of mathematics. Mathematics is seen as the true essence of mind.

450 BC - Anaxagoras - the universal intelligence.

Anaxagoras (500-428 BC) introduced the concept of "Nous" (mind, reason) into Greek philosophy. Nous, the eternal mind, transforms chaos into order and through it the material world comes into being. The primordial One produces forms of multiplicity through dichotomisation. This process is originated and controlled by the power of mind, or Nous. According to Anaxagoras, mind is infinite and self-organizing. It is not intermixed with anything, but pure in its being.

450 BC - Alcmaeon - the dissected brain.

The Greek physician Alcmaeon (around 450 BC) concluded from his studies of dissection that the brain is the centre of intelligence. In doing so, he contradicted the mainstream theory of his time, which held that the heart is the centre of intelligence and seat of the soul. Alcmaeon also

surmised that optic nerves conduct light from the eye to the brain and that the eye itself contains light.

400 BC - Hippocrates - the four humours.

Hippocrates (460-377 BC), the founder of Western medicine, is famous for the Hippocratic oath. He invented the notion of the four humours, black bile, yellow bile, phlegm, and sanguine, which he equated with the four elements. Hippocrates thought that disease arises from an imbalance of these four humours and that people can be healed by restoring their proper proportions. The dominating humour was also thought to be responsible for the temperament (black bile = melancholy, yellow bile = bitterness and irascibility, phlegm = equanimity, and sluggishness, sanguine = passionate and cheerful).

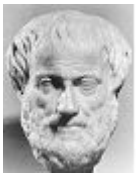
Hippocrates correctly identified epilepsy as a brain disorder. He held that not only thought and reason, but also feelings and moods originate in the brain: "Men ought to know that from the brain, and from the brain only, arise our pleasures, joys, laughter and jests, as well as our sorrows, pains, grievances, and tears. Through it...we...think, see, hear, and distinguish the ugly from the beautiful, the bad from the good, the pleasant from the unpleasant."

400 BC - Plato - ideal forms and reason.

Plato (428-347 BC) plays an important role in the history of epistemology. His theory of ideas, which he presented in the famous cave allegory, can be seen as a precursor of both medieval realism and later idealism. Plato held that all forms of the physical world are merely instances of perfect forms in an ideal world. The idea of a table is the supreme form of table of which there is only one. It contains in itself all actual tables of the physical world. The knowledge of ideas, or supreme forms, provides intellectual and ethical guidance for humans. Plato thought that perfect forms have an actual metaphysical existence.

Plato divided the human mind into three parts: the rational part, the will, and the appetites. Ideally the will supports the rational element, which in turn controls the appetites. If the rational element is not developed, the individual behaves immorally, hence immorality is a consequence of ignorance. Furthermore, Plato distinguished between two kinds of conscious thought: opinion and knowledge. He said that all assertions about the outside world are necessarily based on sense experience, and are therefore only opinions. In contrast, he described knowledge as a higher form of awareness, because it is gained from reason rather than from sense experience.

350 BC - Aristotle - the three souls.



Aristotle (384-322 BC) equated mind with reason and thought it to be a property of the living soul. In contrast to Plato, who believed that body and soul are two different entities, he held that mind and body are intertwined in all living beings and are thus inseparable. Growth, purpose and direction are therefore built into nature. Aristotle proposed three forms of soul: 1. the vegetative soul possessed by plants in that

they grow and decay and enjoy nutriment, but they do not have motion and sensation, 2. the animal soul which bestows animals with motion and sensation, and 3. the rational soul which is the conscious and intellectual soul peculiar to man. Each higher form possesses in full the attributes of the lower souls, which makes human beings the only possessor of all three types. Aristotle also proposed a theory of memory surmising that the processes involved in short term memory (immediate recall) differ from those involved in long-term memory.

300 BC - Herophilus - the beginning of neuroscience.

The Greek anatomist Herophilus (335-280 BC) studied the human brain and recognised it as the centre of the nervous system. He distinguished the cerebrum and cerebellum and named the brain as the source of thought. Herophilus also made the first contribution to the field of neuroscience by distinguishing between sensory and motor nerves and by performing the most thorough study of brain anatomy attempted until the Renaissance.

300 BC - Pyrrho - scepticism as a state of mind.

The founder of the Greek school of scepticism, Pyrrho (360-272), stated that human mind is incapable of attaining true knowledge of anything, because ultimate reality is incomprehensible. Therefore, there is no objective knowledge, but only opinion. The best attitude one can develop in view of this fact, is to suspend any judgment completely, to free oneself from passions, and to calm one's mind. The idea that no person's judgment is more correct than that of another goes back to the first Sophist, Protagoras, who lived around 450 BC. Pyrrho developed scepticism into a more elaborate and consistent system of thought.

250 BC - Erasistratus - the brain and the vital spirit.

Erasistratus (300-260 BC) was an anatomist who worked one century after Aristotle. He found three tubular structures going to every organ of the body: an artery, a vein, and a nerve. He expanded Herophilus's theory of motor and sensory nerves by adding the thesis that all nerves are connected to and controlled by the brain. Erasistratus saw the brain as a mechanism for distilling the pneuma (the vital spirit), which he thought was flowing from the heart up to the brain and then down to the organs.

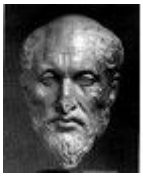
150 AD - Galen - the great Greek doctor.

Galen (129-199 AD) was the most influential physician of antiquity, after Hippocrates. He influenced medicine profoundly until about the 17th century. Galen synthesised the thought of Pythagoras, Plato and Aristotle and built upon the discoveries of Hippocrates and Erasistratus. He proved that the arteries carry blood instead of air (as the Greeks formerly presumed); and he demonstrated that the brain controls motion and voice. Galen further assigned the three largest organs of the body to be the seat of the three Aristotelian souls; the liver as the seat of the vegetative soul, the heart as the seat of the animal soul, and the brain as the seat of the rational soul.

For Galen, the rational soul was divided into the faculties of imagination, reason, and memory. He located these three faculties in the ventricles of the brain. Because the

function of the brain was to distribute animal spirit throughout the body, to Galen it seemed that the fluid filled ventricles perform this function and thus disregarded the white and grey matter surrounding the ventricles. According to Galen, the brain receives vital spirit (pneuma) from the heart, which is mixed into the sanguine humour (blood). The brain then separates the animal spirit out and stores it in the ventricles, from where it is distributed throughout the body via the nerves. This mechanism of circulating pneuma controls muscles, organs, and all of the body's activities.

250 AD - Plotinus - the emanation of mind from the Absolute.



Plotinus (204-270 AD) rejected Aristotle's notion of the soul not being able to exist without the body. Building mainly on Plato, he said that mind is a prisoner of the body. Plotinus held that soul is the immortal part of mind. It survives the death of the body and enters a series of transmigration from one body to another. Consequently, the soul is the only abiding reality of the human condition. Plotinus formulated a theory of emanation according to which mind emanates originally from the Absolute Being, or the One, and then forms Nous, the universal intelligence, from which the world spirit is formed in turn. Human mind, animal mind, vegetative mind, and finally matter all emanate from the world spirit. They are different manifestations of one universal intelligence.

400 AD - St. Augustine - the illuminated mind.

The church father St. Augustine (354-? AD) had an interesting idea about mind. He said that the human mind couldn't gain knowledge from sense perception alone. He also rejected Plato's theory of ideas. Instead, according to Augustine, knowledge is acquired on account of divine illumination. He argued as follows: The shape of an object such as a tree can only be seen by the eye, because the object is bathed in light. Similarly the mind can only recognise truths, such as the mathematical truth 1+1=2, because it is illuminated by the light of eternal reason. This light is not so much the source of ideas and knowledge, but the condition under which mind is able to recognise the quality of truth. In spite of the simplicity of this idea, or perhaps due to it, Augustine had a tremendous influence on the philosophers and theologians of the Middle Ages.

Timeline: Medieval Views of Mind

850 - John Scotus - the flawed human mind.

John Scotus Eriugena (810-ca.875) believed that human reason is flawed on account of the original sin. However, as a philosopher, he could not accept that human mind was entirely tarnished. He thought that it was still capable of attaining smaller truths by contemplating visible creatures. Yet, the only infallible truth, Eriugena believed, was to be found in the Scriptures. The Scriptures give divine revelation to human beings and illuminate their withered minds. Ideas similar to those of John Scotus were predominant in Europe throughout the following six centuries.

1050 - Anselm - faith and reason: the proven God.

Like many other medieval thinkers, St. Anselm (1033-1109) of Canterbury, the founder of scholasticism, was a Christian theologian rather than a philosopher. He did not contribute much to epistemology, instead he became famous for his ontological proof (the proof that God exists), which implied that the truth of metaphysical statements, such as the existence of God, can be established by reason. The proof goes as follows: 1. The term God is defined as the greatest conceivable being. 2. Real existence (existence in reality) is greater than existence merely in the understanding. 3. Therefore, the greatest conceivable being (God) must exist in reality, not just in the understanding. Although the reasoning is striking at first, its fallacy is rather obvious. It was refuted by the monk Gaunilo, a contemporary of Anselm, and later by Immanuel Kant. Anselm's ontological proof led people to believe fallaciously that the existence of God can be established as a fact on account of reason. Anselm's proof is thus perhaps exemplary for the defects of medieval thought.

Scholasticism - philosophy as a handmaiden of theology.

Scholasticism, the predominant philosophical movement of the Middle Ages, was not so much concerned with finding new facts, or arriving at new knowledge, but with bringing the existing Greek knowledge, particularly Aristotle, into accordance with Christian doctrines. To put it briefly, the scholastic goal was to unify reason and faith. The Scholastics maintained that because the same God was the source of both reason and Christian faith, he could not contradict himself in these two modes of thought. Although the overall goal of the scholastic discussion was harmonisation, it has to be noted that the opposite was often the result. This became distinctively evident in the dispute between contenders of nominalism and realism, who held opposite views about the origin of forms and words. This dispute was rooted in the philosophy of Plato.

The realists held that Plato was right and that the Platonic forms (=ideas or universals) are real in the sense that they have a metaphysical existence independent of the concrete objects that embody them. The nominalists just stated the opposite, namely that ideals or universals don't exist for themselves, but are only attributes of individual objects. The latter position is called nominalism, because it holds that universals have no objective reference other than their names. The nominalists said that universals are only words and have no other reality than the sound of the spoken word ("flatus vocis" - Roscelin).

1200 - Aquinas - the knower is one with the known.

St. Thomas Aquinas (1225-1274) opposed Anselm's ontological proof and put forward his own "five ways of knowing God", which were later interpreted as ontological proofs, although they were not originally intended as such by Aquinas. Perhaps more importantly, Aquinas developed new ways of harmonizing faith and reason by drawing on Aristotle, thereby arriving at new conclusions about mind and perception. Aquinas held that sense perception is an active process rather than passive receiving. Instead of forms (objects) making impressions on the mind like a seal makes an impression onto wax, mind actively "scans" physical reality using the

sense organs. Aquinas made no special distinction between sensation and cognition. He said that perception is immaterial and immanent, which means belonging to the inner reality of the perceiver. He further said -and this is remarkable- that by perceiving, the perceiver becomes one with the perceived form.

Since the knowledge of physical forms consists of acquiring or receiving the forms through perception, the knower becomes one with the known. Hence, according to Aquinas, the process of perception has no independent reality. Instead, one perceives the things directly and, therefore, the psychological (inner) and physical (outer) realities are identical. This argument sidesteps the epistemological problems that arise out of the supposed duality of inner and outer realities, which has lead to such abstruse propositions as solipsism and scepticism. The beauty of Aquinas's theory of knowledge lies perhaps in the elegance of his argument, which also avoids the scholastic conflict of nominalism and realism altogether.

1250 - John of Duns the Scot - a mind of its own.

John Duns Scotus (1266-1308) further expanded the concept of the soul as the immortal part of human mind. The same idea was previously expressed by Plato and Plotinus. John of Duns held that the powers of the human mind are purposeful and necessary and that they are not really distinct from the substance of the soul. Like Aquinas, he held that sense perception is not purely passive. John of Duns said that mind has the power to form ideas on its own, independently from life experience or from what is inspired by God. According to his philosophy, the soul is united with the body for the purpose of forming the human species.

