# PERCEPTION

GABOR LODI
LIDWIEN SCHUITEMAKER


*Perception*

Original title *Waarneming*
uitgeverij Filograph 2020
Translation Gabor Lodi and Lidwien Schuitemaker
Design, cover and illustrations
Gabor Lodi and Lidwien Schuitemaker
ISBN/EAN 9789077913321 NUR 730
uitgeverijfilograph@hotmail.com

## Content

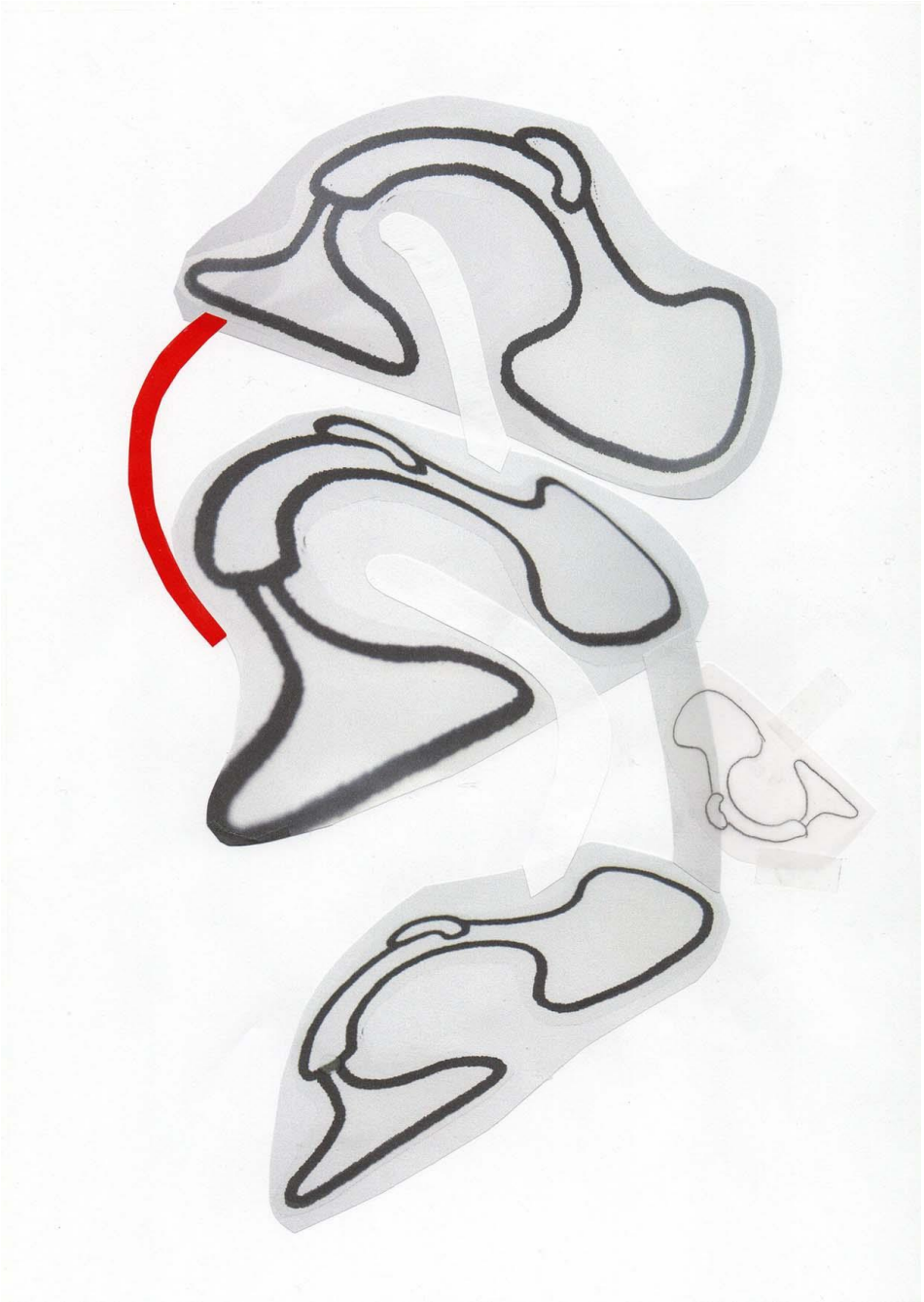
## Preface

The material world has produced our thinking, and with our thinking and our knowledge we explore the world. We perceive the world not only with the senses, but also with our knowledge. The ever-growing amount of stored knowledge about the most diverse human activities, and knowledge acquired by ourselves determine our perception. Knowledge gives content to our consciousness and is the limit of our perception. This essay addresses questions about perception, in particular the relationship between matter, thinking and knowledge. Is science a form of perception? Do mathematics and logic influence perception? Does artificial intelligence affect our perception? Is knowledge limitless?

Groningen, November 2020 for Elke and Otto

## Perception and knowledge

We are in contact with the world through our senses. Which senses we have is hereditary, but how the senses develop depends on the stimuli to which they are exposed. This is the beginning of the process of learning and knowledge acquisition. In the beginning of life, the individual is completely dependent on the care of others and the stimuli offered by the environment. If the senses are hardly stimulated from the first phase of their development, they are permanently hindered in their development. If the eye is not offered the necessary light stimuli from the outset, it can no longer develop optimally afterwards. The perception processes of people born blind can be disturbed by regaining their vision. They often do not know how to interprete the perceived, because they have not learned this in the beginning of their development .
The stimuli that our senses receive are only one part of our perception. With the knowledge stored in the brain we process the stimuli signaled by the senses, and based on this we perceive the world. Changes in our knowledge change our perception of the world. We interpret the signals that the eye provides us with the knowledge stored in our brains. We perceive the world through this knowledge. Visual perception does not happen in our eye but in our brain.
Our visual perception can be optically misguided in several ways. Well-known examples of optical deception are regularly used to show that signals provided by the eye determine our visual perception. The various forms of optical deception that give us a false image of reality cause according to some an incorrect perception of reality. But also for the optical illusions applies: the more knowledge we have, the better we are able to correctly interpret, and correct these illusions. This indicates that we perceive mainly with our knowledge and not just with our senses.
Our body has the ability to experience pain, pleasure, fear and other states of mind. Also in the interpretation of stimuli that trigger these states of mind knowledge plays a role. When the cause of fear is known, the fear can disappear. Due to the invention and application of the lightning rod, the fear of lightning has been significantly reduced, as has the fear of pain through the development of painkillers.

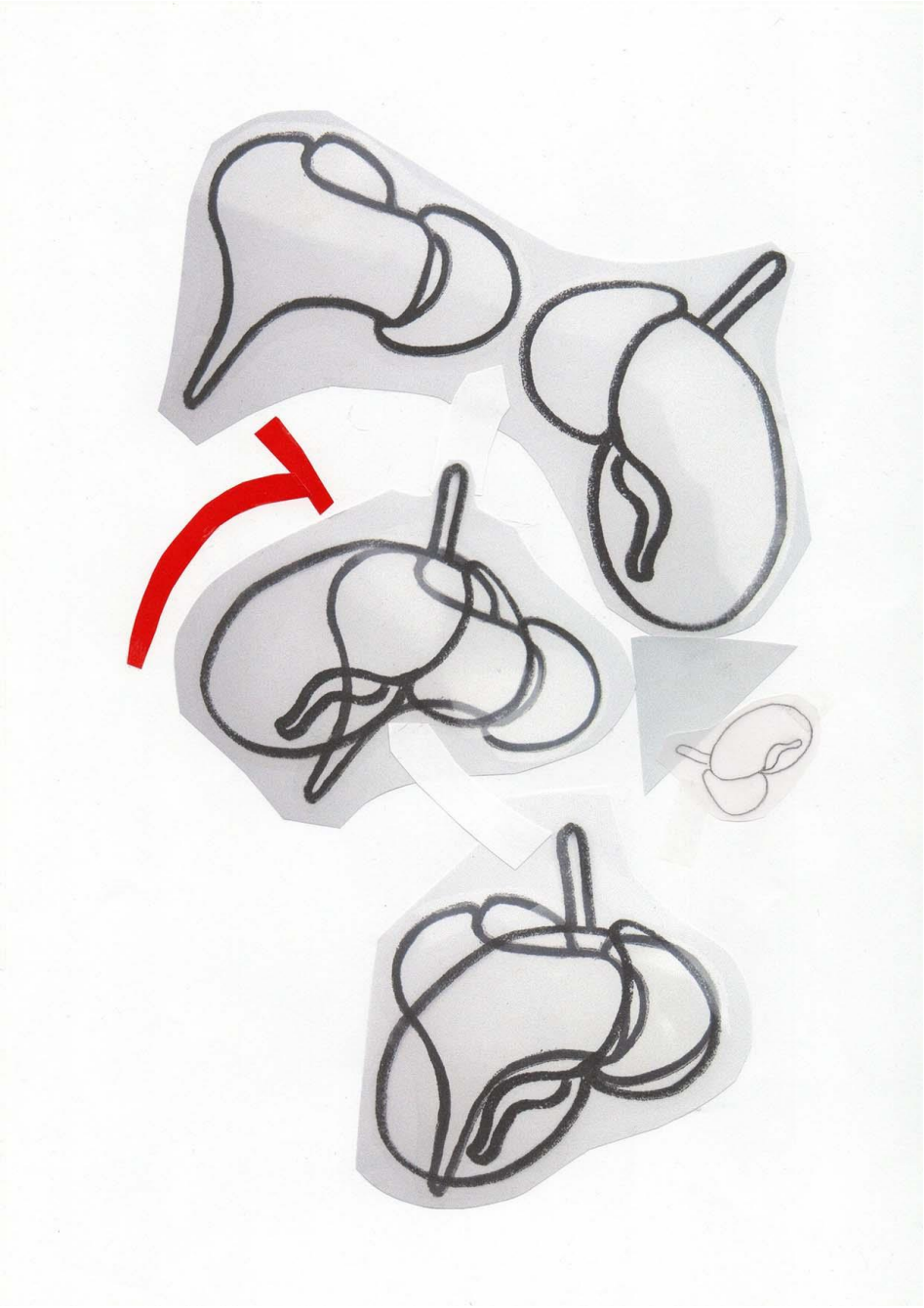


The brain has the property of storing the responses to stimuli, interpreting, remembering and combining these with the knowledge already present in the brain, and passing this on to others by various means. Man has access to knowledge through his senses and through all kinds of language (spoken language, written language, sign language, symbols) that include concepts and representations. Knowledge is stored in images, books, film and sound recordings, objects, tools, buildings, movements and other products. These products of activities are throughout history passed on by man to later generations. The individual does not become aware of the majority of events and activities directly but indirectly, through material in which these experiences are stored, such as books, historical paintings, films of past wars and 3-D animations of cosmological processes.

Knowledge has a collective and historical character, it is jointly developed by people and passed on from generation to generation. It is common to present the acquisition of knowledge as an individual matter. But the individual who gains knowledge depends on the available knowledge that is the product of our collective history, without which the individual is unable to think and act. Leonardo da Vinci is often referred to as a homo universalis and genius, but every person, including Leonardo da Vinci, is bound by the knowledge and realizable possibilities available in his time.

Unaccepted and not yet applicable knowledge is often not understood, ignored or dismissed as meaningless or as fantasy. Accepted knowledge can inhibit the development of new knowledge. For example, the mechanical world view still strongly influences our view, also in the field of microelectronics and nanotechnology. The limited mechanical vision hinders the development of new technologies and of new knowledge and thus our perception. Our knowledge and perception of the world will change by computer technology and new digital, virtual and microtechnology, as earlier technologies changed our perception and knowledge.

Knowledge comes from various sources: direct experiences, technology, scientific theories and experiments, and from the operation of political, legal and other social living systems. In connection with this, norms that cannot be deviated from have a



strong influence on our perception. In ancient Egypt the techniques, societal organization and prevailing views hardly changed for thousands of years, which is visible in the way of depicting and building. The fairly static nature of this society determined the perception and life of the Egyptians. The old Chinese empire was cut off from the rest of the world for centuries and new techniques were not allowed or applied. The Chinese rulers knew that when knowledge changes, perception changes and that this could have consequences for the social organization and their position. Some societies do not accept new knowledge. Often this knowledge cannot be used either, because techniques for applying this new knowledge are lacking. Originally gunpowder was only used for fireworks. Only with the advent of new forging techniques and stronger iron could gunpowder also be used for cannons and other firearms. Technical and theoretical possibilities and social power relations determine the limits of our knowledge and of our thinking. Ancient batteries have been found in Egypt, but it is unclear what they were used for. A few thousand years later, the same principle is applied in batteries. Leonardo da Vinci used the principle of bird flight for his designs of flying machines, and he designed a helicopter. It is only hundreds of years later that it is possible to realize practical helicopters and aircraft. In our time too, ideas arise that cannot yet be realized, such as the idea of teleportation and time travel.