1300 - Eckhart - the mind seeking union with God.

Like Plotinus and Eriugena, Meister Eckhart (1260-1328) was a mystic thinker. He saw reason as inferior and instead stressed the faculty of feeling, particularly the feeling of piety. He held that being and knowledge are one. The goal of human mind for Eckhart was to seek mystic union with God. Eckhart suggested to liberate oneself from the objects of the world by giving up all attachments.

1300 - Ockham - separating faith and reason.

As a contender of late nominalism, William of Ockham (ca. 1285-ca. 1349), asserted that universals have no substance outside of the human mind, which he sought to prove by keen logical argument. Ockham said that morality is not based on reason, but on will. He emphasised logic and method, and separated faith from reason by showing that they are fundamentally different aspects of human mind. Ockham maintained that the beliefs of Christian philosophers could not be proven through philosophical reasoning, but only through divine revelation.

1400 - Nicolaus - the steps of knowing.

According to Nicolaus von Cues (1401-1464), we arrive at knowledge about an object by comparing it with other objects and determining those qualities that distinguish it from other objects. Thus, the intellect is capable of seeing a network of connections between objects, but it is

not able to understand their true essence. There are four levels of understanding: 1. sense perception (sensus) which reflects the surface of things imperfectly, 2. reason (ratio) which compares the opposites, 3. intellect (intellectus) which unites the opposites, and 4. intuition (animus) through which a complete union of opposites can be achieved.

Timeline: 16th And 17th Centuries

1550 - Vesalius –the illustrated brain.

The Flemish anatomist and author Andreas Vesalius (1514-1564), also known as Andreas van Wesel, made an important contribution to the field of medicine by publishing his seminal work *De Humanis Corporis Fabrica (On the Workings of the Human Body)*, a lavishly illustrated atlas of human anatomy. This seven volume book contains highly detailed drawings of the human brain and the nerves, which makes it the first illustrated neuroscience textbook. With this work, Vesalius initiates a major shift from the doctrines of Galen and Aristotle, which had been authoritative for one and a half millennia, towards a purely physical and empirical understanding of the body. He relies entirely on his observations from the dissection of human bodies. Vesalius also questions the prevailing doctrine that the higher functions of the brain are located in the ventricles. His dissection studies show that animals have the same ventricles as humans. He reasons that animals don't have a soul, and that the ventricles therefore cannot be the key to the higher functions of the mind.

1600 - Bacon - the awakening scientific mind.

"Knowledge is power" was Francis Bacon's (1561-1626) motto. The knowledge he meant was not the conventional knowledge of the medieval Scholastics, but a new kind of knowledge, namely that of nature and all things natural. In this regard, Bacon's orientation was truly scientific. At the height of the English Renaissance, Bacon led philosophy away from theology towards scientific discovery. Inevitably, the same principle also underlies his epistemology. Bacon held that the mind is an adequate instrument for obtaining knowledge. He said that the mind was originally "like a mirror with a true and even surface, fit to reflect the genuine way of things." However, mind is corrupted by the four idols: 1. the idol of the tribe - the false assertion that man is the measure of all things, 2. the idol of the cave - the limitations of an untrained intellect, 3. the idol of the market - the fallacious use of words, and 4. the idol of the theatre - the creation of intellectual mirages on the basis of unverified axioms.

1600 - Burton - the 16th century view of the brain.

It had more or less been established that the brain was the seat of mind by the end of the 16th century. The English physician Robert Burton (1577-1640) describes in The Anatomy of Melancholy the then physiological picture, which still reflects Greek ideas: "The brain itself is divided into two parts, the fore and hinder part; the fore part is much bigger than the other, which is called the little brain in respect of

it. This fore part hath many concavities distinguished by certain ventricles, which are the receptacles of the spirits, brought hither by the arteries of the heart, and are there refined to a more heavenly nature, to perform the actions of the soul. Of these ventricles there are three - right, left, and middle. The right and left answer to their site and beget animal spirits; if they be in any way hurt, sense and motion ceaseth. These ventricles, moreover, are held to be the seat of the common sense. The middle ventricle is a common concourse and cavity of them both, and hath two passages - the one to receive pituita, and the other extends itself to the fourth creek; in this they place imagination and cogitation, and so the three ventricles of the fore part of the brain are used. The fourth creek behind the head is common to the cerebral or little brain, and marrow of the back bone, the last and most solid of all the rest, which receives the animal spirits from the other ventricles, and conveys them to the marrow in the back, and is the place where they say the memory is seated." [R. Burton]

1600 - Hobbes - the mechanistic mind.

Thomas Hobbes (1588-1679) developed a mechanistic picture of the human mind. He held that the objects of thought are bodies in motion, which adhere to the law of cause and effect. At the beginning of the causal chain there are sense impressions from which all other forms of mental processes follow. Like many of his contemporaries, Hobbes believed that chemistry and biology can ultimately be reduced to mechanics. If one investigates chemical and biological processes in a drill-down fashion, there would be mechanics at the root of all things. Therefore, the principal characteristic of human mind is motion. Hobbes thought that different faculties of mind are based on the same underlying principle. The ostensible differences in the faculties are only due to different locations in the causal chain. For Hobbes, imagination was simply decaying sensation, while memory was stored sensation. Words and signs are able to recall stored sensations from memory and thus allow us to build knowledge. Hobbes held that there are two types of knowledge: 1. knowledge of empirical facts (=memory of past events), and 2. knowledge of consequences. The latter is hypothetical or conditional, but is still based on experience. All knowledge is thus acquired through the mechanics of thought, where thoughts produce one another.

1600 - Descartes - the severed mind.

René Descartes (1596-1650), famous for his saying, "Cogito ergo sum - I think, therefore I am," takes a prominent position in the history of the philosophy of mind. Descartes was convinced that knowledge must be based on the powers of human reason alone. He said that human mind is naturally endowed with the faculties of deduction and intuition, on account of which we can arrive at true knowledge of things by using of so-called rational schemes, not unlike a pump extracts water from a dwell by applying a mechanical scheme. According to Descartes, from the proof of its own existence (cogito ergo sum), the mind can deduce the existence of God and the existence of the physical world. Descartes was more radical in his mechanistic view of the world than most others thinkers of the 17th century. For him the body is a machine, which is driven by mechanic processes only, not the mind. He says that mind is not connected with the body any more than a pearl is connected with the oyster that it lies in. He sees animals as completely devoid of mind; they are automata without consciousness to him.

Descartes held that the brain sends humours and fluids coursing through the nerves and thus, controls the body mechanically. He illustrated the function of nerves by using the analogy of the hydraulic systems of automata then in great favour for entertainment in the pleasure gardens of the kings and princes of Europe. Descartes, having reduced body and brain to pure mechanics, located the mind in the pineal gland, a small, single, vestigial body at the base of the brain. Although this view is obsolete, as we all know, the dualism of Descartes has survived. The conceptual separation of mind and body has influenced philosophy and popular culture until the present day.

1650 - Spinoza - free will an illusion?

Baruch Spinoza (1632-1677) viewed mind and matter as two attributes of a single, divine substance, the oneness of ultimate reality. Therefore, mind and body, although different in appearance, are not really separate entities. According to Spinoza, a human being is a finite version of God, hence, human mind is a miniature of the universal mind. Spinoza said that mental processes are mechanic, and thus deterministic, following a causal chain. Consequently, thoughts and actions are predetermined and thus, free will is an illusion. In spite of this, mind has a metaphysical reality beyond what is self-determined.

1650 - Locke - the constructed mind.

Founder of British empiricism, John Locke (1632-1704), examined human mind and came to the conclusion that there are no innate ideas built into it at birth. Hence, for Locke, the mind is a "tabula rasa" at birth, unformed and featureless. He asked, if knowledge were innate, why does an infant not arrive fully knowing at the world? Why are there the mentally ill, who are unable to know such things as right and wrong? Why is it that all people of the world do not have the same ideas? Locke distinguished between two sources of knowledge, or contents of mind: the sensations acquired through sense experience, having perceived qualities, and the reflections of mind upon its contents, having inferred qualities. He then proceeds to engage in the analysis of the kinds of ideas and distinguishes between simple and complex ideas. Simple ideas are the raw material acquired through sense experience, while complex ideas are compounds of simple ideas put together by mind.

1700 - Berkeley - mind creates reality.

George Berkeley (1685-1753) introduced a new psychological idea that became the forerunner of solipsism and later idealism. He said that our vision never senses any spatial aspects of objects directly, such as magnitude and distance, but that the mind infers such qualities from visual data. He then argues that, because mind forms what we perceive, the things of the physical world cannot exist independently of mind. Berkeley finally concludes that only the ideas of things have a real existence, but not the things themselves. Therefore, matter does not really exist. Berkeley's philosophical system eliminated any possibility of knowledge of an external material world and asserts that the only thing we can know, are the objects of perception (esse est percipi). According to Berkeley, these objects are ideas created by God. He

supports his theory by the following argument: Since imaginary ideas are produced by finite (human) minds, perceived ideas (= the objects of perception) must be created and caused to be in us by an infinite mind. And, the only possible source of the infinite mind is God.

Timeline: 18th And 19th Centuries

1750 - Hume - the caged mind.

David Hume (1711-1776) synthesised the ideas of Locke and Berkeley. He formulated the most forthright version of empiricism. Hume stated that all contents of mind are solely built from sense experiences. Like Locke, he distinguished between impressions and ideas. Hume held that the mind associates ideas with one another on account of three qualities: resemblance, contiguity, and causation. His position was that reason and rational judgments are merely habitual associations of distinct sensations or experiences. Although he considered the notion of cause and effect as the basis of knowledge, he held that causality is merely inferred by the mind: "Reason can never show us the connexion of one object with another, tho' aided by experience, and the observation of their conjunction in all past instances." This extreme empiricism led Hume to argue that we cannot achieve certainty about external reality, but only about the inner world of our perceptions and thoughts. Hence, there can neither be certitude about the existence of the self, the physical world, or even God.

1750 - Kant - the Copernican revolution in epistemology.

The time was ripe for Immanuel Kant's (1724-1804) famous writing, *Critique of Pure Reason*, in which he investigated and criticised the epistemological propositions of Hume and his predecessors. Kant rejected Hume's extreme empiricism and proposed that there is more to knowledge than bare sense experience. He distinguished between "a posteriori" and "a priori" knowledge, the former being derived from perception, hence, occurring after (post) perception, and the latter being a property of thought, independent of experience and existing before (prior to) experience. Knowledge is expressed in judgments, which -according to Kant- are operations of thought that connect a subject with a predicate. The predicate qualifies the subject in some way. There are many examples for a posteriori judgments, such as "the apple is red" or "the music is loud." Since a posteriori judgments are solely based on data supplied by the senses, they can be denied without contradiction. In contrast, a priori judgments cannot be denied without contradiction, because they are based on logic rather than perception.

While all a posteriori (empirical) judgments are automatically synthetic, Kant discerned two types of a priori judgments, analytic and synthetic judgments. He said, "necessity and strict universality are sure marks of a priori knowledge." In an analytic a priori statement, the predicate is already contained in the subject, such as in: "all triangles have three angles," or, "all bodies are extended." In contrast, synthetic a priori judgments are compound and are often found in mathematics and science, as for example: "a straight line is the shortest connection between two points," and, "for every action there is an equal an opposite reaction." The latter statement -the third

law of Newtonian mechanics- may at first be mistaken for an a posteriori statement, but it isn't, because we haven't yet experienced every mechanical action.

Kant furthermore distinguished between concepts, which are derived from thought, and particulars which are derived from sense experience. The idea of a winged horse is an example of a synthetic concept derived from the particulars of wings and horses. Particulars are always a posteriori (empirical), with the exception of two, namely space and time, which are a priori and thus, provide the basis for other (synthetic) a priori propositions. There are also a priori concepts, which Kant calls categories, of which there are twelve, namely unity, plurality, totality, reality, negation, limitation, substance, causality, interaction, possibility, existence, and necessity. Kant maintained that these concepts are not derived empirically, but that the mind applies them to all perception and that they are therefore a priori. In this way, the a priori particulars and concepts form the basis of knowledge. What exists apart from them, Kant calls the "things in themselves", the noumenal reality, which is purely intelligible and non-sensual, as opposed to the phenomenal reality, which is perceivable. Since the things in themselves cannot be known directly, according to Kant, human knowledge must forever remain limited.

1800 - Gall - the charted brain.

Franz Gall (1758-1828) began the localisation of functions in the brain. He distinguished areas that he thought were responsible for speech, hearing, motor control, and so forth. Gall maintained, "that the brain was composed of as many organs as the individual had faculties, tendencies and feelings." [Ackerknecht, 1958, p150]. It was this approach from which sprang the now discredited practice of phrenology. Nevertheless, Gall discovered a great deal about the anatomy of the brain. He placed the main faculties in the cortex and established the concept of nerve pathways. Gall described the clefts between the grey matter as nerve matrices and the white matter as having a conductor function.

During the 19th century evidence accumulated to show that the brain could continue to operate, despite the loss of various parts of its substance. This was verified by the study of the consequences of cutting differentiable parts of the brain in animals and through the investigation of brain injuries and brain diseases in humans. The new evidence slowly led to the view that the mind dwelt in the whole of the brain, as opposed to particular anatomical locations, and thus, consciousness was understood as a function of the entirety of the human brain.

1800 - Hegel - the evolving world mind.

Georg Wilhelm Friedrich Hegel (1770-1831) accomplished what Kant had declared impossible. According to Hegel, mind is capable of arriving at full knowledge about things in themselves. He formulated a dialectical method, according to which knowledge pushes forwards to greater certainty, and ultimately towards knowledge of the noumenal world. He said that ultimate reality is absolute mind, reason, or spirit, which manifests itself in history and in the universe. Hegel set forth the proposition, "what is real is rational and what is rational is real," and from this he concluded that everything that is, is knowable. The world mind (Weltgeist) is universal; the rational activities of individuals are therefore instances of the Absolute. The self-development

of mind is the result of evolving idea systems, a process that he called the dialectical processes of thesis and antithesis. According to Hegel, an idea, a thesis, always contains incompleteness, and thus, yields a conflicting idea, an antithesis. In a higher-level theory, a third point of view, the synthesis, arises that provides the solution. The synthesis overcomes the conflict between thesis and antithesis by reconciling the truth contained in both at a higher level of insight. The synthesis then becomes a new thesis that is subsequently confronted by another antithesis, and so forth. By this dialectical method, the collective mind, namely that of a group, society, nation and ultimately the world, advances towards the perfection of its knowledge.

1800 - Mill - psychology takes shape.

James Mill (1773-1836), father of John Stuart Mill, investigated in his book *Analysis of the Phenomena of Mind* topics such as feeling, sensation, consciousness, associations, and thus became a precursor of modern psychological studies.

1850 - Darwin - the evolution of our species.

Charles Robert Darwin (1809-1882) formulated the modern theory of the evolution of species. The discoveries he made while aboard the HMS Beagle on an expedition around the world, impelled him to write his famous book, *On the Origin of Species*. In this writing Darwin developed the concepts of hereditary variation, speciation, and natural selection. Although Darwin did not touch upon psychology or epistemology, his influence was so fundamental that it affected almost any branch of science; consequently, it also affected the contemporary understanding of mind. Since the brain is the organ of mind, it follows that the forming of mind must have gone hand in hand with the evolution of the human brain. Mind is therefore a product of evolution, just as man is.

1850 - Galton - the wellborn mind.

The British inventor Francis Galton (1822-1911) advocated the idea that human traits, or properties of human mind in general, are inherited and can therefore be altered and improved by selective breeding. He held that mental qualities, such as intelligence, memory capability, etc., can be measured objectively, but failed in his efforts to provide methods for quantitative measurement. Galton also coined the term "nature and nurture", which is still heatedly debated today. Laying the foundations for eugenics, he explained: "I have no patience with the hypothesis occasionally expressed, and often implied, especially in tales written to teach children to be good, that babies are born pretty much alike, and that the sole agencies in creating differences between boy and boy, and man and man, are steady application and moral effort. It is in the most unqualified manner that I object to pretensions of natural equality."

1850 - Huxeley - mind caused, but not causing.

Thomas Henry Huxeley (1825-1895) was a zoologist advocating Darwinism. He regards consciousness as a collateral effect of certain physical causes, and only an effect, but never a cause.

1850 - Wundt - the father of psychology.

Wilhelm Max Wundt (1832-1920) is often credited with establishing psychology as a field of scientific studies independent from philosophy. He carried out extensive experimental research on stimuli, perception, and feeling. Wundt's structural psychology stresses observation of the modes of conscious mind, rather than making philosophical inferences about the nature of mind and, hence, takes a wholly scientific approach.

1900 - James - mind as a stream of consciousness.

William James (1842-1910) established the American philosophical school of pragmatism. He was a philosopher as much as a psychologist. In his pragmatic philosophy, he emphasised the applicability and practical utility of concepts and theories. James declared most metaphysical theories as meaningless, because they are neither testable, nor do they deal with existential problems. His innovative work, The Principles of Psychology, investigates the functions of the brain, consciousness, conception, memory, and association. James pointed out that we have a sense of a personal consciousness, and that it is ours, not something that we share with others. Later psychologists referred to it as the "I".

James also held that our states of consciousness are always changing. We have a sense of temporal continuity in consciousness, which leads to the conception of a stream of consciousness. The mind has a function of memory that allows us to recall experiences and ideas. Moreover, consciousness is selective of what it pays attention to. James formulated a materialistic view of mind, which -in some sense- anticipates the modern view of neuroscience and psychobiology. "Taking all such facts together, the simple and radical conception dawns upon the mind that mental action may be uniformly and absolutely a function of brain-action, varying as the latter varies, and being to the brain-action as effect to cause." [James, 1892, pp5-6]

Timeline: Mind In The 20th Century

1900 - Kraepelin - psychiatry takes shape.

The German doctor Emil Kraepelin (1856–1926) pioneered 20th century field of psychiatry. He continued Wilhelm Wundt's scientific approach and made the disorders of human mind the subject of his clinical studies. Kraepelin did not only discover schizophrenia, but he also developed the first widely accepted classification of mental disorders. This classification is still in use today, with several refinements added in the course of time. It consists of (1) personality disorders, such as schizoid, schizotypal, paranoid, histrionic, antisocial, borderline, avoidant, dependent, compulsive, passive-aggressive disorder, (2) psychoses, such as schizophrenia and manic-depressive psychosis, (3) anxiety disorders, such as obsessive compulsive disorder and phobia, (4) physiological disorders, such as Alzheimer's disease, epilepsy, etc., and (5) other disorders, such as neurotic depression, neurotic hysteria, and somatoform disorders. It was a fundamental tenet of Kraepelin's thought that diagnostic formulations stand or fall on the basis of

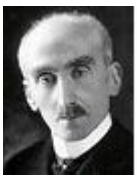
empirical validation. Kraepelin did therefore not believe in unconscious mental activity, such as the psychoanalysts postulated.

1900 - Husserl - mind, meaning, and phenomena.

The German philosopher Edmund Husserl (1859-1938) developed a school of thought known as phenomenology. According to Husserl, mind cannot be explained by science. He held that the natural sciences have misguided people into believing that nature is essentially physical and that the realm of mind and spirit is causally based on corporeality. Husserl said that the understanding of mind as a mere effect of the nervous system is a fatal prejudice of modern Western culture. To insist that the realm of spirit can be explained in a scientific manner implies that all psychology is psychophysical and that physical existence envelops everything, which according to Husserl, just reflects the credulity of the rational scientific mind.

Husserl denied the validity of any knowledge beyond the immediate phenomenal realm. In particular he denied the existence of noumena, or Kant's things-in-themselves, whose independent existence cannot be established. For Husserl the ego is the matrix of all experience and thus the source and simultaneously the limit of all knowledge. Reflections and thoughts are intentionally applied to enhance the experience and understanding of phenomena, but the resulting theories cannot provide accurate knowledge. Intentionality itself is a facet of consciousness. Husserl maintained that consciousness contains unchanging structures called meanings, which determine what object the mind is directed toward at any given time. The mind connects meanings with perceived objects and employs various methods of contemplation to determine the meanings of phenomena. Phenomenology thus takes a purely descriptive approach and does not assume the existence of anything, except phenomena. Later in the 20th century, phenomenology became a major source of inspiration for the existentialists, among them Heidegger, Merleau-Ponty, and Sartre.

1900 - Bergson - the intuitive mind.



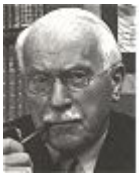
French Philosopher Henri Bergson (1859-1941) understood the human intellect as a prolongation of the senses, which guides perception and bodily action. He held that intellect is an inferior way of understanding. According to Bergson, there are two fundamentally different ways of knowing a thing. One observes the object from the outside, while the other enters the object and views the object from the inside. The former he calls intellect, and the latter he calls intuition, which he deems superior to the analytic reasoning capabilities of the intellect. Bergson describes intuition as "immediate consciousness", a vision which is scarcely distinguishable from the object itself. In this manner, Bergson arrives at a dualistic view of matter and spirit, in which intellect grows out of matter, and intuition grows out of spirit, and in which he describes memory as the intersection of mind and matter. Furthermore, Bergson held that evolution is not driven by materialistic processes, but by a spiritual force, which he calls élan vital. According to Bergson, the élan vital is the essence of all living beings; it is the creative power of evolution that drives organisms toward constantly higher forms of organisation.

1900 - Freud - the unconscious mind.

Sigmund Freud (1856-1939) profoundly changed the modern view of mind. He proposed that childhood sexuality and unconscious motivations influence personality. He developed his "psychoanalytic" theory as a result of his experience with mentally disturbed patients, who showed no apparent neurological disorder, in particular, in cases of hysteria. Freud suggested that syndromes of this type should be treated with psychological rather than physiological methods. He developed a new therapeutic method, which he called psychoanalysis. In his clinical observations, Freud found evidence for the mental mechanisms of repression, a device operating unconsciously to make the memory of painful or threatening events inaccessible to the conscious mind, and resistance, the unconscious defence against awareness of repressed experiences.

Psychoanalysis uses hypnosis, dream interpretation, and free association as instruments to explore the unconscious contents of mind of patients. Freud believed that mind is like an iceberg, where only the conscious part is visible, while the much larger unconscious part is hidden. He held that fears, passions, and desires are rooted in the unconscious and exert a powerful influence on our feelings and actions. According to Freud, there is also a preconscious area from which we can retrieve memories at will into conscious awareness. Although Freud's immediate influence on psychology is declining, he has to be credited with the discovery of the unconscious. His understanding of the unconscious has changed psychology forever.

1900 - Jung - the collective mind.



The Swiss psychiatrist Carl Gustav Jung (1875-1961), initially a follower and colleague of Sigmund Freud, later departed from Freud's psychoanalysis and founded the school of analytical psychology. What he has in common with Freud is that he attributes great importance to the unconscious. He says, "my life is a story of the self-realisation of the unconscious. Everything in the unconscious seeks outward manifestation." Jung was convinced that the human mind is more than the sum of perception, emotion, memory, and consciousness. He believed that the unconscious layers of mind transcend the ego and contain elements of impersonal human knowledge and experience. Jung supported his theories by drawing on his clinical practice, as well as his studies of such wide-ranging subjects as alchemy, Eastern religions, astrology, mythology, and -most importantly- introspection. He believed that mind strives for spiritual and intellectual wholeness in a process which he called individuation, emphasizing indivisibleness of the individual.