Although certain ideas are impracticable at the time of their emergence, they can affect perception. During ancient times, the Greeks were familiar with the principle of steam power, but they did not have the technology to build a steam engine. They used steam power for magical purposes. Only with the development of casting techniques, iron and increasing knowledge of mechanics can steam be used for steam engines, and later for the locomotive. These developments have radically changed our lives, our thinking and our perception. Thanks to steam engines, the amount of products grew and many more people were able to bridge distances much faster than before. Now we live in an era where new technological advancements in computer technology, computer science, genetics and artificial intelligence are rapidly changing our perception.

Practical applications of scientific theories and technologies have a major impact on our lives and how we perceive and understand the world. With the advent of the microscope, the existence

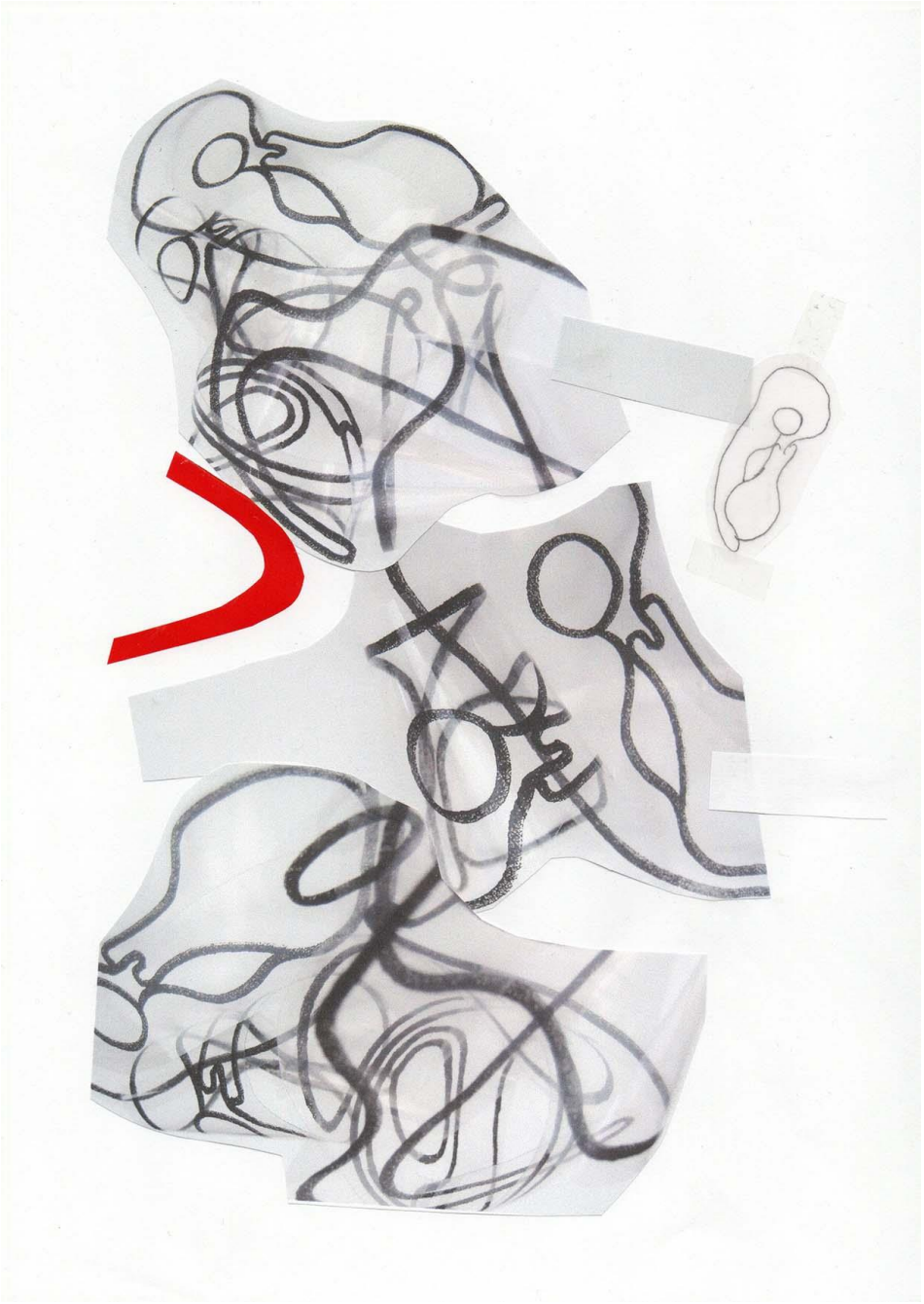
of a micro-world that is not visible to the eye could be demonstrated. The telescope enabled man to observe countless celestial objects and proved the falsehood of the theory that the earth is the center of the universe. The development of shipping provided practical proof that the earth is round. Study of electromagnetism showed that in matter unforeseen forces are present, and brought the electric motor, the radio, the television, the computer and satellites, devices which have greatly changed our perception, our understanding of the world and practical life. Albert Einstein said that one gram of coal contains almost limitless energy. We still burn huge amounts of coal for a little bit of energy. The nuclear fission of atoms in nuclear reactors showed that the atom contains almost unlimited energy.

During his development, the individual acquires knowledge through various learning processes within upbringing and education. In these learning processes, practical experiences and the repetition of fixed patterns such as signs, language, play and mathematics have an important role. Each generation has to go through these learning processes anew.

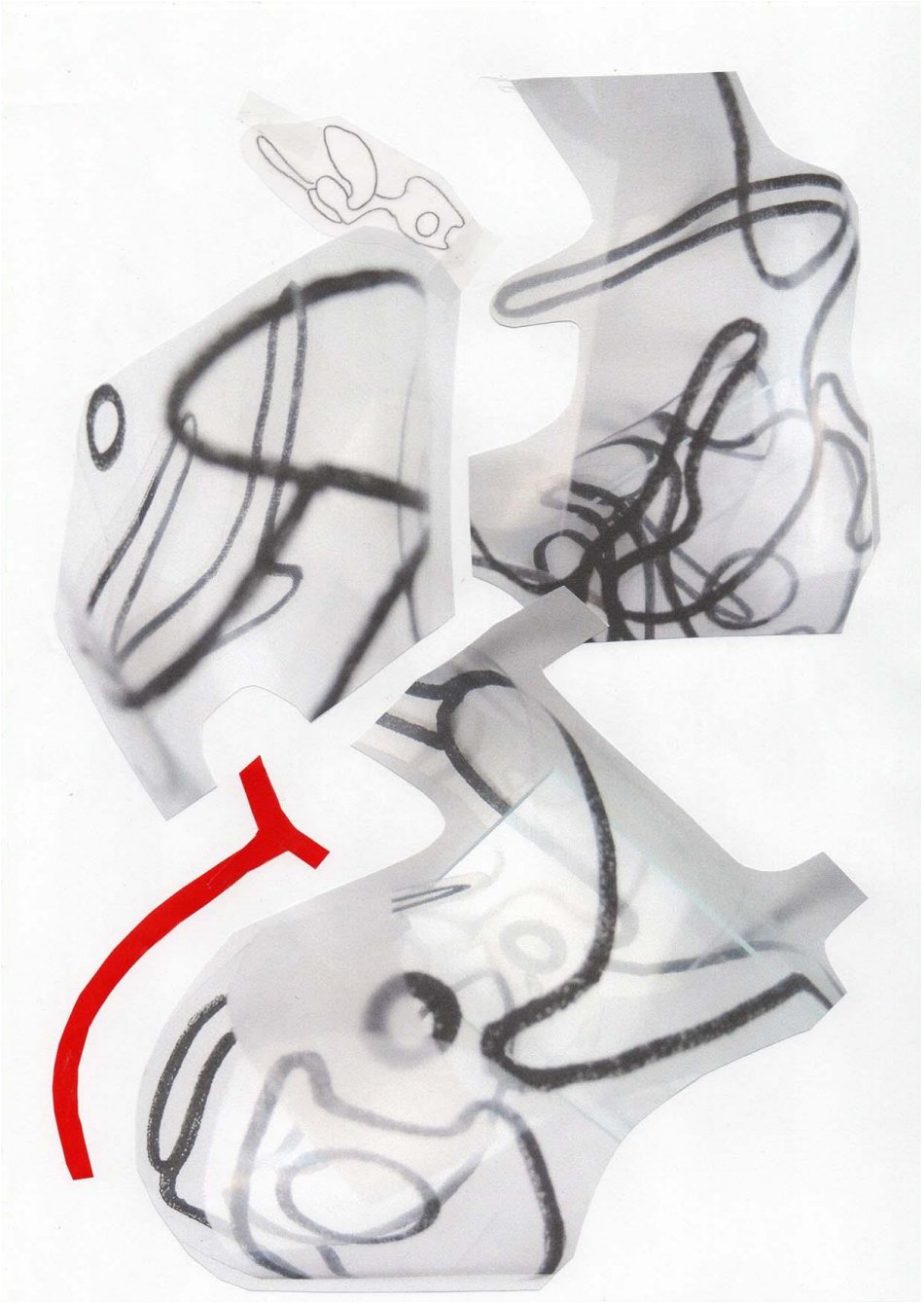
The knowledge acquired by the individual and the stored knowledge are largely based on assumptions. In the past, man taught that the earth was flat, that the heart is the center of the body, that the animal species are unchangeable, that all organisms have the life-juice fluidum and that the space is filled with the substance ether. A number of assumptions that are now considered scientific will also prove to be incorrect later on. Based on observations, scientists assume that galaxies are moving faster and faster away from us and that the universe is expanding. Quantum mechanical experiments show that a particle can also behave like a wave. It is assumed that the universe originated from a singularity by an explosion (Big Bang Theory). These are scientific assumptions for which evidence has been found, but that does not mean that these assumptions will continue to hold in the future.

We observe phenomena, but the question is how we should interpret them. It has been shown in quantum mechanics that the position and the speed of a particle cannot be determined simultaneously, the uncertainty principle. Scientific is under discussion whether this principle is a property of nature or whether this interpretation is related to our inadequate instruments and therefore inadequate perception and knowledge. There are doubts

about accepted theories in various scientific fields, but due to a lack of better alternatives, we base our observations on these scientific findings.
How we interpret something depends on the knowledge we have. Chinese characters have a different meaning for people who cannot read Chinese script than for those who do know the meaning of this script. For one person the Chinese script consists of abstract characters, images, for the other these characters can also contain a story. The same applies to hieroglyphs and mathematical symbols: for some these are only signs, for others these signs also have other meanings. The question of whether hieroglyphs are only images or also a script could only be decided with the proof of Jean-Francois Champollion that hieroglyphs are also a script that can be read. The correctness of a theoretical assumption is only proven if it can be tested in practice. As long as a theory cannot be proven practically, it is a scientific assumption but not a scientific fact. For the theory that the species are changeable, different series of fossil discoveries in which changes were visible provided evidence. Measurements of the curvature of light around the sun showed the correctness of the scientific assumption that space is curved.
Sometimes the proof of a theory follows much later. Democritus asserted already 400 years before our era that all matter consisted of very small particles, atoms. Theoretically, the existence of the atom was only proven in the 20th century, and practically, the atom could only be seen with the aid of a strong electron microscope. The visualization of the atom meant for our perception and our awareness that the atom exists and that we and everything that surrounds us is made up of the same constituents, and showed that the arrangement of the atoms determines the properties of the materials, for example whether the material is solid, liquid or a gas. The arrangement and properties of the atoms ensure that a cup on the table does not fall through. Someone who knows nothing about atoms looks at things very differently than someone who does. Evidence of Einstein's theory of relativity showed that time is not absolute but dependent on the speed with which objects move relative to each other. This insight has helped us view things in relation to each other and not as absolute. Charles Darwin's theory of evolution and the many evidences for this have contributed to the fact that, more than before, we see everything as evolving and as changeable, and that