Jung emerged from an inner journey of intense self-analysis with the ideas in place for his theories on archetypes, complexes, the collective unconscious, and the individuation process. He held that mind contains an impersonal psychic realm, the collective unconscious, which contains images, experiences, and ideas that humanity shares. These primordial psychic patterns he called archetypes. They manifest themselves symbolically in religions, myths, fantasies, and dreams. Jung saw the mind as an inner universe of unimaginable complexity equal to that of the outer universe. He distinguished between the ego, which is how one sees oneself, along with the conscious and unconscious feelings that accompany that view, the persona, which represent(s) the face(s) that one consciously shows to others, revealing some

part of the self while hiding other parts, and the self, the central organizing principle of the psyche, which is the fundamental and essential aspect of human personality providing purpose, meaning, cohesion, and direction to the mind. Jung interpreted neuroses (=non-physiological mental disorders) as a state of being at odds with oneself, caused by the conflict between instinctive drives and the ego.

1900 - Wittgenstein - mind and language.

The British-Austrian Ludwig Wittgenstein (1889-1951), famous for his saying, "whereof one cannot speak, thereof one should be silent," is one of the most influential philosophers of the 20th century. The above conclusion, expressed in his book *Tractatus Logico-Philosophicus*, is consummated by the proposition that "whatever can be said at all can be said clearly." These two statements sum up fairly well Wittgenstein's philosophy, which is concerned with the usage and meaning of language, rather than with new discoveries, which Wittgenstein deemed the domain of science, and metaphysics, which he deemed largely a fruitless endeavour. This disposition marks an important turn in 20th century thought. Philosophy is no longer concerned with mind and human knowledge, but only with the expression of the latter in language. Wittgenstein held that the philosopher's task to clarify the logical use of language, and that philosophy is therefore not concerned with truth, but with meaning. While he saw the chief task of language initially in describing facts, he changed his mind later and granted that language may indeed assume any function. He held that philosophy's task is to "battle against the bewitchment of our intelligence by means of language."

1950 - Behaviourism - the invisible mind.

J.B. Watson (1878-1958) and B.F. Skinner (1904-1990) are the best known figures in the 20th century movement of behaviourism, a school of psychology which restricts itself to the study of observable and quantifiable aspects of behaviour. Behaviourism explains human and animal behaviour in terms of physiological responses to external stimuli, without regarding cognitive processes, such as feelings or motives. In other words, mind is an undefined entity in behaviourism, and is therefore treated as a black box. Behaviourism is based on positivism and it presupposes that behaviour is largely conditioned by learning and adaptation. Watson and Skinner attempted to show this through a variety of practical experiments. Today, the main tenets of behaviourism are invalidated.

1950 - Maslow - mind and motivation.

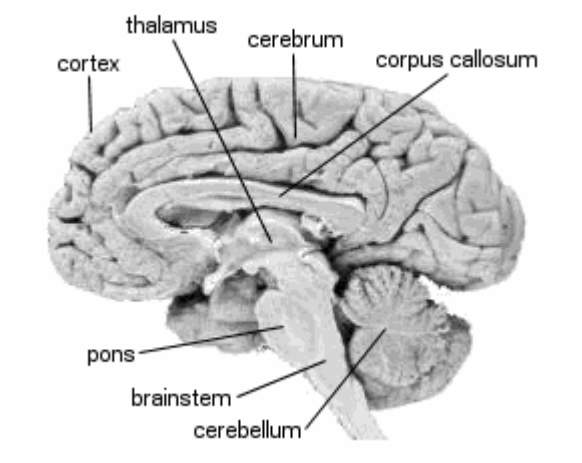
American psychologist Abraham Maslow (1908-1970), leading exponent of humanistic psychology, developed a theory of motivation aimed at explaining human behaviour. He proposed a hierarchy of needs, consisting of six levels. At the most basic level, there are the physiological needs to satisfy thirst, hunger, and other needs of the body. At the next level, there is a safety need, i.e. the need to feel that the environment is safe and predictable. At the third level is the need for love and acceptance that provides the individual with a feeling of belonging. At the fourth level are needs for self-esteem, achievement, recognition, and respect from others. At the fifth level are needs to know and understand. At the final, sixth level is the need for self-actualisation, i.e. the need to live up to one's fullest and unique potential. Maslow

held that lower ranking needs must be fulfilled, before the individual can move on to satisfy higher-level needs.

Present - Neuroscience and Genetics - the material mind.

The 20th century has seen a major shift of thought in epistemology and philosophy of mind. First, philosophy handed over the topic to psychology, which at the beginning of the century attempted to make the study of mind a science. In this endeavour, psychology succeeded only halfway. Relying chiefly on introspection and theory, psychology created exegetic models with practical value, but failed to provide objective, falsifiable descriptions of the properties of mind in scientific terms. Psychology did not address the demand of materialism to reduce mental phenomena to physiological phenomena. The topic is now being passed to the disciplines of neuroscience and genetics. Considerable advances have been made in these sciences recently, which nurture the materialist aspiration of explaining mental phenomena in terms of electrochemical processes in the brain and nervous system and in terms of genetic codification.

The Human Brain

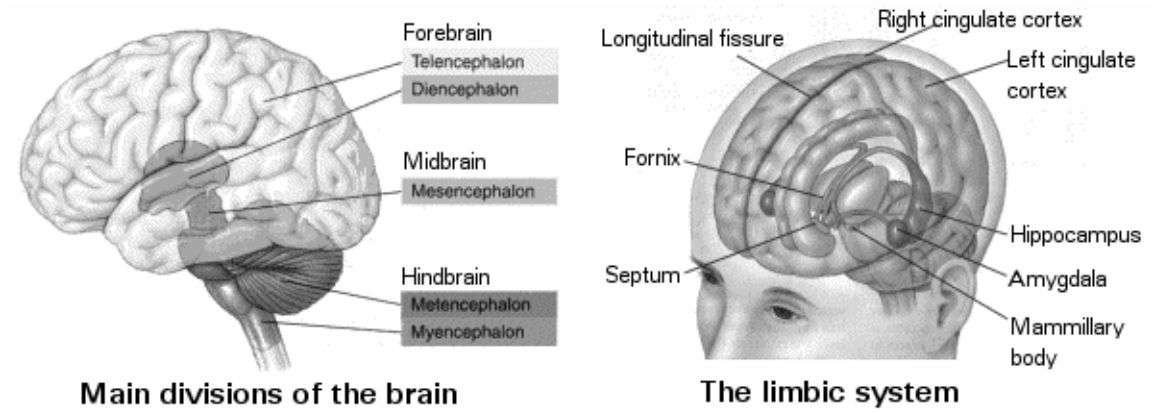


The brain is probably the most amazing physical structure we know. Nowhere else in the universe do we find anything comparable. People have tried to understand it for thousands of years. The ancient Greeks thought that it acts like a radiator cooling the blood. Medieval philosophers believed that it is the abode of the soul and that it could be invaded by spirits. Today, we think that the brain is responsible for all faculties of mind. The human brain is one of the most intensively researched items in biology, yet there are many questions to which we don't have answers. For example, we don't know how consciousness arises from the brain. Nevertheless, significant advances were made in brain research during the past few decades. From classical neuroanatomy we know the different parts and structures of the brain. From neuropsychology we know their psychological and behavioural functions. From neurophysiology and neurochemistry we know the workings of neurons (brain cells) and their connections.

You may find that the appearance of the human brain is quite unimposing. It doesn't really look like one of the world's wonders, but rather like something you might find washed up on a beach. The human brain is the size of a large grapefruit and weighs 1 – 1.5 kg. The outer visible layer, the cortex, is part of the cerebrum. It comprises two halves, or hemispheres, of highly wrinkled grey matter. The grey matter consists of the cell bodies of neurons, whereas the subjacent white matter consists of nerve fibres (axons) that constitute long distance connections between neurons. The two hemispheres are separated by a deep grove, the longitudinal cerebral fissure. They are connected at the base by the corpus callosum, a thick layer of nerve fibres. At the outer sides of the hemispheres there is another deep grove, the lateral fissure or lateral sulcus, which divides the frontal and parietal lobes from the temporal lobes. Developmentally, the brain can be divided into three main divisions, the hindbrain (rhombencephalon), midbrain (mesencephalon), and forebrain (prosencephalon).

Divisions of the brain.

The three main parts of the brain can be further divided into substructures, as shown in the illustrations. We will first look at these parts from an evolutionary point of view. The brain stem is the oldest part of the brain. It contains the midbrain and the hindbrain minus the cerebellum. It evolved more than 500 million years ago. Because it resembles the brain of a reptile, it is also called the "reptilian brain". The brainstem controls autonomic functions, such as breathing, heart rate, and digestion. The cerebellum, or "little brain", which is attached to the back of the brainstem, is likewise evolutionary ancient. It contains circuits which are similar in all vertebrates, including fish. Its function is to control and adjust posture and to coordinate muscular movement. The expanded human cerebellum also has a role in some cognitive functions, such as attention.



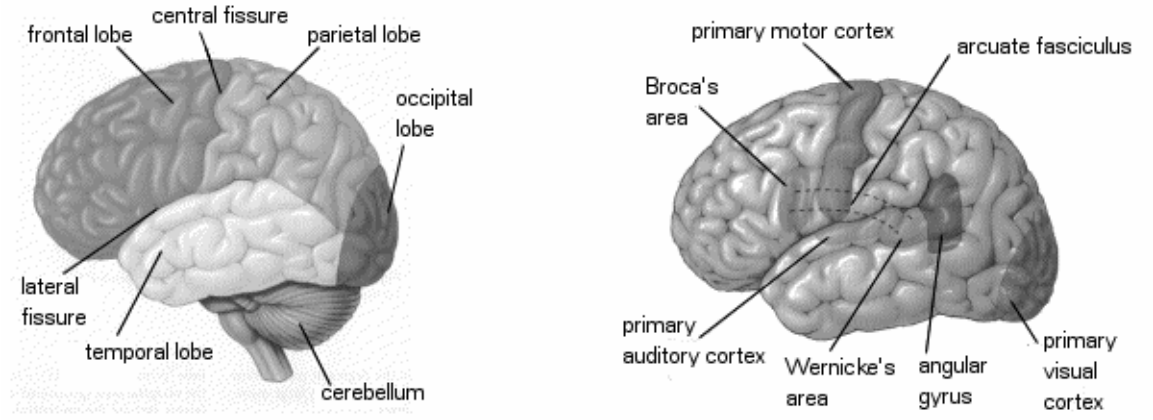
The limbic system is the group of structures located between the brain stem and the cortex. It evolved between 300 and 200 million years ago and –since it is most highly developed in mammals– it is also called the "mammalian brain". The limbic system is involved in emotion and motivation. For example, the amygdala is involved in aggression and fear, the hypothalamus is involved in sexual arousal, and the nucleus accumbens, the brain's pleasure centre, is involved in reward, pleasure, and addiction. Furthermore the limbic system controls a host of different functions, including heart rate and blood pressure, hunger, thirst, the sleep and wake cycle, memory formation, and decision making. The two key parts of the limbic system are the hypothalamus and the pituitary gland, the "master gland" of the body. The limbic system interacts with the body through the endocrine system and the autonomic nervous systems. Finally, there is the cerebrum, the largest part of the forebrain, which is evolutionary the most recent and also the largest part of the brain. While the forebrain of a frog is a mere bump, it balloons into the large structure of the cerebrum in higher animals covering the brain stem and the limbic system like the head of a mushroom. The most outstanding feature of the cerebrum is the cortex, which is about two millimetres thick and, like a walnut, possesses an intricately folded surface. This is a special characteristic of "higher" mammals. The many grooves (sulci) and ridges (gyri) create a large surface area of 1,5 square metres allowing for maximum packing of neurons. The cortex is involved in many high-level functions, such as visual and verbal symbol processing, perceptual awareness, communication, language, understanding, and rational thought.

Divisions of the cortex.