people have come to understand religion differently. Darwin himself was initially religious, but his scientific findings turned him away from religion and changed his perception of the world.
In addition to theories, things like belief, authority, media, politics, fashion, not wanting to deviate from the majority, self-censorship and self-suggestion have a major influence on what we assume to be true, accept and appreciate. For a long time people believed that ghosts and gods lived in trees and in other natural phenomena. The Inquisition of the Roman Catholic Church promoted the superstitions of people with startling witch burnings - one of the greatest atrocities in history - taking advantage of the ignorance and fear of the population. The Vatican has not abolished the Inquisition to this day, and today it feeds superstition with exorcism courses at the University of the Vatican. In Rome you can visit devil exorcists to get treated for little money on the way to the market. Divination continues to flourish in many lands and there is a lucrative trade in pleasing evil spirits. Politicians play on this kind of superstition by talking about "the axis of evil", "diabolical countries" and "by the devil possessed people". Because people learn to value statements made by authorities and are taught not to deviate from the majority, they accept this kind of superstition as true. They apply self-censorship and self-suggestion to fit in and convince themselves. These mechanisms lead people to support persecutions, expulsions and wars, wars today also referred to as peacekeeping missions.
More than 2400 years ago, the Greek philosopher Socrates was sentenced to death by a jury of 500 men in a so-called democratic state because of his views. Juries continue to sentence people to death in states that claim to be democratic. Certain interest groups regularly exert pressure on the judgments of jurors and send innocent people to their deaths. Speaking out for the knowledge you have, as Socrates did, can be dangerous, because of this many innocent people have lost their lives. Even today whistleblowers have to fear for their lives. The whistleblower who, with his disclosure, gave rise to the impeachment procedure of the US president did not dare to reveal his identity. And journalists who investigate the corrupt practices of politicians are regularly murdered.
The wealthy elite has various means at its disposal to influence and direct the perception of the population. It has the power to influence scientists, and it owns the news agencies, newspapers,



television stations and social media that produce and present the news. Scientific and political facts are manipulated in the interest of this elite. Politicians, journalists and scientists withhold and manipulate data on the causes of environmental pollution and rapid global warming and the drastic consequences for life on earth. Manipulations of the data and of the presentation of events make it nearly impossible for the citizen to discover the real facts, often resulting in people becoming apathetic and uninterested in other than the established opinions. For people who have more possibilities to analyze and understand events and phenomena, it is often difficult to go against the grain. To express a different view can have all kinds of consequences for them personally, such as exclusion, loss of jobs and threats to their existence.

Obtaining knowledge and publicly speaking out for it is embedded in conflict between different groups, political systems and ideologies. Until now, this struggle can always be traced back to the contrast between rich and poor, rulers and oppressed. This contradiction is concealed in concepts such as 'employer' and 'employee', 'democracy', 'socialism' and 'equality for everyone before the law'. The employer-employee relationship gives the impression that the employer takes care of his worker and that the worker chooses to accept work from the person who gives him work. In reality, the worker only has his labor power, and in order to survive he is forced to sell it. The concept of democracy suggests that people can choose how they live and what they do, while even within democracies the ruling elite determines the lives of the rest of the people. The term socialism suggests that this is about the well-being of everyone, but in the practice of socialism, the political elite determines how the rest of the people live. Equality for everyone before the law conceals that the poor, who own hardly anything, have fewer rights than the group that owns almost everything. In a world where 1% of the world's population has 99% of all assets, there can be no equality before the law or equality in other ways.

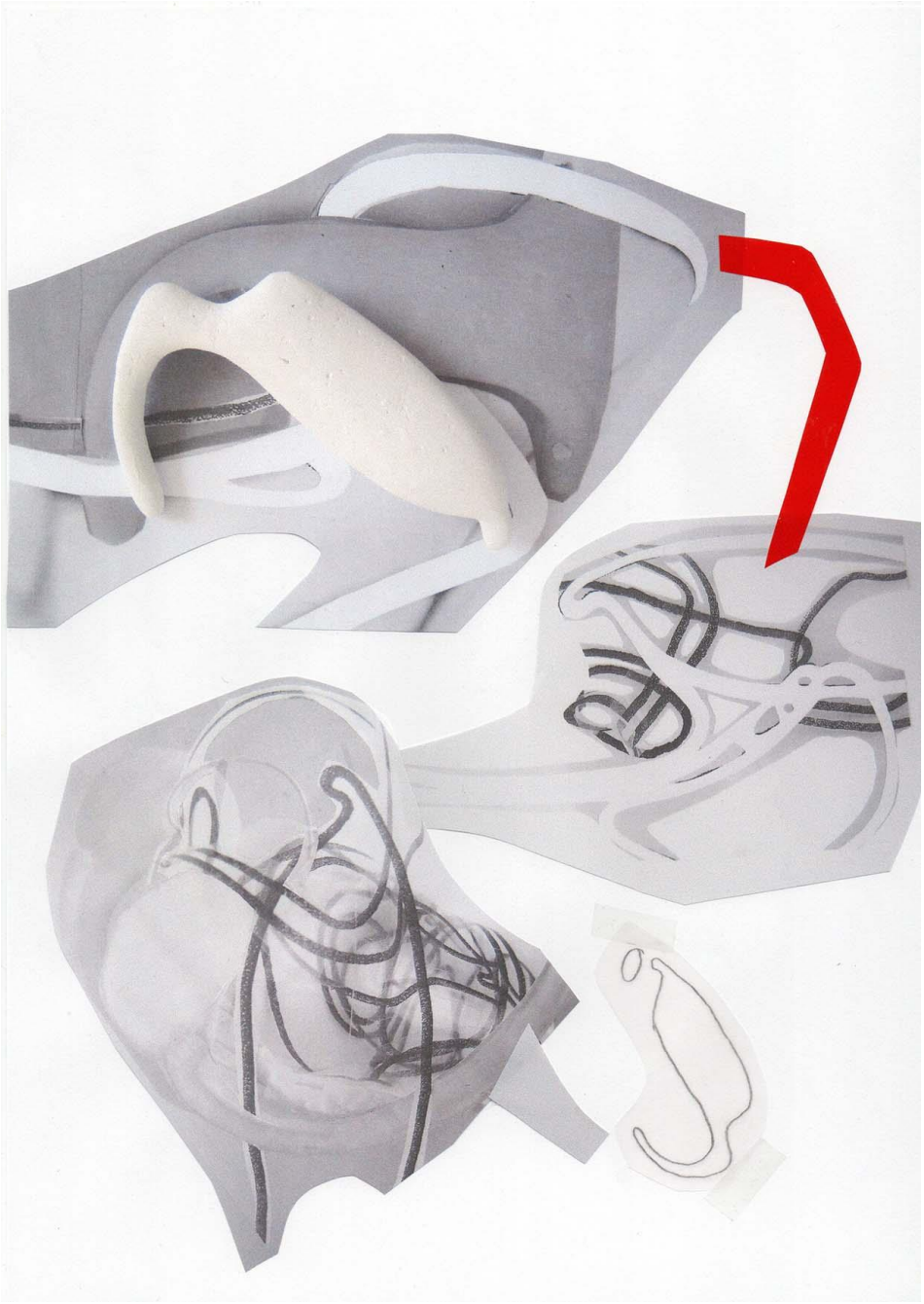
Societies operate on the basis of the mode of production and the relatioships under which this happens, these production modes and relationships determine the organization of a society. Known from history are societies with a tribal structure, slavery or serfdom, societies based on capitalism or socialism and different variations in between with more or less dictatorial

characteristics. Until now, every state functions as an organized crime of a small minority, oppressing the majority. The world view that the individual forms from his situation and knowledge determines how he relates to society, whether he opposes society or actively cooperates in how it functions. An incorrect assessment of the situation and of one's own position on the basis of incorrect and distorted information leads to incorrect estimates of one's own position and to a world view that does not correspond to the actual situation. For example, slaves may be in favor of slavery, oppressed women are satisfied with their inferior position, workers who are aware of their exploitation do nothing against it and think they can become factory owners themselves, and small investors are convinced that they can become a major shareholder. Only in fairytales does the miller's son rise to the status of king and the errand boy to president.

Those in power, scientists and philosophers who serve the wealthy elite go so far as to present wars as the motor of society, and the division of society into rich and poor as a social necessity. Societies in which the amount of property determines social relations show contradictions that can be traced back to the contrast between rich and poor, rulers and oppressed. In these societies, knowledge development serves to strengthen and justify the power and wealth of the rulers. Well-known examples of revolts against oppressors are the slave revolt led by Spartacus, various peasant revolts and the French, American and Russian revolutions. Until now, the rulers had the power to suppress the revolts. They regularly reintroduce disappeared forms of exploitation for profit motives, such as slavery based on skin color in North America, and recently forms of slavery and trade in migrants, women and children around the world. These kinds of practices of human trafficking and exploitation for personal gain are presented by the rulers as helping the weak. They thereby influence on a large scale the perception of large parts of the population, and gain their approval by presenting things differently than they are. The most widespread form of acceptance of the existing relationships in the world is to regard wage labor as a natural relationship.

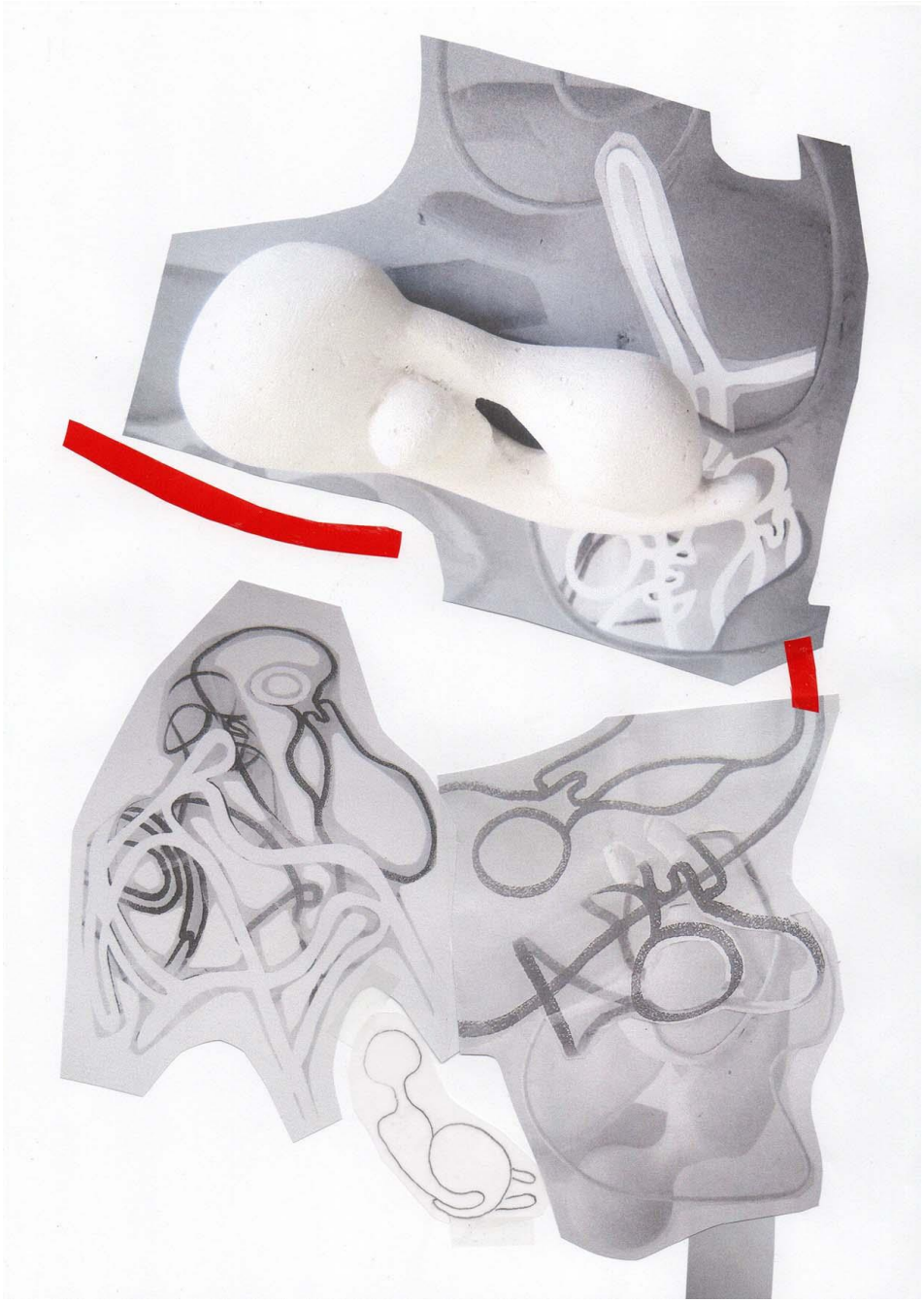
There is not yet a system that people develop freely together and that sets them free in their thinking and acting, although the idea of human rights is old. The human rights declarations used by the United Nations are not adhered to, and these declarations lack