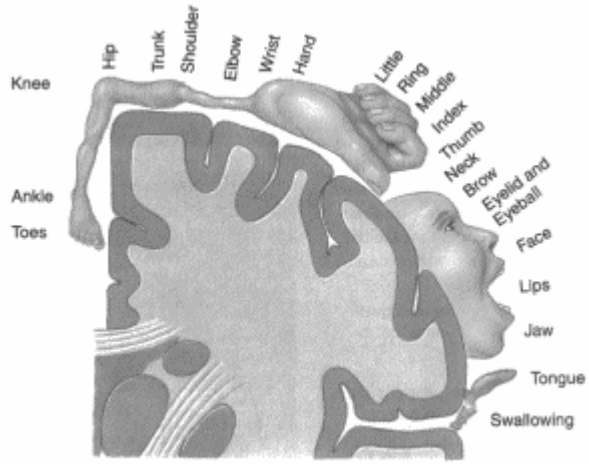
The cerebral cortex evolved in three stages and the resulting parts are called archicortex, paleocortex, and neocortex. The most recent one is the neocortex which occupies the topmost layer of the cortex; it is especially developed in humans. Generally, the cerebral cortex acts as a processor of sensory input information, which it receives via the thalamus. The cortex of each hemisphere can be divided into several different areas which are called lobes. At the rear of each hemisphere, the occipital lobe deals primarily with vision, hence, it is also called the visual cortex. It processes visual information transmitted from the eye and analyses it for movement, orientation, and position. A person can become blind if the occipital lobe is damaged, even while the eyes and optic nerves remain intact.

The temporal lobes, located at the outer sides of the hemispheres near the temples, have a number of different functions. A part of it is responsible for hearing. This part

is called the auditory cortex. The auditory cortex sits at the lateral fissure and has the size of a large coin. The adjacent areas are involved in high-level auditory processing, such as language perception. Wernicke's area, which is located at the junction of the temporal and parietal lobe, is mainly responsible for the comprehension of spoken language. Additional temporal lobe functions include behavioural expression, the recognition of faces and scenes, as well as episodic and declarative memory, i.e. the memory and retrieval of events and facts as in textbook learning. Damage to the temporal lobes can cause aphasia, the loss of the ability to form and comprehend language. Damage to the right temporal lobe can result in impaired performance of spatial tasks, for example the ability to draw. If the temporal lobe is electrically stimulated, some persons report being present at two places at the same time. They are conscious of the present moment, as well as of another event stored in memory. For example, they might feel they are at the same time in the kitchen of their home, cooking a meal.



The parietal lobe is a relatively large area located at the back of the hemisphere just above the occipital lobe. Much less is known about this lobe than about the other three lobes. It is involved in touch, pain, and taste sensation, visual and spatial perception, and body orientation. It seems that the parietal lobe is where we put our world together. The parietal lobe integrates visual information and constructs maps and coordinate systems that represent how we see the environment. Another function of the parietal lobes is to combine letters into words, and words into sentences. Damage to the left parietal lobe can lead to Gerstmann's syndrome which includes the confusion of left and right, impairment of with writing (aphasia) and calculation abilities (acalculia), and difficulty with recognising body parts (agnosia). Damage to the right parietal lobe can result in difficulties with spatial perception, such as unilateral neglect, the limited conscious awareness of information coming from one side of the body, and constructional apraxia, the inability to draw or construct simple configurations.



Primary motor cortex controls body parts movements.

The frontal lobe, just behind the forehead, is the largest of the four cortical lobes. It controls much of the rest of the brain's functions. In particular, it is responsible for the higher functions, such as reasoning, planning, organising, problem solving, selective attention, and personality. The frontal lobe is highly connected to the limbic system, which suggests that it is involved in emotions. Moreover, it plays a key role in memory, language processing, speech production, and movement. Cognitive maturity in adulthood is associated with the maturation of cerebral fibres in the frontal lobe. The frontal lobe contains a great number of dopamine-sensitive neurons, which are linked to pleasure, motivation, attention, problem solving and long-term memory. Broca's area, located at the base of the frontal lobe just above the parietal lobe, is thought to be responsible for the production of speech. Brain damage to this area causes expressive aphasia, the inability to form sentences. If the frontal lobes are damaged, the individual may show symptoms of dementia, such as becoming incapable of planning and executing, incapable of comprehending situations and ideas, unable to focus attention, and being distracted by irrelevant stimuli. Other symptoms include impairment of short-term memory, lack of inhibition, and difficulty in learning new information.

The primary motor cortex is located in the precentral gyrus of the frontal lobe, running from the longitudinal fissure at the top of the brain down to the lateral fissure. It controls movements of specific body parts. Electrical stimulation of certain areas of the motor cortex results in movement of the associated body part. From top to bottom, these are feet, legs, hip, trunk, elbows, hands, and face. The areas are not represented in proportion to the size of these body parts. For instance, the areas for the hand and its individual fingers, as well as the area of the face and its different parts are larger than the areas for other body parts. The primary motor cortex receives feedback from the primary somatosensory cortex to which it is intricately linked. The primary somatosensory cortex, located in the postcentral gyrus behind the primary motor cortex, is the main sensory receptive area for the sense of touch. These two areas wok in conjunction with the secondary motor cortex, located before to the primary motor cortex, which prepares movements and combines series of movements into coordinated sequences. Damage to the primary motor cortex disrupts the ability to move one body part (e.g. one finger) independently of another. It can also reduce the speed and accuracy of movements, but it does not cause paralysis.

Lateralisation and the split brain.

The two hemispheres of the cerebrum look almost identical, but at closer inspection we find significant differences. In 1836, a virtually unknown French country doctor found that all of his brain-damaged patients with speech problems suffered injuries to the left side of the brain. This early finding anticipated modern research of brain

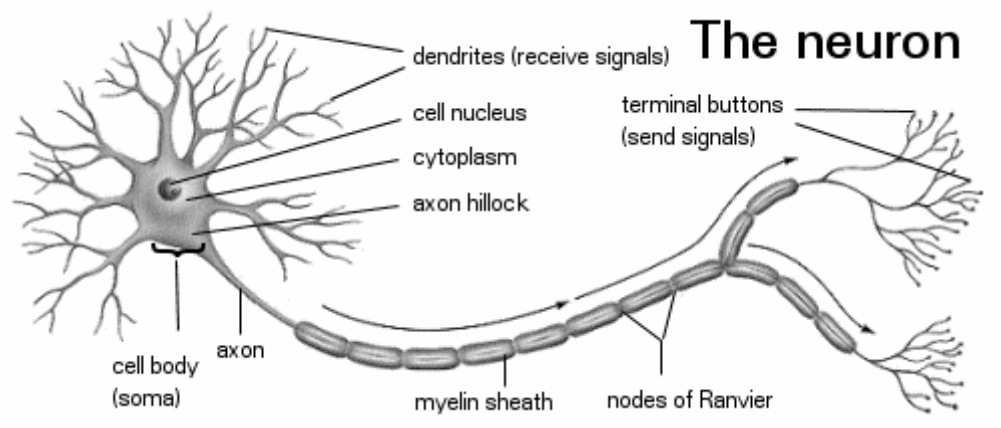
lateralisation. Clinical evidence suggests that the two sides of the cerebrum serve different functions. Injuries to the left side usually impairs reading, writing, speaking, calculation, and understanding. Injuries to the right side have less dramatic effects, but tend to affect spatial perception and movement. More extensive research has shown that the left and right hemisphere's involvement in certain functions is disproportionate.

Left Side Dominance	**General Function**	**Right Side Dominance**
Words Letters	Vision	Geometric Patterns Faces Emotional Expression
Language Sounds	Audition	Non-language Sounds Music
	Touch	Tactual Patterns (Braille)
Complex Movement	Movement	Spatial Movement Patterns
Verbal Memory	Memory	Nonverbal Memory
Speech Reading Writing Arithmetic	Language	Emotional Content
	Spatial Ability	Geometry Direction Distance Mental Rotation of Shapes

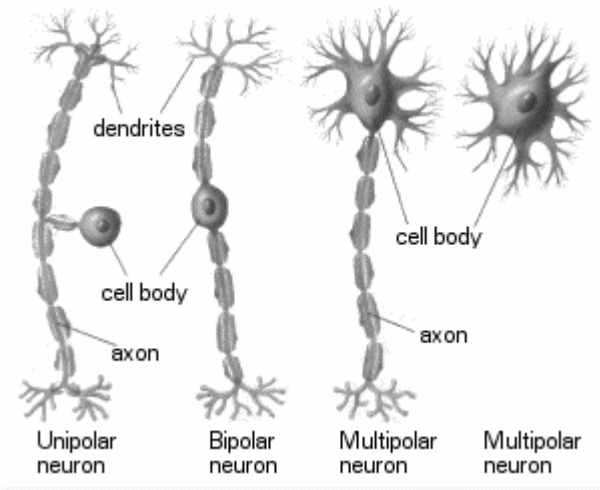
Yet, it would be wrong to speak of compartmentalisation. The hemispheres of the brain work in tandem as a complex whole. In a famous experiment in the 1950s, the American neuropsychologist Roger Sperry separated the corpus callosum, to treat epileptics. The corpus callosum is a strand of approx. 200 million nerve fibres connecting the left and right hemispheres, which the brain uses to transfer signals between the hemispheres. The patients remained largely normal, but each hemisphere worked independently. Human split brain patients seemed to have two independent brains, each with its own abilities, memories, and emotions. Notably, the left hemisphere of split brain patients was capable of speech, whereas the right hemisphere was not.

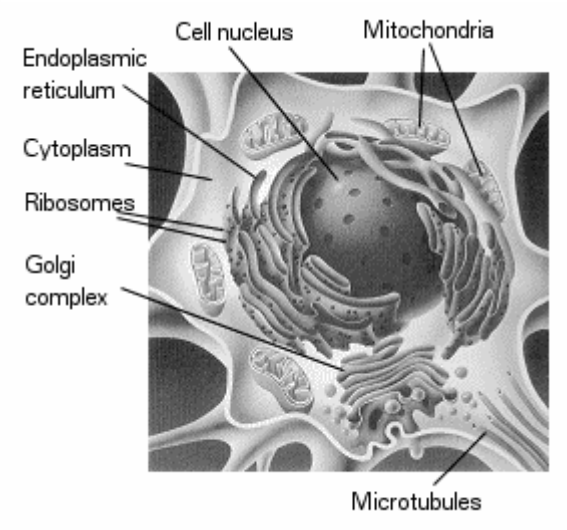
The Inner Workings Of The Brain

Although the structure and organisation of the brain seems highly complicated, all the different parts boil down to the same fundamental building block: the neuron. The neuron is a special type of cell which processes and transmits information by electrochemical means. Neurons are found in the brain, the spinal chord, and in the nerves of the peripheral nervous system. They come in a great variety of shapes and sizes, however, most of them look like the one in the illustration below. Neurons are tiny. The cell body (soma) has a diameter of only 10-25 micrometres, which is just a little bit more than its cell nucleus. Their quantity, however, is immense. The human brain has roughly 100 billion neurons, each of them having several thousand connections to other neurons. This comes up to a whopping total of 500-1000 trillion connections within the brain. No computer on earth has that many connections or such a massively parallel organisation. At any rate, the often cited brain-computer analogy is inept. Nervous systems are a far cry from the simple feed forward input/output circuits of a contemporary computer. Unlike a computer, the brain is a living thing; it can grow and change; and the processes of neural conduction is much more complex than signal conduction in the logical gates of a computer chip.