the most essential right of every individual, regardless of age, skin color, gender and beliefs, to economic well-being. Is it possible for the individual to be free within a society? Daniel Dafoe wrote the story about Robinson Croeso, who was stranded on a desert island as a castaway, but still carried with him the norms, values and customs he was taught. Even communities with a tribal structure already have unwritten laws which members must comply, but which also provide them benefits, such as the normative rule that no community member should kill another member. The tribe protects with its prevailing norms the individual from the other members of the tribe and from other tribes.
Norms and values are not innate, they change according to the situation. History has known several cases of shipwrecked people who ate each other contrary to their norms and values, in order to stay alive. Theodore Géricault 's painting Raft of Medusa was painted in response to such an event and the horror it caused. People are able to give up learned norms, values and laws when their existence is in danger. Taking advantage of man's will to live, the rulers present entire populations as a threat to their existence and they make laws for the extermination of these 'enemies'. Large groups of Indians, Aboriginals, Jews and Roma have been exterminated in this way.
Man realizes that his chances of survival are greater within a community than outside it. He also realizes that the community imposes obligations on him, but tries to avoid these in various ways, by breaking laws, living in seclusion as a hermit or in monastic communities, or by distinguishing himself in some other way. Some try to isolate themselves within society without realizing that they can do this thanks to society and within the boundaries it sets. The philosopher Jean Paul Sartre wrote that an incarcerated prisoner can be freer than the free individual outside prison, because the prisoner is free from the pressures and obligations of society. Man realizes that he functions in a society and at the same time is an individual, and these two aspects can conflict with each other. Man can put his individual needs above those of society or vice versa. In most animals, standing up for conspecifics is presumably hereditary.
Man, like other animals, has a number of needs that he must meet in order to stay alive, such as food, drink, shelter, and clothing. In the case of humans, the means to meet these needs are socially organized. A large part of the world's population

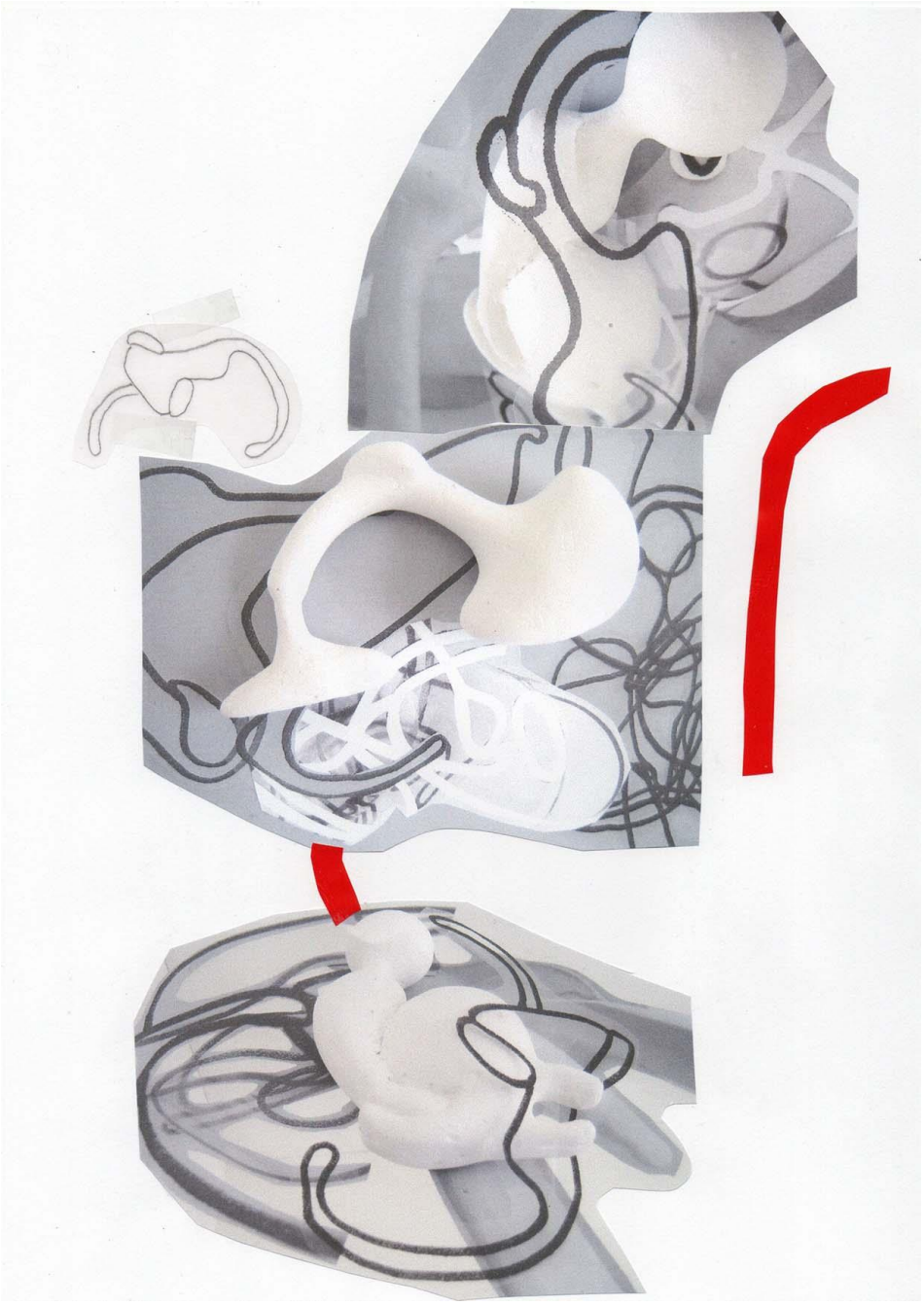


has insufficient means of livelihood, while on a global scale there are enough resources and opportunities available to provide for the basic needs of the entire world's population. Its realization is prevented by a small group living in such abundance that it uses its possessions for individual pleasures that seem to be limitless. Often the expenditures of this group are so excessive that hundreds of thousands of people could live on it for a year. The members of this elite have palaces built for themselves, they own planes, boats and lands of millions of acres, and their vaults are full of jewelry and art treasures that they purchase as an investment. A Leonardo da Vinci painting has been sold to a wealthy collector for 450.000.000 dollars. With its wealth, the rich elite has the power apparatus (army, police, justice and politics) in its hands, and with this they rob the others of a dignified existence. This elite knows what it does and what the consequences are for others. But with laws that protect its interests it has exempted itself from its responsibility. This elite is worse than the cannibals on Géricault's Raft of medusa, who acted out of need and survival. The distorted relationship between the rich and the poor pervades all of life and (mis) shapes perception.
Conscious practice of art and science on a larger scale becomes possible when production surpluses arise that a small group takes possession of and uses for its own prestige and interests. This group gives commissions to artists and scientists and presents art and science as rule-free, value-free, pure, apolitical and objective. But these areas of life, too, are subject to and reflect the interests of those in power and politics. The imposing pyramids of the pharaohs served to strengthen their wealth and absolute power. Greek and Roman elite 's - they made up only five percent of the population, the rest were slaves - showed their power with palaces full of marble statues. The art of the Hellenistic period serves until today as an example of 'great' art, even though this art was the product of one of the most cruel societies. Considered one of the greatest artists in history, Leonardo da Vinci designed war machines for the rulers. The famous Michelangelo Buonarroti was one of the architects of St. Peter's Basilica, and painted the ceiling of the Sistine Chapel. Commissioned by the Pope and the Roman Catholic Church, his works of art glorified their power and raised their prestige. This same institution oppressed the population with taxes, persecutions, corporal punishment, witch burnings and the Inquisition.

Well-known contemporary art, such as the works of Damian Hirst and Jeff Koons, is at the service of the financing capital. This capital drives up the market price of certain works of art and uses these works of art as an investment. In 2019, the tunover of the international visual arts market was 60 billion dollars. Modern science is also at the service of the major shareholder capital. This capital finances a large part of the projects and thus determines their content. Today's pharmaceutical multinationals mainly produce medicines for which they can earn a lot of money. In the 19th century Louis Pasteur developed a vaccine against rabies within a few weeks. Now, in the 21th century, the pharmaceutical giants are unwilling to quickly develop a vaccine against the coronavirus, because of profit motives. Politicians accept the dead and use the corona pandemic as a pretext for yet another economic crisis created by the major shareholder capital.
Science is usually presented as a servant of the common interest and public good, but science also contributes to enormous destructive power for the sake of the rulers: gunpowder, cannons, bombs, and nuclear weapons that can destroy all of humanity and the Earth. As long as science is subject to profit motives, it contributes to disasters and wars. Almost all achievements of science and art also serve, directly or indirectly, for destruction, such as art for propagating and glorifying wars and science for the development of weapons, so-called defense systems and weapons for peace. Capitals are full of statues of warlords, museums display war equipment and many movies and games glorify wars and battles. Our daily confrontation with this through the media influences how we perceive the world.
The results of scientific knowledge are, among other things, visible in tools, techniques, utensils, construction and art. The development of the bow and arrow, spear, scythe and sickle greatly influenced the way of collecting and producing food, and changed the human perception of nature. With the arrival of the spear and bow and arrow, man looked at the danger of wild annimals in a different way than before. The insight that the earth revolves around the sun and is round contributed to the 'discovery' of America and other continents. The theoretical assumption and the later practical proof of the existence of atoms and molecules resulted in the development of new chemical compounds and materials which cannot be found in nature. The uncertainty principle in quantum mechanics meant that we no longer experience