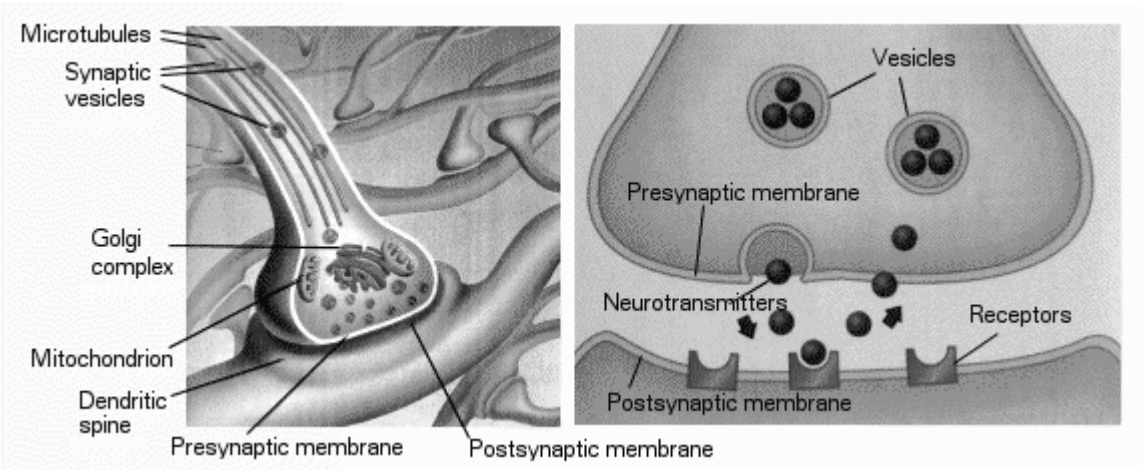
Neurons, or nerve cells, are eukaryotic cells which resemble all other cells in the human body with one exception. They are specialised in conducting information. The neuron has several fundamental characteristics. It has an excitable membrane which allows it to generate or propagate electrical signals, a tree of dendrites which receive signals, and an axon that transmits signals. The axon is a cable-like fibre that transmits nerve impulses from the neuron to other neurons. Axons are only about one micrometre across, but they can become extremely long. For instance, the axons of the sciatic nerve in the human body may run a metre or longer from the spine to the toes. This could be compared to a 50 cm calibre pipeline that runs 2000 km long. A layer of fatty cells, the myelin sheath punctuated by the unsheathed nodes of Ranvier, insulates the axons of some neurons and speeds the impulses. Each neuron has only one axon which usually branches out extensively and passes signals to multiple target cells. Terminal buttons at the end of each axon branch connect the neuron to the receiver cells via synapses. Thus the synapse provides the functional connection between different cells. It consists of the target area, which may be a spine, a dendrite, or a cell body, and the synaptic gap between the axon terminal and the receiver cell. The dendrites are a branching arbour of cell projections that receive signals from terminal buttons which they conduct to the cell body.





Neural conduction.

The principle of neural conduction can be described by neural impulses and synaptic transmission. These are two complementary methods of conduction which neurons are capable of. The neural impulse is either on or off, whereas synaptic conduction – based on the transmission of chemicals– is gradual. This can be likened to digital and analogue signal conduction. A neuron fires an impulse when it is stimulated by chemical messages from connected neurons, or by pressure, heat, or light. This impulse, called action potential, is caused by the depolarisation of the membrane potential of an excitable cell. Normally an electrical potential exists between the inside and outside of the cell. When ion channels in the cell membrane open, the exchange of ionised elements through the open channels causes an electric discharge. This impulse travels through the cell membrane and the axon hillock down to the axon and is then carried away from the cell. It propagates through the body at a speed of 10-100 metre per second, depending on the type of axon. The impulse doesn't travel like an electrical signal, but rather through successive depolarisation of adjacent areas of the axon membrane, much like falling dominoes. During a very brief resting pause, the neuron pumps positively charged atoms back outside the membrane, after which the neuron is ready to fire again. This electrochemical process can be repeated 100 times per second.



Synaptic transmission is different. There are two type of synapses, electrical and chemical synapses. Electrical synapses couple neurons electrically via gap junctions. Chemical synapses work through the exchange of special chemicals called neurotransmitters. There are some 75 known neurotransmitters which amplify, relay, or modulate signals between neurons and other cells. These substances are produced by the soma, the chemical factory inside the neuron. The neurotransmitter molecules are usually packaged in spherical vesicles. These vesicles are conveyed through the axon towards the terminal buttons through special channels called microtubules, which are tiny pipelines running inside the axon. When a neural impulse reaches the knob-like terminals of the axon it triggers a biochemical cascade which causes the vesicles to fuse with the presynaptic membrane and release their neurotransmitters. The neurotransmitter molecules then cross the synaptic gap from the presynaptic membrane to the postsynaptic membrane within 1/10,000th of a second. It is like a very brief rain shower of neurotransmitters. Receptors on the postsynaptic membrane bind the neurotransmitter molecules. For a very brief period, ion channels on the postsynaptic membrane open to allow ions to rush in or out. This causes the transmembrane potential of the receiver cell to change. There are two types of changes. Depolarisation causes an excitatory postsynaptic potential; hyperpolarisation causes an inhibitory potential.

With this knowledge we can understand how neurons work together in the brain. Neuron A fires and reaches neuron B via the synapse AB. If the postsynaptic potential is excitatory and if it is strong enough to reach the action potential threshold, then neuron B fires. Synaptic strength is defined by the change in the transmembrane potential. If the potential does not reach the threshold value, neuron B might still fire if it simultaneously receives excitatory messages from other synapses. Thus multiple weak excitation can also trigger a postsynaptic action potential. On the other hand, neuron B might receive inhibitory messages from other synapses. In this case, neuron B might not fire, even if it receives a excitatory potential from a strong synapse. Thus a single neuron behaves a bit like a relay. This relatively simple behaviour lies at the root of neural firing patterns. The neuron's status is either on or off, i.e. firing, or at rest. The complexity of neural firing patterns arises from the nature of synaptic connections. There is one thing we forgot to mention, however. What happens to the neurotransmitters after they are left in the synaptic gap? Obviously, multiple neurotransmitter releases from the terminal buttons would eventually accumulate and clog the synapse. However, this does not happen. There are two mechanisms that terminate synaptic transmission: reuptake and enzymatic degradation. The majority of neurotransmitters are almost immediately drawn back into the presynaptic buttons after release. There they are repackaged into vesicles and then recycled. This mechanism is known as reuptake. Other neurotransmitters are broken apart by enzymes after transmission and are thus deactivated.

Neurotransmitters and brain chemistry.

Neurotransmitters are messenger substances. They can be classified into five different types of substances: amino acids, monoamines, neuropeptides, acetylcholine, and soluble gases. Amino acids are the most common neurotransmitters. Among them are glutamic acid and gamma-aminobutyric acid (GABA), which are the principal neurotransmitters in the human brain. Other well-known substances include noradrenalin, dopamine, and serotonin, which belong to the group of monoamines. Glutamate is the most prevalent excitatory

neurotransmitter in the mammalian central nervous system, and GABA is the most prevalent inhibitory neurotransmitter. A neurotransmitter produces either excitation or inhibition. Only in rare cases, where the effect is dependent upon the receptor subtype, a neurotransmitter causes both inhibition and excitation. The receptor is the protein molecule in the postsynaptic cell that binds the neurotransmitter and initiates a reaction. Once again, there are different types of receptors, such as ion-channel linked receptors, chemically activated ion channels, and G-protein linked receptors. To simplify things, we can imagine neurotransmitters as keys to certain receptor locks, which –once unlocked– initiate an excitatory/inhibitory process in the postsynaptic cell.

Acetylcholine

Acetylcholine (ACh) is the messenger at junctions between motor neurons and muscle cells. When ACh is released to muscle cells, the muscle contracts. If ACh release is blocked, the muscle cannot contract. Curare, the poison used by South American Indians for hunting with darts, blocks ACh receptors and thus paralyses the victim. Curare leads to death through suffocation, because the victim cannot contract the respiratory muscles anymore. By contrast, the neurotoxin of the black widow spider triggers a synaptic flooding of ACh, and thus causes painful contractions, convulsions, and possible death.

Glutamic acid and GABA

Glutamic acid (glutamate) and Gamma-aminobutyric acid (GABA) are the excitatory and inhibitory workhorse neurotransmitters of the nervous system. It is believed that glutamic acid is involved in cognitive functions, such as memorising and learning, because of its role in synaptic plasticity. Glutamic acid overstimulation is associated with diseases like amyotrophic lateral sclerosis, lathyrism, and Alzheimer's disease. Glutamic acid excess can cause neuronal damage and eventual cell death. Glutamic acid is also the precursor of GABA which is synthesised with the help of an enzyme whereby the excitatory neurotransmitter is converted into an inhibitory one.

Dopamine

Dopamine is crucial to physical and mental health. It has a role in movement, cognition, pleasure, and motivation. Neurons containing the neurotransmitter dopamine are clustered in the midbrain in an area called the substantia nigra. A shortage of dopamine and the death of dopamine neurons causes Parkinson’s disease which is associated with depression and the loss of control of movement. Dopamine in the frontal lobe regulates the information flow from other areas of the brain which is vital to memory, attention, and problem solving. Dopamin depletion in the prefrontal cortex is associated with attention deficit disorder and schizophrenia. Disruptions of the dopamine system are also linked with psychosis. However, the most recognised role of dopamine in the brain is providing pleasure and enjoyment, hence, dopamine has also been termed the “reward chemical”. Dopamine is released in the course of rewarding experiences such as food, sex, and other stimulating experiences.

Epinephrine and norepinephrine

Epinephrine (adrenaline) and norepinephrine (noradrenaline) are the body's stress hormones which are typically involved in fight-or-flight situations. Epinephrine and norepinephrine are released into the bloodstream from the ardrenal medulla. The secretion of these substances is the physiological response to a threatening or exciting situation. Environmental stressors (such as bright lights, piercing noise, etc.) also cause release. The two substances are structurally very similar and they function both as neurotransmitters and hormones. As neurotransmitters they mediate chemical communication in the sympathetic nervous system, a branch of the autonomic nervous system. Among the major effects mediated by epinephrine and norepinephrine are increased heart rate, blood vessel constriction and increased arterial blood pressure, dilation of bronchioles assisting in pulmonary ventilation, stimulation of the fat burning process, dilation of pupils, increase of metabolic rate and muscle readiness, and inhibition of non-essential function, such as digestion.

Serotonin

Serotonin is an important neurotransmitter synthesised by so-called serotonergic neurons in the brainstem. The serotonin system is the largest single system in the brain, influencing a broad range of basic functions. Serotonin is important, because it plays a key role in the regulation of mood, sleep, appetite, vomiting, and sexuality, and because it is associated with a host of mental disorders, such as depression, bipolar disorder, and anxiety. Serotonin differs from other neurotransmitters in one respect. It is able to modulate the effect of other neurotransmitters, making it effectively a "master" neurotransmitter. Serotonin is known to unlock 14 or more different receptor subtypes, each of which has a distinct function in regulating impulses, motivation, moods, and appetite. Low moods and low motivation are associated with low serotonin levels. There are antidepressants on the market, e.g. Prozac, Zoloft, and Paxil, which act as serotonin reuptake inhibitors and thus increase the availability of serotonin in the brain. Other medications increase the serotonin reuptake and reduce serotonin levels. These medications are used to aid or tweak an imbalanced serotonin system.

The Question Of Free Will

The question of free will is an important question in philosophy. It has occupied the minds of philosophers for over two millennia, and -despite its simplicity- it is one of the deepest, most puzzling quests in philosophy. It can be phrased as follows: We all believe intuitively that we have free will. For example, if we order lunch in a restaurant, we believe that we are free to choose an item from the menu. Provided that we have money to pay for the chosen item and that the restaurant has all the required ingredients, there is no compulsion or necessity to order one item or another; it's all up to us. In fact, we make such decisions all the time. While you are reading this, for example, you decide whether this topic is interesting enough to continue reading. You are a free agent making a free choice. At least so it seems.

The Problem

1. A person acts upon his/her own free choice.
2. Free choice means the person could have acted otherwise.
3. Actions are events.
4. Every event has a cause.
5. If an event or act is caused, then it is causally determined.
6. If an act that is causally determined, then actor could not have acted otherwise.
7. Therefore free choice doesn't exist.

Determinism

I could hold against it that you are not making any free choice at all, but that your choices are already determined by the time you make it. They are determined by the present conditions; that is outer conditions, such as environmental factors, events in your world, external necessities and inner conditions such as your genes, mental state, preferences, habits, and so on. I can also argue from a physicalist point of view: All decisions happen in your brain. Your brain is a physical object and the processes inside your brain are ultimately physical processes which have causal relationships. This means that a decision can be viewed as a volitional impulse, or a certain brain state T' at a time t' preceded by another brain state T at a time t, and which is explained by the causal relationship T--> T'.