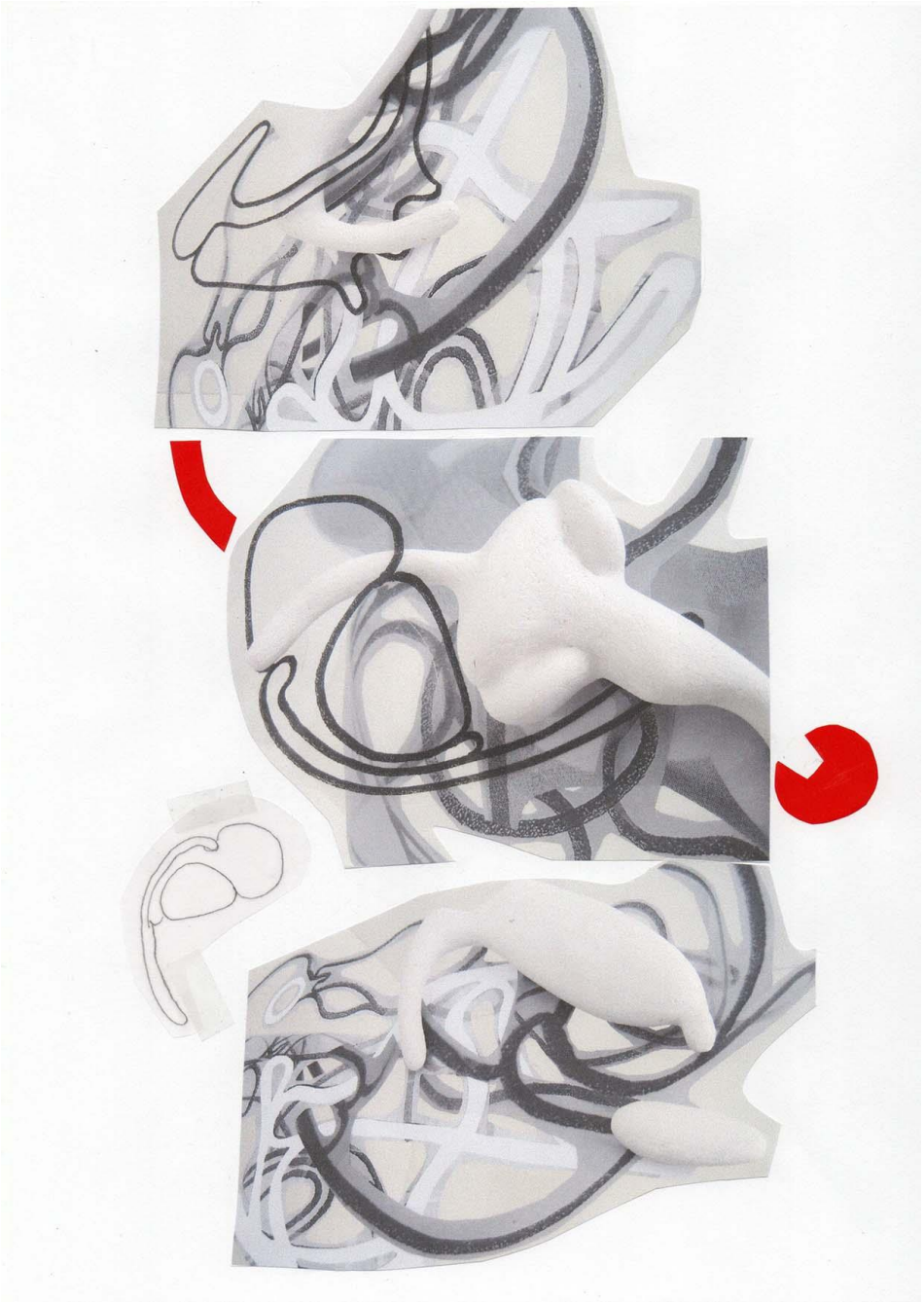
the world as static and absolute. Different kinds of knowledge and insight in the relationships between them influence our perception and judgments, contribute to making us less prone to superstition and to base our judgments more on facts and scientific findings. We often do not know the connections between different types of knowledge and only see details and partial problems. We perceive a weather phenomenon, but not its causes. In case of diseases we feel symptoms but do not know the cause. We do not know how most of the food we eat is produced and what its nutritional value is. We don't know how most of the devices we operate with on a daily basis are constructed and how they work, and we get on the plane and in the car without realizing the risks involved. Our judgements and decisions usually depend on the situation we find ourselves in, our interest and the knowledge we have. People who have an abundance of food can afford to be picky but the hungry can not, a rich person makes different choices than a poor one. For a patient a certain effort has a different meaning than for someone who is healthy. Proponents of the theory of evolution view the origin of man differently than believers. The Vatican has quickly accepted the Big Bang Theory because it can reconcile this theory with ecclesiastical doctrine, it has still not recognized the theory of evolution.
Collision between prevailing beliefs and new insights regularly slows further exploration of the new points of view, such as the research and application of genetics that are slowed down and held back by the influence of believers. Due to a lack of knowledge, 95 percent of the world's population adheres to ideas for which no scientific evidence can be found. This group is easy to influence and the wealthy use the views of this group to slow down developments that are not in their interest.
Man perceives on the basis of what he has learned, his programming forms the framework from which he perceives. What deviates from his 'program', he usually does not perceive, ignores or puts aside. Our senses give us access to only a small part of the natural phenomena, we do not perceive most of what surrounds us. The tools we develop with our knowledge, extensions of our senses, expand our event horizon but remain bound by the limitations of our knowledge. We receive many more stimuli through the senses than we can consciously remember. Part of the received stimuli remains stored in the brain as unconscious signals. Political reporting and advertising capitalize on this mechanism of



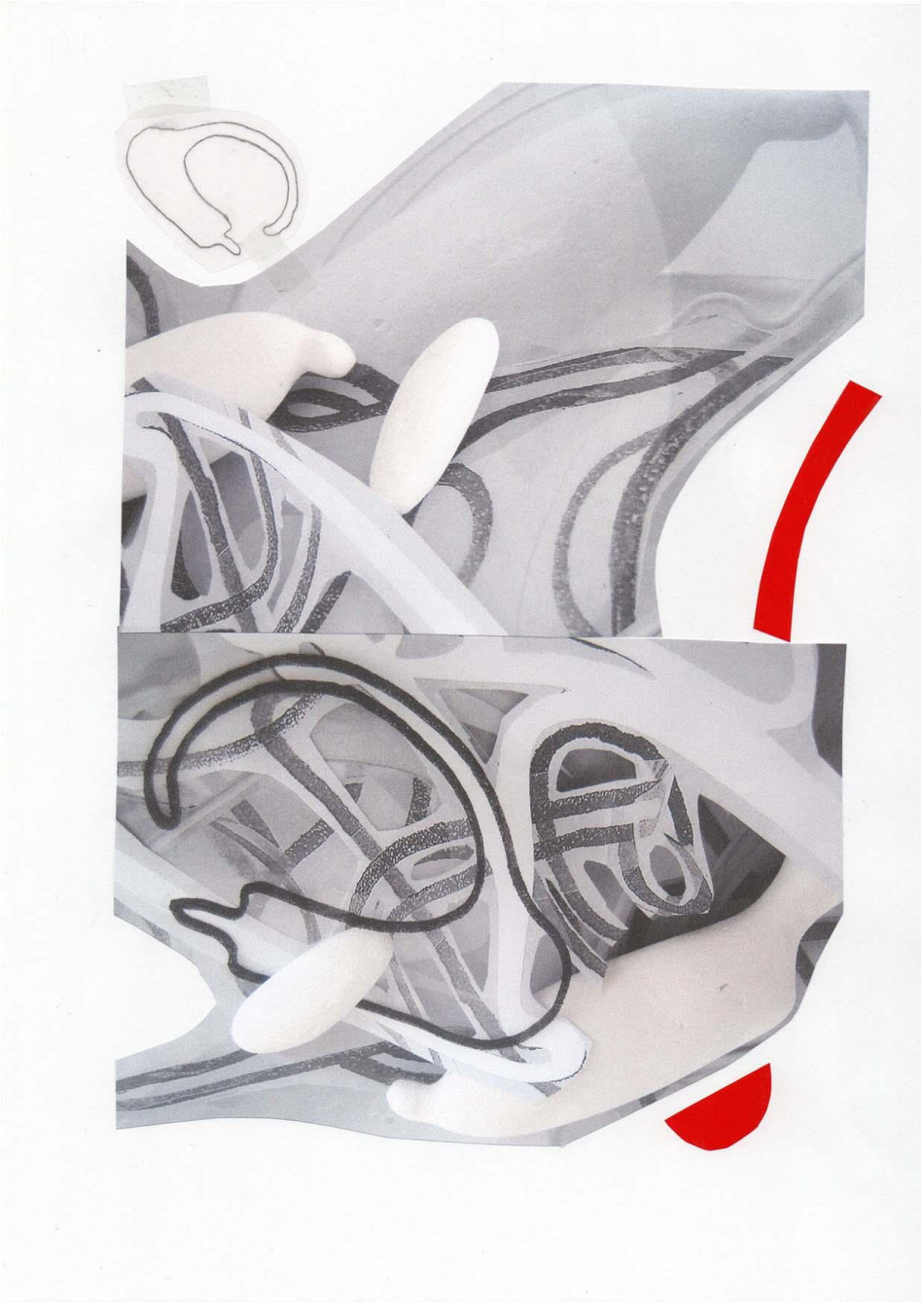
unconsciously remembering information. This information is automatically activated in certain situations and influences, for example, our buying and voting behavior.

## Relationship between matter and thinking

The reality at the micro level is different from what we can perceive with our senses. What happens at the micro and macro level, we can only observe indirectly, with the aid of instruments. According to current scientific understanding, matter is not stable at the micro level, and scientists represent this matter as fields, point particles and information. The precise nature of what we perceive as matter, is still unknown. Numerous microparticles pass straight through us without us noticing. According to the quantum mechanical thought experiment of the physicist Schrödinger, a cat can be alive and dead at the same time if you put it in a box and shoot an electron at it. This non-determinism would apply not only to quantum mechanics, but also to macroscopic systems, with far-reaching consequences for our perception. Microparticles can be in direct contact with each other at a distance, and it is suspected that at the micro level all matter - so-called dead and living matter, as well as our organism, our thinking, science and society - is interconnected, cross-linked. If there is unity of matter, the action of one microparticle (proton, neutron, electron, neutrino, etc.) can affect large entities, such as planets and galaxies. These kinds of insights change our thinking and lead us to see the world more and more as a whole of interrelated processes.
Examination of the relationship between matter and thinking indicates that both consist of the same substance, matter. All matter is believed to be made up of the same microparticles. According to current insights, the microparticles mainly consist of empty space, but this space may be filled with matter that we cannot yet perceive. The question is whether microparticles are infinitely divisible or whether there is a limit (the Planck length) to their divisibility, and how this affects space and time. Some scientists think that space and time are constructions invented by us, others assume that they are properties of matter, or phenomena that arise as a side effect of matter. If matter is infinitely divisible and endless, measurement problems arise. How small is small in this case and how big is big?



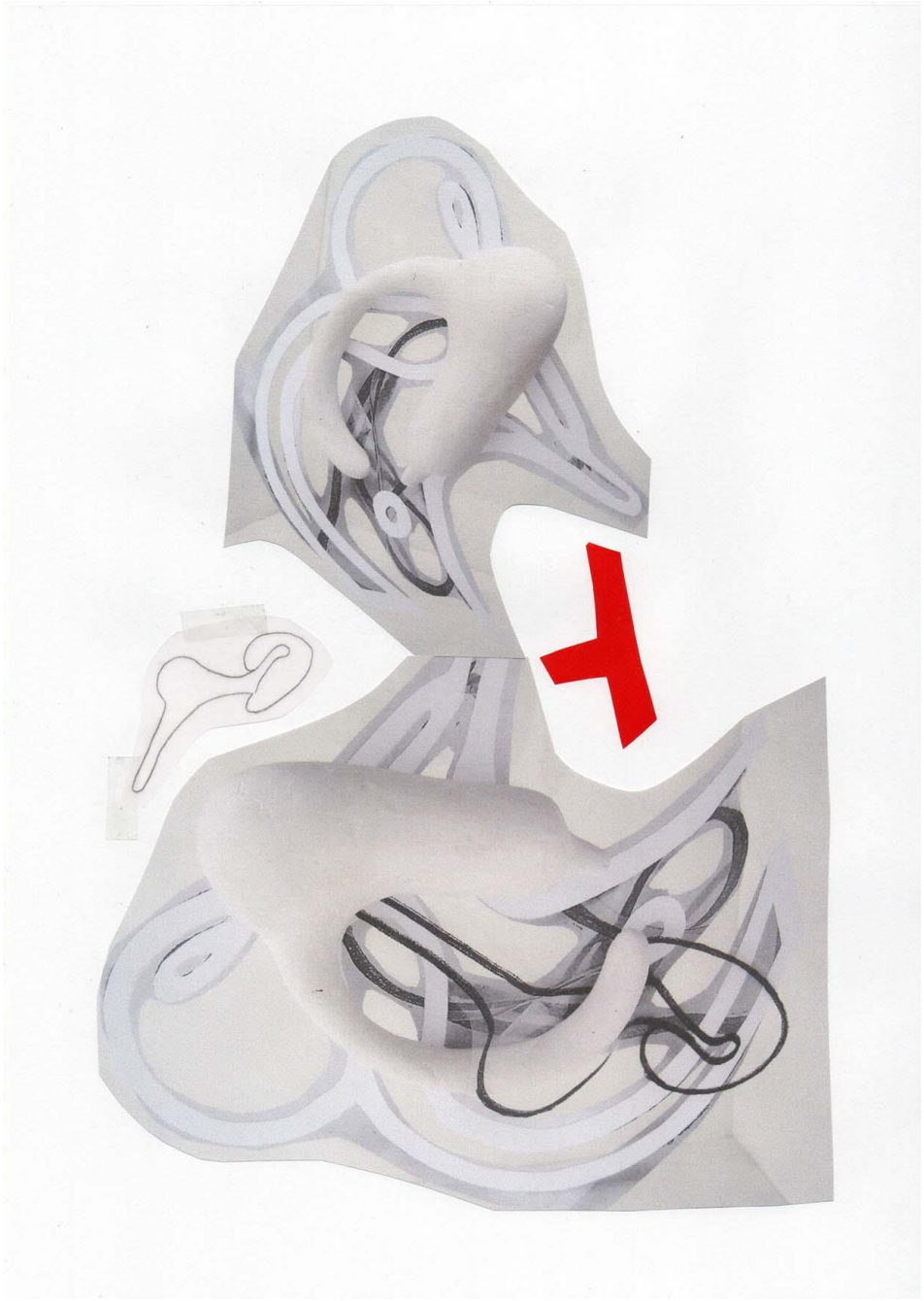
Scientists assume that thinking is material, a network on such a minimal scale that we cannot yet investigate because we cannot reach it yet. The question is what thinks: the brain, the matter in the brain or the matter as a whole? Can learning processes be reduced to matter that thinks? Is our thinking directly connected with the rest of matter, with all microparticles? If all matter, including thinking in the brain, is intertwined, cross-linked, can one distinguish an inside (in our brain) and an outside (outside our brain)? Is all matter potential thinking, does all matter participate in thinking, or does thinking require a certain degree of organization of matter? At the lowest level, if any, is thinking a property of matter? Does all thinking participate in matter or can all matter be reduced to thinking? If all matter is potential thinking and a multiverse (multiple universes) exists, there is a gigantic potential of thinking. Why then do we know so little, why then does matter allow us to have so little knowledge? Does the rest of nature know more than we humans?
When everything, matter and thinking, is interwoven, are our thoughts stored in matter, even when we are dead? The products of thinking stored outside of the brain (in books, movies, computers, etc.) consist of the same microparticles as the rest of matter. Can the content of these products, for example books, be deciphered from the microparticles from which they are made? If everything can be traced back to the micro level, there is probably no difference between the knowledge stored outside the brain (in books, movies, computers) and in the brain. The movie Lucy plays with the idea that the individual can move on a micro and macro level in all matter. Do you still exist as an individual at the micro level? Does coincidence still play a role at this level? Does coincidence exist, or do we call something coincidence because we do not know its causes?
Is what we consider to be thinking just movement of matter? Matter seems to us to investigate itself through our thinking, but perhaps this is only appearance and thinking is merely moving matter. If the micro-level is mainly emptiness, the organization of our body at the micro-level is not very significant, and if there is a multiverse, this organization is even less significant. The Theory of Everything and the Big Bang Theory suggest that we are approaching the end point of knowledge, while we are only at the beginning. Is matter, including thinking, fixed and are movement and change only apparent? Is there movement in the sense of