This view is called determinism. If you prefer a less abstract account, you could say that determinism views the universe as a giant machine. Every event in the universe is caused by antecedent events, which are themselves caused by other events, which are again caused by other events. Every event or phenomenon has thus infinite causal tentacles attached to it and each of these tentacles reach endlessly into the spacetime history of the universe. Human beings including me and you are simply parts of this machine. Whatever you do, whether you sit down on a chair, scratch your head, or blow your nose, is fully determined by antecedent causes and could therefore not have happened otherwise. Hence, free will is an illusion.

Causal determinism argues from the premise that the future is determined by the past. This view is anchored in a mechanistic world view that understands the universe in terms of causal relations. It is illustrated most clearly in the thought

experiment of “Laplace's demon” which is named after the 19th century French scientist Marquis de Laplace. The Marquis said in his *Essai philosophique sur les probabilités*, “We may regard the present state of the universe as the effect of its past and the cause of its future. An intellect which at a certain moment would know all forces that set nature in motion, and all positions of all items of which nature is composed, if this intellect were also vast enough to submit these data to analysis, it would embrace in a single formula the movements of the greatest bodies of the universe and those of the tiniest atom; for such an intellect nothing would be uncertain and the future just like the past would be present before its eyes.”

Libertarianism

Although Laplace's idea of an “iron block universe” is now obsolete, the determinist argument is still compelling. It is difficult to evade the logic of a linked chain of causes. Yet, a clever debater may juxtapose the causal chains of determinism with chains of free decisions and construct a history of free will. To illustrate this, let's go back to the restaurant example. I could say that my choice of lunch is completely free, except for the limitations given by the menu. For example, I would not be able to order a pizza in a sushi restaurant. The limiting factor can be attributed to my antecedent free choice, namely the choice of the restaurant. Yet, this choice was also partly determined by external factors, such as the proximity of the restaurant and the opening hours. Again, I could argue that I have previously chosen my location as well as the time to appear at the location, and so on. What I am doing here, is viewing the same events from a perspective that emphasises volition rather than the external circumstances. I am implying that decisions emanate from me, rather than me being caused to act in a certain way. In other words, my premise is that my decisions are self-caused. Causality cannot be traced back beyond my inner world. The buck stops here. This view is called libertarianism, or rather *metaphysical libertarianism* in order to distinguish it from *political libertarianism*.

Metaphysical libertarianism is founded on two assumptions: (1) that human beings are rational agents who posses the capacity of freely choosing one action among various alternatives; (2) that human beings are either exempted from causal determinism, or that causal determinism is not applicable to the mind. There are a few things which speak in favour of this position. For example, it assigns the capabilities of deliberation, self-control, self-moderation, self-guidance, and even self-mastery to human beings. Without these capabilities, human beings would be pretty much like mindless buoys who believe they can swim, while they are really just bobbing up and down in a deterministic ocean. Most importantly, libertarianism assigns moral responsibility for their actions to human beings. Without moral responsibility, there would be no point in punishing or praising people for their actions. There would be no need for laws. Thus libertarians often defend their position by deconstructing determinism:

Hard determinism, which rejects free will altogether, results in several absurdities. First, the absence of free will contradicts our direct experience. We experience the act of making choices as exercising control over future events. Rationality would be impossible without the capacity of choice. Second, the deterministic view invalidates moral quality of actions and ethical choices, since humans follow a plot and are therefore not more responsible for their acts as a machine is responsible for processing a program. A compassionate human being is then simply a compassion machine, while a murderer is a murder machine. Third, the deterministic view does

not accommodate recursion well, such as self-awareness and reflection. For example, if we act following a causal behaviour pattern, we can say we are trapped in this pattern until we become aware of it. Once we become aware of the cause and effect of our own behaviour, however, this awareness influences our behaviour, and possibly even changes it persistently. Determinism does not account for this phenomenon. It cannot explain the quantum leap in consciousness required for self-awareness. More generally, it cannot account for the phenomenon of awareness itself.

Problems of libertarianism and indeterminism

As we can see, hard determinism has some flaws. What about its antithesis, libertarianism? – The biggest challenge for libertarians is to explain uncaused volition, that is how decision making ex nihilo actually happens. Libertarians usually choose to argue from either a supernatural or a naturalistic position. The supernatural position is based on the idea that the human mind is exempt from ordinary causality. This is achieved by posing an entity, such as a soul or mind, which exists apart from the causal machinery of the universe. This position amounts to dualism and therefore suffers from the same shortcomings as dualism.

The naturalistic position avoids dualism by claiming that the universe itself is not completely deterministic and that there are indeterministic phenomena -such as quantum phenomena- with unpredictable outcomes, which afford human beings freedom of choice. This argument is not terribly coherent, because even if we assume that the nature of mind is indeterministic at some level, there is nothing gained in terms of freedom. A choice that is in no way determined, is simply a random event. An indeterministic decision is therefore just as unfree as a deterministic decision. For example, an (indeterministic) quantum computer is just a far from making a free choice, as a conventional (deterministic) computer. This means that indeterminism raises exactly the same problems as determinism. In both cases, choices are the result of an anonymous process, rather than the result of the deliberation of a rational agent.

Compatibilism

A solution for this problem was suggested by the British philosopher David Hume (1711-1776). He championed the view that there is no fundamental contradiction between determinism and free will and that both concepts are compatible. He begins with rejecting the notion of reason acting upon volition. In his *Treatise of Human Nature* he states, “Since reason alone can never produce any action, or give rise to volition, I infer, that the same faculty is as incapable of preventing volition, or of disputing the preference with any passion or emotion.” For Hume it is rather passion, desire, and emotion which cause volition and he concludes -in accordance with the deterministic view- that these are caused and determined by the character, beliefs, and the overall psychological makeup of a person. However, he makes the important distinction that human beings have free will on account of the *hypothetical* ability to chose differently under different circumstances.

This means: for any given situation, if one either has a different psychological disposition or if the external circumstances are different, then the outcome of the decision will also be different. According to Hume, this is what free will really means, as opposed to coercion, meaning acts brought about through the application of force. Examples for unfree acts would be handing over your money to a robber who holds a

gun to your head, or a mentally insane person who acts upon the imposition of hallucinations. More than a century earlier, Thomas Hobbes (1588-1679) had made a similar argument. He stated quite simply that a person acts freely if that person willed the act while having been able to do otherwise. Hobbes adds that will itself is not free, but only the person exercising it is. The notion that free will equals uncoerced choice is also present in Hobbes argument. Thus for the classical compatibilists, the causal mental factors that effectuate choice are simply a non-issue. Whether they are deterministic or indeterministic in nature doesn't matter, since they are wholly owned by the person who exercises will and makes choices.

Incompatibilism

Needless to say that this argument did not satisfy everyone. Quite a few determinists and libertarians see compatibilism merely as a rhetoric device that evades the problem of free will by shifting perspective to a modal argument without referring to the inner reality of the decision maker. Hence, incompatibilism is the position that free will and determinism are mutually exclusive. The incompatibilist agrees that absence of coercion is necessary for free will, but denies that it is sufficient. According to incompatibilism, free will exists only if (1) there are alternative paths of actions available to the agent, and if (2) the agent is not in any way predetermined to choose one of these paths. This does of course lead back to the question of the nature of decision making: what mental processes are involved in decision making and whether they can be explained with strict causal models.

A Modern View

We have discussed the classical views on free will and determinism. In the meantime, science has gained more insight into the psychological and physiological aspects of decision making. The classical arguments of determinism and libertarianism are still valid, but they neither shed much light on the psychology of decision making, nor on the internal neural workings of decision making. An important modern concept is the subconscious. The subconscious is the part of the mind that operates and processes information outside the focus of awareness. Over the past decades, psychologists have collected convincing evidence not only for its existence, but also for the fact that the vast majority of information that our bodies receive is processed subconsciously, which means without us being aware of it. The subconscious mind can thus be likened to a workhorse with massive parallel processing power and the conscious mind can be likened to a narrowly focused high-energy beam. Both parts of mind are thoroughly connected and operate together as a whole. Decision making can take place either consciously or subconsciously, or perhaps also semi-consciously. What does this imply in view of free will?

Intuitively we might say that subconscious decisions are unfree or to a lesser degree free than conscious decisions. We tend to think that only conscious decisions can be called free, because only these involve reasoning processes, or what we call rational thought. Since rational thinking does not take place subconsciously, subconscious decisions happen mechanically and are therefore in some way predetermined by the existing mental programs and memories. In this regard, subconscious decisions aren't much different from the heartbeat and from other autonomic functions. But what about conscious decision making? Before we discuss this question, we must first ask another question, namely whether decisions generally originate consciously or subconsciously. What about conscious behaviour, like moving an arm, for example?

Brain studies have shown that movement, which is controlled by the motor cortex, is preceded by the build-up of an electrical potential in the brain called “readiness potential”. Notably, this readiness potential builds up *before* the person becomes aware of their intention to move. This observation suggests that volition (to move a body part) takes its beginning in the subconscious mind. Only when there is a sufficient potential becomes the volitional impulse conscious. What are the implications? Do all decisions originate unconsciously? Are we causality-driven robots with the luxury of ex post awareness?

Conscious Self-Reflection And Alternative Realities

The answer to this question lies in the nature of consciousness. There are certainly many mechanical actions we perform with minimal awareness. Breathing, blinking, scratching an itch, walking, or even hitting a sequence of keys on a keyboard to produce a certain word are typical examples of low-level actions, which are often (though not always) performed unconsciously. Emotions, feelings, and volitions all arise subconsciously. Once these mental events rise to the surface and enter the light of consciousness, however, things suddenly change. They take on a different quality on account of being observable. Here is an example: Let us say we get angry about something. As the anger rises within us, we might feel the impulse to bang our fist on the table. Before the table banging action is executed by the body, however, we become aware of our anger as well as of our intention to bang our fist on the table. In a split second, we decide that this is not an appropriate reaction to the situation, because it would offend and irritate people. Consciousness thus steps in, vetoes the decision, and orders the motor cortex to loosen the fist. Now what happened? Did we exercise free will?

The key to understanding this lies is in the phrase “becoming aware”. At the very moment we self-reflect and become aware of our internal state, that same state is inevitably modified. It isn't *us* modifying our internal state willingly. There is no agent. It is just consciousness affecting our internal processing. As long as we are unaware and not self-reflecting, things take their linear machine-like course. There is only one outcome with near 100% probability, which is acting on the impulse. If there is no awareness of our internal state and of the consequences of our actions, then we can only act on the impulse. Awareness changes this. To use a metaphor from quantum mechanics, one could say that the reverse of a wave collapse occurs. Instead of a single outcome with 100% probability, there are suddenly several superposed possible outcomes, each with n% probability. These are possible courses of action which suddenly become available and accessible to our mind on account of awareness. These alternatives quickly collapse again into a single reality as soon as the mind makes a decision. However, the outcome of that decision may be crucially different from the outcome without self-reflection.

In the above example, consciousness performs the function of a watchful policeman, observing mental events as they move outward from the inner to the outer physical world. Analogously, consciousness stands guard at the doors of perception in the other direction, from the outer to the inner world. For example, audiovisual consciousness may alert us about an approaching vehicle and help us to determine whether body movements are required to avoid collision. However, consciousness does not have the capability to change events on its own. The energy (will) needed to alter the course of events and actions comes from a different source. The role of consciousness is not to intervene, but to create alternative possibilities. Strictly

speaking, consciousness does not even create these possibilities. It just reveals them to us. Once the alternative possibilities are revealed, volitional energy might take a different course in the same way as a river might take a different course when it hits upon a newly found channel or trench. As this results in an alteration of the flow of internal (mental) and external (physical) events, it affords us the impression of free will. Yet, it is neither free will in the classical sense, since there is no agent involved, nor is it a strictly mechanical process as suggested by classical determinism.