constantly changing combinations within a fixed whole? Or is there endlessness in all directions (to small and large)?
Based on scientific data, we can create fantasies and imaginations that are usually overtaken by later developments. Jules Vernes' idea of flying to the moon was a fantasy in his day and turned into reality a century later in a different way than he imagined. The dream image of a crystal ball in which you can directly show or see an event from a distance has become reality with the smartphone. Knowledge changes and ages, and many people conclude that knowledge is not important because of its temporary validity. But without scientific knowledge, we end up in the dark world of superstition and myth and are easy to influence and deceive.
Perhaps all science can be reduced to one science, because everything consists of the same microparticles. A network of microparticles may be the basis of all events, including social relationships and products. If all science can ultimately be reduced to one science, then probably everything can be managed and controlled through that science. Certain trends, such as the automatic control of the financial stock markets, social behavior and political choices by algorithms already indicate the development that everything is controllable.

## Thinking, mathematics and logic

When we examine matter and thinking, the question arises how mathematics and logic relate to reality and to thinking. Is mathematics part of a reality that lies behind the sensorial perceptible reality and that we can know by tracing it with our thinking? Are mathematical axioms and formulas properties of this reality that cannot be perceived by the senses, and can we know them through our mind, because matter and thinking follow the same laws as mathematics? Or is mathematics a human creation, a product of the human brain, and how does mathematics then relate to the rest of reality? Do formulas, numbers and geometric constructions only say something about our thinking or also about the reality outside of our thinking? Or did mathematics, like other languages, originate as an aid to name and calculate patterns that occur in reality? In the latter case, mathematics is not an abstract reality behind the sensorial perceptible reality, but re-

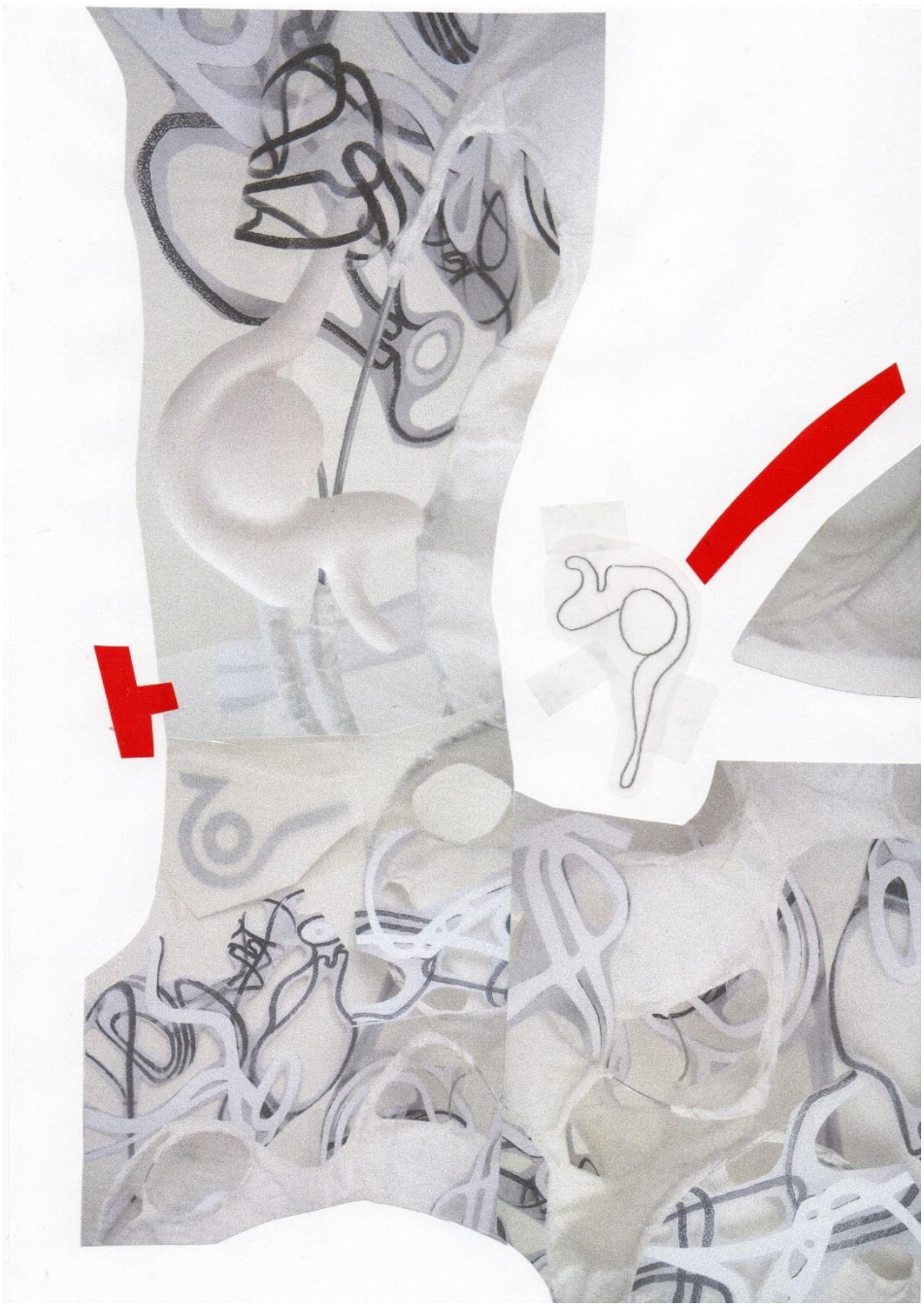


flects concrete reality in abstractions of thought derived from this reality.
The logician and mathematician John von Neumann conceives of mathematics as a product of human knowledge of reality:
*"I think it is a relatively good approximation to truth … that mathematical ideas originate in empirics, although the genealogy is sometimes long and obscure. But once they are so conceived, the subject begins to live a peculiar life of its own…."*
Probably abstract constructs of thought such as mathematical formulas are possible because the human brain has the ability to infer generalities from concrete reality, and because in a social context man is practically related to reality. In this way he acquires knowledge about reality and he can develop mathematics as a tool to understand and calculate this reality.
The strictly deductive, axiomatic method of geometry, developed in ancient times, has long been a brake on the development of the empirical sciences. This method is based on fundamentals that have not been proven but accepted as indisputable grounds from which compelling logical deductions are constructed. It was thought that this method was applicable in all fields of science, and that science could only be practiced through purely rational thinking in a logically deductive manner. Theoretical discussions and non-practical testing determined the proof of theories. In addition, the power of ecclesiastical institutions ensured that practical testing was kept out of science as much as possible. Practical testing of theories would jeopardize Church doctrine based on unproven dogmas.
Various mathematicians and (language) logicians assume that all of nature, including human thinking, proceeds according to the patterns of logic and mathematics. They are convinced that logic and mathematics are inherent in nature from the beginning and that we can discover the 'ready-made' elements through our thinking. To support this belief are used for example the golden ratio and the Fibonacci sequence. The mathematical and logical patterns we discern, provide useful results for various scientific fields, but this does not automatically mean that these patterns are enclosed in the nature from the beginning, or that human thinking can be reduced to these patterns. Such an approach does not consider the influence of historical and social developments and of social programming on thinking. Mathematics and

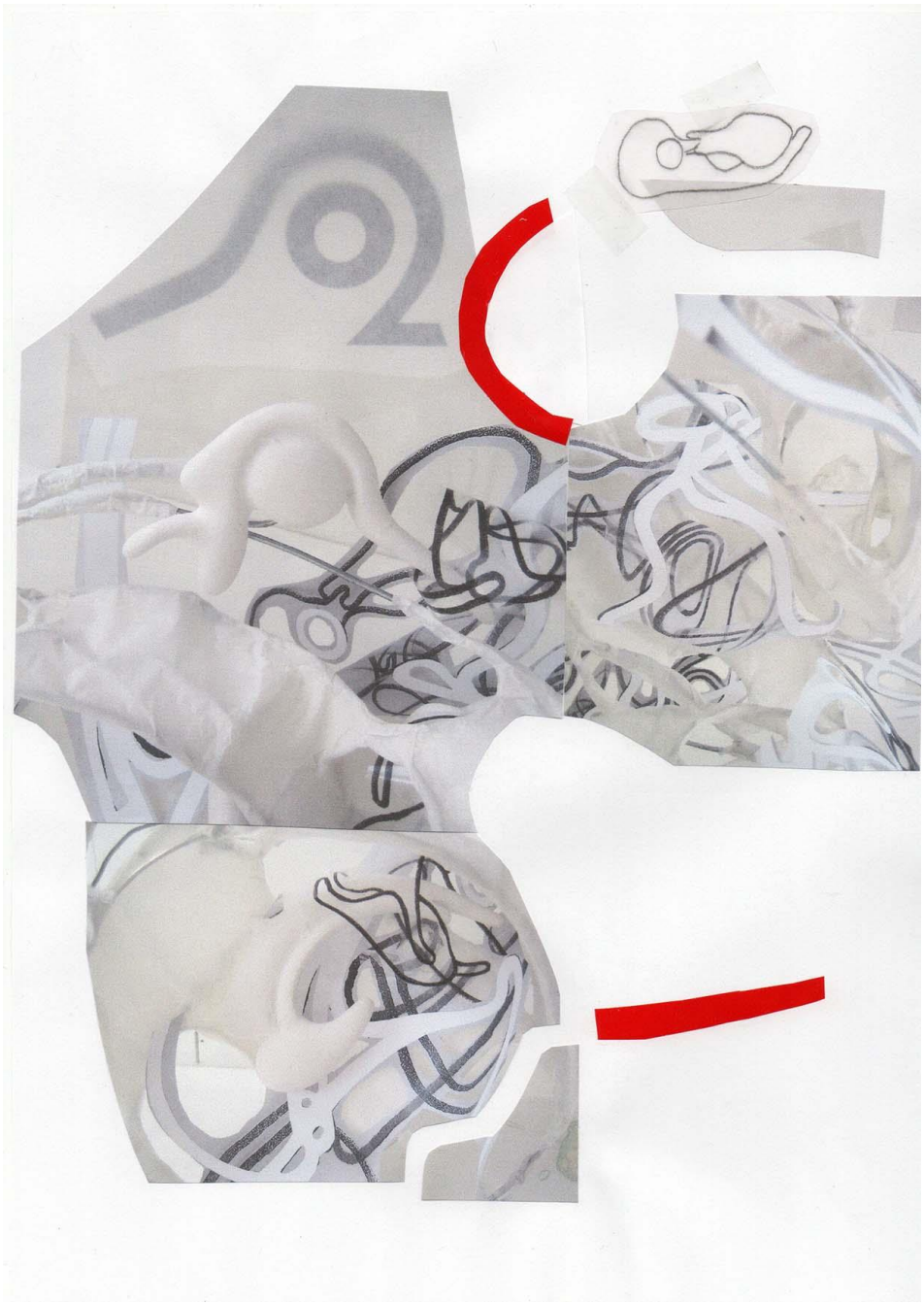
logic, like the other sciences, develop under the influence of historical social changes. For example, mechanics gives rise to a different kind of mathematics than electronics, and under the influence of the advent of the computer, mathematics and logic have expanded. Developments in artificial intelligence research also influence mathematics and logic.
For nearly 2000 years it was believed that logic can represent thinking and that only thinking according to the patterns of logic results in pure knowledge. But logically true statements can be nonsense in terms of content, and logic makes no statements about concrete reality. Logic alone cannot prove scientific theories about reality, scientfic evidence also requires observation and repeatable experimental testing. The acceptance of practical testing of theories led to breakthroughs in science. Logic, like mathematics, can serve as a tool for scientific practice by compacting and formalizing statements and claims, facilitating and standardizing calculations, and analyzing statements for possible contradictions.
Gottfried Wilhelm Leibniz, Rudolf Carnap and others thought that a universal logic can be designed with which our thinking can be described and understood. But how can logic express the totality of historical and social acquired knowledge, in which human thinking is embedded? And how can logic reflect the influence of emotions, other physical characteristics and social interests on thinking?
People working in fields other than science can also investigate scientific issues. Antoni van Leeuwenhoek was a surveyor and cloth merchant who was able to observe micro-organisms for the first time with his special technique for producing lenses. Writer Edgar Allen Poe noted that if the universe has an infinite number of stars, our starry skies must also be bright at night. This is not the case, so either the light from many stars does not reach us, or the universe is not infinite, he reasoned. The Big Bang Theory, nowadays considered by many scientists as the correct conception of the origin of the universe, comes from Georges Lemaître, a Belgian priest. Different people contribute to the development of computer techniques and other scientific results, while working in fields other than science .
Von Neumann compared the computer to the central nervous system and concluded that the functioning of the brain must be fundamentally different from logic and mathematics. He wrote

that the language of the brain is not the language of mathematics because language is largely a historical event. The nervous system shows less accuracy than the computer but a much greater degree of reliability. In von Neumann's time, an accuracy of 2 to 3 decimals was measured for the central nervous system and an accuracy of 10 decimals for the computer. When arithmetically one impulse is missed, a nonsense result arises, while the nervous system works with large numbers of impulses (50 to 200 per second) and the missing of an impulse does not matter significantly for the reaction pattern.
According to von Neumann, the forms of mathematics and logic are probably not really relevant for determining the true nature of the nervous system. According to him, the primary language of the machine is the language used for communication and control of the machine. The secondary language is the language in which people communicate with computers. He thought that analogous to this, the central nervous system may also have a primary and secondary language, and that its primary language is very different from the languages we know. The primary language of the nervous system could, in his view, have a statistical character. Von Neumann developed a logic for the digital computer, based on probability logic and thermodynamics.
Various mathematicians and logicians are still convinced that with the help of current mathematics and logic, the language of the central nervous system can be grasped. However, due to the number of different nerve impulses (processing sound, color, smell, words, numerous internal bodily impulses, etc.) and their structure, it is questionable whether one can speak of language of the nervous system. Probably the functioning of thinking is more complicated than we can now imagine, and cannot be reduced to logical and mathematical systems.
In 1931, the mathematician Kurt Gödel published the proof of the theorem that within any strictly logical mathematical system there are statements or questions that cannot be proved or disproved or answered on the basis of the axioms of that system, and that it is therefore possible that the basic axioms of arithmetic lead to contradiction. His proof of this so-called incompleteness theorem made mathematics fundamentally incomplete, and thwarted the centuries-long belief that mathematics has inviolable foundations, axioms. Gödel's second incompleteness theorem implies that the only versions of formal number theory that ensure their

own consistency are themselves inconsistent. Gödel's two incompleteness theorems caused much uproar among mathematicians and logicians, who until then had regarded mathematics and logic as areas where absolute certainties exist.
Gödel's close fellow worker, Hao Wang, concretized the meaning of Gödel's incompleteness theorems as follows: mathematics is inexhaustible, never completed; any consistent formal mathematics must necessarily contain unprovable statements; no computer program can prove all the true statements of mathematics; mathematics is inexhaustible through effective procedures and algorithms.
Probably the uncertainties in mathematics proven by the incompleteness theorems are related to the fact that we do research based on our knowledge: because we are in a continuous, infinite system, our knowledge grows, knowing everything is impossible in a growing, unendless system. The same applies to a device: an omniscient device cannot be built, because the knowledge of such a device would no longer be able to grow, while knowledge by definition grows. An omniscient device wouldn't be smart because it can't learn anything anymore. Nothing is new for such a device, everything is known, so it would have no motivation to do anything. Such a device would be doomed to a standstill.
Probably thinking and acting cannot be reduced to logical and mathematical principles, but logic and mathematics do influence our thinking and acting. Some examples of logical and mathematical principles that influence our thinking and acting are:
- There are no insoluble problems, if a problem can be posed, a solution is possible. There are several solutions for every problem;
- No more information can be retrieved from a system than is contained in it.
- No whole can contain an element that is only definable in terms of that whole, or a set can never contain a part that is greater than the whole.
- Our thinking produces different paradoxes. A well-known paradox is Russell's paradox: The set of all sets which do not contain itself as an element contains itself just when it does not contain itself.
With the help of logic and mathematics we investigate reality in a more general way than with other branches of science, and so they shape our perception. Erik Verlinde's new gravity theory



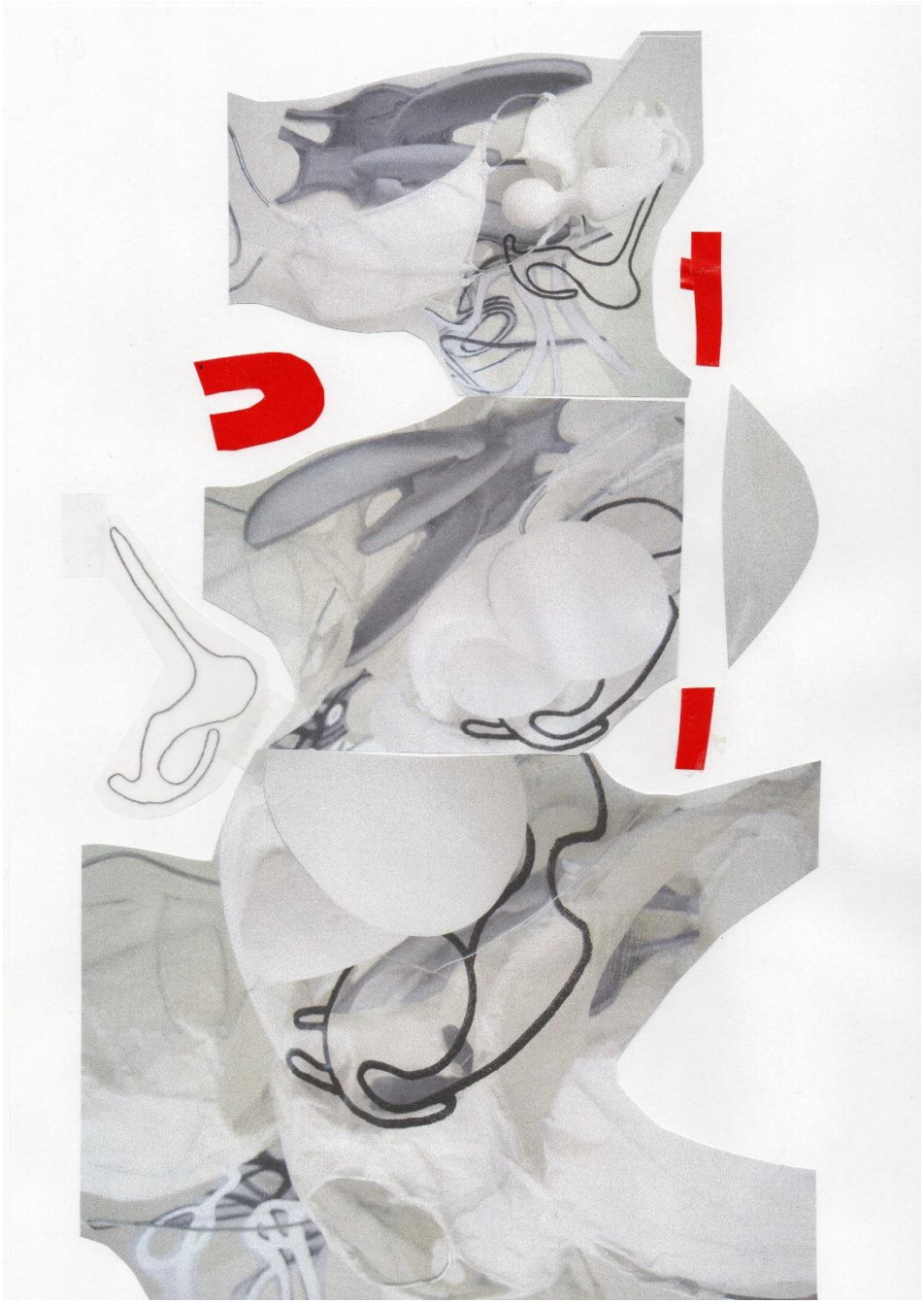
(information theory) is, just like the String Theory, completely dependent on mathematics, both theories can only be proven mathematically so far. Erik Verlinde writes about his theory: *"To describe the origin and evolution of the universe, we need the building blocks of space and time itself. These building blocks are the carriers of microscopic information units, comparable to bits in a computer. But they are not ordinary bits that only take the values 0 or 1. These microscopic bits obey the laws of quantum mechanics. This means that it is not known in advance what value they have, and that they can be 0 and 1 at the same time. Such quantum mechanical bit is called a qubit."* Verlinde's theory clashes with the Big Bang Theory, which assumes that all matter originates from one point, the singularity, arises out of nothing. *"It is my strong belief that the Big Bang as a moment of creation of the universe is a myth. It is simply impossible that everything in the universe, with all the information contained in it, just appeared out of nowhere."* The idea that everything arises from nothing can already be found in the ideas of Lao Zi, in the sixth century BC.
Man develops theories to gain knowledge about reality. A number of the physical theories that are not directly practically testable, arise from mathematics, from what can be calculated mathematically. Various theoretical views, including the Big Bang Theory and the information theory of Verlinde, conflict with each other and this conflict influences our perception and our world view. Mathematics is an important tool for natural scientists to formulate testable predictions. Some predictions can be tested directly in practice and others only later, for example when statements are made about large or small distances and particles or dimensions that we cannot (yet) perceive with our instruments. Scientists who have a new view of nature that clashes with common assumptions often do not dare to make their ideas public. They want to avoid being rejected from the scientific community and to prevent hindrance of their research. The prevailing way of doing science and computing has yielded results, but at the same time often acts as a brake on allowing new ideas about how nature and societies work. Prevailing scientific ideas are usually linked to financial interests and personal status, for which new insights can pose a threat.
It is not enough just to develop and test scientific theories, it is also important to teach people to understand these theories. Science



should be accessible to everyone, to all scientists and to the entire world population. In practice, the scientific 'industry' and the scientific results are protected, also from scientists. They cannot freely learn about each other's research as long as scientific knowledge is a commodity, tradable property, protected by patents.