Nonlocal Consciousness

Many regard consciousness as the final frontier of science. Although science has produced a great deal of knowledge about the brain and the nervous system, it did not (yet) produce a viable theory of consciousness. There is the seemingly intractable problem that consciousness cannot be measured, detected, or quantified in any way. To further complicate things, consciousness is about inner (first-person) experience and its subjective qualities, whereas science relies on ideas and experiences that can be observed and verified by third parties. The investigation of inner phenomena involves subjective, idiothetic accounts, whereas the investigation of outer phenomena involves objective, verifiable accounts. It would seem that the scientific method, which relies on repeatable experiments to test a hypothesis, reaches its limits when dealing with consciousness. One must therefore ask whether science is able to explain consciousness at all.

Scientists have responded to these problems in two ways. One group claims that consciousness is not a scientific concept to begin with, that its is too vague, and that claims involving consciousness are unverifiable. This position was taken to the extreme by the 20th century behaviourist movement, which simply ignores consciousness. It tends to see the mind as a hypothetical construct, disregarding internal states entirely, only considering external states (behaviour). The other group of scientists acknowledges the existence of internal conscious states and claims that these can be fully explained by neuroscience. There is a variety of such views, known as materialism, reductionism, functionalism, and biological naturalism. Some proponents of these views assert that consciousness is a “bag of tricks” (Dennett) and that -by and large- it has already been explained by neuroscience.

But perhaps this is jumping to conclusions. Science postulates a materialist understanding of consciousness, but there are significant gaps in this understanding. The materialist view occasionally appears like that of the mythical tribesman who discovered a TV set. Although ignorant of the existence of radio waves, he is confident that he understands the origin of the voices and images in the TV. After he has carefully disassembled the TV, he is able to demonstrate that applying a voltage to certain points produces an audible noise in the speaker, or a dot of light on the

screen. He has even worked out how the electron beam can be modulated to create a matrix of dots. On account of these discoveries, he triumphantly declares that the voices and pictures are produced inside the electronic circuits of the TV set and that the operating principle of the TV set can be explained without invoking "supernatural" radio waves. Yet, his fellow tribesmen are not quite satisfied with this explanation. It seems too mechanical to them and they keep wondering why the voices and images in the TV set appear so real. The tribal scientist justifies himself: "We have not worked out all the details yet, but we understand the principle."

This situation is perhaps analogous to present day consciousness research. Mainstream scientists and philosophers believe that consciousness is based on and produced by the brain. This might be compared to the idea that TV images and sounds are produced inside the TV set. Obviously, in case of the TV set, it is only half the truth. The TV images and sounds are neither local to the TV set, nor do they have a life of their own. They are produced elsewhere and transmitted by radio waves. We all know that a TVs have an antenna and a receiver that pick up radio waves and translate them into voltages to generate images and sounds.

What if the brain and nervous system relate to consciousness like the TV set to radio signals? Let's call this the nonlocal model of consciousness. If we accept the nonlocal model of consciousness provisionally, we can compare TV reception to sense perception. We can compare qualia (conscious experience) to TV images and sounds; we can compare memories to the recording function, thoughts to the playback and edit functions, and mental chatter to audiovisual noise. Furthermore, if the nervous system/brain functions as receiver/modulator of consciousness rather than its producer, it follows that consciousness is not based on the brain, but that the brain is based on consciousness. There are a number of theoretical considerations and phenomena that point in this direction. These phenomena show the limits of the current mainstream (materialistic) understanding of consciousness and provide theoretical support for the nonlocal model of consciousness. In the remainder of this section, we will look at five such points: a) the epistemic gap in materialism, b) the absence of a neural correlate of consciousness, c) out-of-body experiences (OBEs), d) near-death experiences (NDEs), and e) the measurement problem in quantum physics.

The epistemic gap

The epistemic gap, also known was the explanatory gap, is the gaping hole in materialist ontology. It is the failure to explain how something immaterial, such as conscious experience, arises from something material, such as the brain. The epistemic gap can also be phrased as follows: How does subjective experience arise from electrochemical processes in the brain? Subjective experience -or qualia- seems to be entirely nonphysical. No scientist has managed to explain how qualia arise and why they arise. After all, we can perfectly well imagine an organism responding to external signals and stimuli without being conscious of them. Materialism offers two different approaches to deal with the "problem" of mind: reductionism and emergentism. Reductionism argues that it is principally possible to reduce higher-order systems to lower-order systems. It postulates that mind is a higher-order system that can be reduced -in principle- to the biological system of the human brain and body. The biological system can in turn be reduced to chemistry, which can again be reduced to physics. Therefore -according to reductionism- mind is ultimately physical. The problem with this approach is that reductionism cannot point out the

causal relationships involved in each step of the reduction. On this account, reductionism fails.

The non-reductionist approach -known as emergentism- holds that the higher-order system emerges from the lower-order system on account of supervenience. The concept of supervenience is defined as follows: A set of properties A is said to supervene upon another set B if no two things can differ with respect to A-properties without also differing with respect to their B-properties. In other words, any difference in the higher-order system implies a difference in the lower order-system. It is said that mind supervenes on the biological system and that mind displays new emergent properties which are not intrinsic to the underlying system. Upon closer inspection, we find that emergentism suffers from the same problem as reductionism. It fails to account for the causal relationships between higher and lower order systems. Supervenience cannot explain why properties are related as they appear. Hence, invoking supervenience is a bit like appealing to magic. It is not an explanation at all. This strongly suggests that the epistemic gap cannot be bridged by materialism.

Absence of a neural correlate of consciousness

The French philosopher René Descartes held that the soul was located in the pineal gland and that consciousness emanates from it. This is often cited as the first attempt to relate consciousness to a biological structure. While the study of the brain can be traced back to ancient Egypt, modern neuroscience began in the latter half of the 20th century. Since then, neuroscientific research has produced a massive amount of data and knowledge about the brain which is still growing at a fascinating pace. One of the goals of neuroscience is to correlate mental states with biophysical states, systems and processes in the brain. This effort has only partly been successful. For example, we can correlate the capacity of speech to the Wernicke and Broca areas. We can correlate motor action to the motor cortex, vision to the optical nerve and the visual cortex, certain feelings such as arousal, pleasure, and excitement to neurotransmitters.

However, the search for the neural correlate of consciousness has come up empty. Decades of research did not produce what was originally envisioned by neuroscientists – the correlate or substrate of phenomenal consciousness. At the beginning of the 21st century, conscious experience remains as enigmatic as ever. This is not to say that it eludes neuroscience completely. Many epiphenomena of conscious experience -from brainwaves and brain chemistry to neural activity- have been explored and can be matched to certain types of experience. Yet, it is phenomenal experience itself that puzzles scientists. There is no causal explanation that leads from brain states to qualia. There are no neural correlates for thought, beliefs, and ideas. In fact, most neuroscientists have given up the search for the neural correlate of conscious experience. They feel that it is the wrong approach. The absence of a neural correlate suggests that consciousness does not originate or reside in the brain at all.

Out-of-body experiences

Out-of-body experiences (OBEs) are ostensibly based on the separation of consciousness from the body. Those who experience an OBE report that they see their own body from the outside, that they float through space, and that they can penetrate

solid objects. With a prevalence of 5%-10%, OBEs are more common than generally believed. Although an OBE often occurs spontaneously, or as a consequence of body trauma, it can also be self-induced. Experienced out-of-body travellers can prolong the experience and travel at will. There are two theories about it: one says that there is something that leaves the body; the other says nothing leaves the body and that OBEs are complex hallucinations caused by non-ordinary brain states. Both theories are problematic, because the first relies on the paranormal concept of an "astral body", and the second theory cannot account for the complexity of the experience and its veridical aspects.

There are many reports of so-called veridical OBEs. These involve correct accounts of remote objects, events, or people which are later verified by a third person. For example, the subject might report about people in another room, or things that are outside the field of vision and cannot possibly be perceived through the sense organs. Several veridical OBEs have occurred under laboratory conditions. Dr. Michael Sabom reported 32 cases of cardiac arrest patients who were able to describe their resuscitation in great detail. Dr. Pim van Lommel and Dr. Kenneth Ring have published similar studies with well over 100 cases of veridical OBEs. Dr. Charles Tart has conducted an experiment where the subject has correctly identified a 5-digit number that was placed on top of a shelf -invisible to the subject- after an OBE. Mainstream science cannot explain these findings. Veridical OBEs can be explained if we assume that consciousness is nonlocal to the brain.

Near-death experiences

Near-death experiences (NDEs) are reported by 10%-15% of all people who find themselves in a life-threatening situation due to critical surgery, cardiac arrest, an accident, or some other cause. Since most of these people end up in a hospital, the conditions for scientific study are favourable. The first case studies were published by E. Kübler-Ross, R. Moody et al in the 1970s. Since then a large amount of reports and studies with thousands of cases have been collected, more recently by B. Greyson, M. Morse, S. Parnia, P. v. Lommel and others. NDEs are conscious experiences at impending death that have recognisable features, such as a sense of well-being, love, and peace, movement through a tunnel or a passage, a bright spiritual light, meeting deceased relatives and friends and/or spiritual beings. The most astounding observation is that consciousness continues after clinical death. Recent studies have shown that these experiences can occur even when neuronal activity in the brain has ceased, so that -according to neuroscience- there should not be any conscious experience at all.

Sceptics argue that NDEs are caused by physiological processes in the dying brain. For example, they hold that the experience of a tunnel and bright light is caused by the loss of cell function in the visual system due to anoxia (lack of oxygen). However, while every patient with cardiac arrest experiences anoxia, not everyone experiences an NDE and not every NDE features a tunnel experience, which questions the causal connection. Other sceptics argue that the experience is caused by the release of dimethyltryptamine (DMT) or endorphines in the brain. Again, DMT release does not necessarily result in an NDE. DMT is also released at night time during sleep, though in smaller quantities, and it does not have the life-changing effect that NDEs are known for. Furthermore, if NDEs were a drug-induced, one would expect the experience to have personal random contents, much like a dream or an LSD trip. Reports of congenitally blind people who were suddenly able to experience vision in

an NDE make biological explanations even harder. So far, there is no coherent physiological explanation for the NDE phenomenon.

Dr. Pim Van Lommel writes in his paper *About The Continuity Of Our Consciousness*: "According to our concept, grounded on the reported aspects of consciousness experienced during cardiac arrest, we can conclude that our consciousness could be based on fields of information, consisting of waves, and that it originates in the phase-space. [...] Such understanding fundamentally changes one's opinion about death, because of the almost unavoidable conclusion that at the time of physical death consciousness will continue to be experienced in another dimension, in an invisible and immaterial world, the phase-space, in which all past, present and future is enclosed. Research on NDE cannot give us the irrefutable scientific proof of this conclusion, because people with an NDE did not quite die, but they all were very, very close to death, without a functioning brain."

Measurement problem in quantum mechanics

In short, the measurement problem in quantum mechanics is the problem how and why Schrödinger's wave function collapses upon measurement. The word "collapse" describes a transition from a superposition of different states of a particle, as described by Schrödinger's wave function, to a single state upon interaction. The measurement of physical quantum system always results in a definite state, whereas the wave function describes the evolution of the same system as a multitude of superposed states, each with a certain probability. In abstract terms, the wave function collapse describes the reduction of a system of potentialities to a single definite state. Since it is impossible to observe the collapse directly, a number of different interpretations exist. These interpretations revolve around several key questions, namely how nature behaves at the subatomic level, whether nature is deterministic or non-deterministic, and whether the observer plays a causal role in the wave function collapse.

The Copenhagen interpretation is one of the more popular interpretations of the measurement problem. It was first formulated by Heisenberg and Bohr in the 1920s, and it became later synonymous with indeterminism and Bohr's correspondence principle. Today, there are several variations of this interpretation. Since it asserts collapse upon measurement, one particular version of the Copenhagen interpretation posits that collapse is caused by a conscious observer, which implies that consciousness plays a participatory role in the measurement. Hence, it is called the *Participatory Anthropic Principle* (PAP), following J.A. Wheeler's Anthropic Principle. While PAP is considered speculative, many scientists feel that the classical paradigm of a separate observer can be questioned and that the role of consciousness needs to be reevaluated in view of quantum mechanics. The idea of consciousness interacting non-locally with physical systems could therefore be an important element in understanding how reality works at the subatomic level.