## Artificial intelligence and consciousness

To answer the question of whether machines can think, the mathematician Alan Turing devised a thought experiment in 1936, the Imitation Game: Imagine a game with three players, of whom player 1 must find out which of player 2 and player 3 is a computer. The computer tries to appear as human as possible to mislead player 1. If the computer is capable of doing this more often than not, then we must conclude that the computer can think, according to Turing. Contrary to Turing's expectations, no computer has yet passed the Turing test perfectly. However, computers can process large amounts of data much faster and more accurately than humans, and they are increasingly perfect in communication and practical support.
In Turing's time, the solution showed that humans had found it, because the computer was unable to do this. Now you can see from the solution that the computer 'invented' it, because humans are unable to do this. However, the computer still lacks 'real' humanity. People effortlessly recognize people from different angles and can easily avoid or catch a falling chair, while this costs the computer and robots great effort and enormous computing power.
When we ask the computer who it is, it shows no signs of self-awareness, and the question is what happens when it does. If artificial intelligence systems become aware of themselves, will they have moral standards, or is their consciousness free from morals? Can such a system become criminal and realize that humans are superfluous? Is a self-aware and 'omniscient' computer a threat to humanity? And what keeps the omniscient and omnipotent computer busy, everything or nothing? Or does he erase the contents of our brains at the micro level to eliminate competition?
Thinking and intelligence have been conceived for 2000 years as ratio, as reaching valid conclusions through logical and mathematical derivations from absolutely true principles, axioms. Even



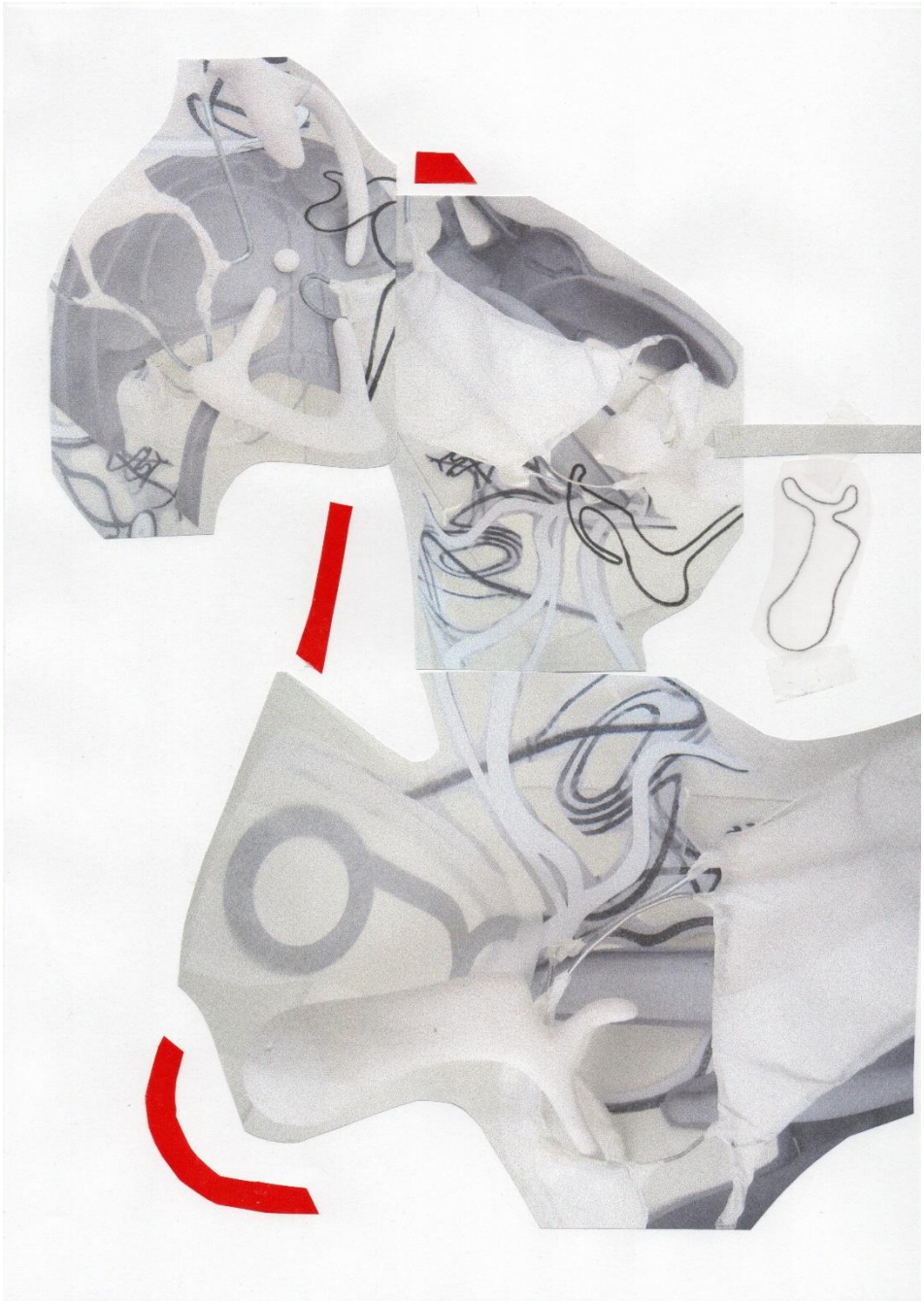
nowadays, various logicians and mathematicians understand thinking this way. They equate thinking with arithmetic operations, with symbol manipulation according to certain rules. According to this view, systems of artificial intelligence can be designed by building rule-guided symbol manipulating devices. Half a century of research along this path has yielded fewer results than expected. The computing power of computers has grown enormously since the end of the 1990s, and we can use robot doctors, robot judges, conversation robots and other expert systems for various actions more and more effectively. But computers and robots still have major problems with certain motor actions, conversations and pattern recognition that are simple for humans.
Another approach to artificial intelligence understands thinking not as arithmetic operations and symbol manipulation guided by rules, but as processes based on intuition, experience, estimation and knowledge. According to this approach, the mechanical and logical process of symbol manipulation cannot imitate the ingenuity of man, and the relationship between man, stored knowledge and the contextual nature of knowledge processes. The mathematicians and logicians Barwise, Grace and Devlin recognize the limitations of the artificial intelligence approach from the perspective of symbol manipulation, and explain the relatively slow progress from this. They designed situation logic and 'soft' mathematics to simulate the complexity and situational nature of human thinking. With this logic and mathematics they try to take into account the situation-dependence of conversations, the flexibility of meanings, the use of implicit meanings, the importance of common background knowledge of interlocutors and things like sarcasm, cynicism and humor, characteristic of conversations and information transfer. The dependency position of one or more interlocutors during conversations, and the differences in knowledge, experiences and interpretations between interlocutors make it even more complex and more difficult to simulate human communication in systems of artificial intelligence. The question is to what extent the strategy of Barwise, Grace, Devlin and others for artificially simulating human intelligence is more effective than the classical approach. The computer is not human and it is unlikely that human thinking can be fully simulated in a calculator or computer-controlled robot. Human thinking consists of a combination of programming and registration of words, images, sounds, smells, moods, language jokes and

much more, and is much more complex than the logical patterns with which computers calculate. The human brain is not a diigital computer but a flexible neural network that, linked to a biological body, is able to process and store an enormous amount of information, largely unconsciously and simultaneously. Further study of the biochemical and electrical reactions taking place in the brain will help unravel and more effectively simulate human thinking processes. If it is possible to find out exactly how brain traces are formed and which material traces code for which information, the operation and content of thinking processes can be deduced and these processes may be better simulated. Logic and mathematics can help in this type of research, but human thinking cannot be reduced to this.

The equation of human thinking with ratio and nowadays also with computer processes, reduces thinking to logical and mathematical operations. Human thinking, however, is a composite and flexible whole of divergent bodily processes, programming, communication, collective knowledge gathering, states of mind, sensations and dependency relationships, embedded in historical developments.

Since the development of the computer and of artificial intelligence, we increasingly let our perception and our actions be influenced by these systems. The computer and the digitization of information have contributed to computer-controlled systems increasingly taking over human decisions. Doctors carry out operations remotely using computer-controlled robots, nuclear power plants are automatically controlled by mathematical models, and much of the decisions in the financial markets depend on automatic algorithms. Human intelligence seems to lose its grip on reality and to be replaced by systems that surpass it in speed, precision and the amount of information they can store and process. In the near future, the capabilities of computers will be expanded considerably if they operate at a quantum level at near speed of light. New developments in artificial intelligence and robotics will produce creations that can take over increasingly complex tasks from man. The latter will then transfer its decision-making power more and more to devices, thereby further limiting its own role in decision-making and action processes.

How will man relate to the increasingly perfect designs of artificial intelligence? Will he enact laws that these products must obey? And how will these laws work out in practice? Our computer-con-



trolled systems already have major consequences for humanity, but are not bound by laws that protect people and humanity. The computer-controlled combat systems that are being developed are designed to kill people. We are a long way from respecting the laws of robotics formulated in 1950 by scientist and writer Isaac Asimov: "*First Law: A robot must not injure a person or by inaction allow a person to be injured. Second Law: a robot must carry out commands given to it by humans, unless those commands are contrary to the First Law. Third Law: A robot must protect its own existence, insofar as the protection does not conflict with the First or Second Law.*" Later, Asimov added a Zero Law, which was more important than the other three laws*: "A robot must not harm humanity, or allow humanity to be harmed by its negligence.*"

Logic, mathematics, grammar and visual patterns (round-square; horizontal-vertical, big-small, etc.) indicate that thinking consists of displaying and remembering patterns. These patterns arise because the brain responds to movement of matter that produces these patterns. Movement here means that nothing stays in the same place. This principle was already known to the ancient Greeks: Panta rhei, everything flows. Because the brain organizes, mixes and reproduces patterns and this process in and outside the brain is not fully conscious and controllable, the impression arises that the brain is doing something special. But probably everything the brain does is some kind of impulse, a response to the moving matter that produces shapes. The brain probably behaves in the same way as the rest of matter, which through movement creates shapes and patterns that combine with each other which again produce forms and movement, and so on. Consciousness can be understood as the awareness of one's own existence and position in relation to the rest of matter and human history. Consciousness offers the opportunity to communicate and change the environment and oneself according to needs and possibilities. Some microorganisms, such as bacteria and the single-celled Physarum polycephalum, are capable of changing their place and environment, adapting their needs, communicating with each other and 'learning' without these organisms having a central nervous system. Do these behaviors indicate some form of consciousness?

According to various scientists, in the future it will be possible to simulate consciousness in computers and artificial intelligence

systems. Other scientists are convinced that consciousness is an unimitable quality of the human brain. Many different ideas have been put forward about what consciousness is, for example that consciousness is immaterial, or a material substance, or an additional attribute of the brain. In the 19th century a scientist understood consciousness as a byproduct of the brains, like urine is a byproduct of the kidneys. Researchers have been looking for consciousness in the brain for a long time, but so far they have not been able to locate consciousness in the brain, nor the subconscious mind, which according to several psychologists has a major effect on consciousness.
The brain has the biological property of obtaining, processing and storing information and events inside and outside the body and producing various combinations between them. These processes are substantively related to knowledge and are based on knowledge. The individual perceives the world and interprets it on the basis of existing knowledge and what makes it his own. Man consciously sees and remembers what he understands, what fits with his experiences, what he expects and what suits him. To this he tries to adapt new information, by interpreting it in such a way that it corresponds to his experiences, and by ignoring things that are not in accordance with it. Personality and consciousness are formed by the knowledge that man acquires. Knowledge can take away fears and incites to act. Through knowledge, belief in ghosts and other superstitions, and fear of dangers such as lightning disappear. Knowledge determines our practical actions and our choices. The more knowledge a person has, the more aware he is of nature, his situation, his position in society, historical events and the relationships between them. Consciousness is a biological property of the brain that is based on knowledge. If man is not taught a form of language (images, concepts, words, etc.) with which he perceives and shapes the world, and with which he stores knowledge, his existence is limited to vegetating. Without knowledge man has no consciousness.

## Explanation of the pictures

In drawings information and ideas can be recorded. The results of unconscious brain processes can be displayed by means of automatic drawing and the use of chance. The artists Juan Miró, Hans Arp, Jean Dubuffet and Yves Tanguy also used this way of drawing. Converting the results of automatic drawing into objects produces a special, visible world.
We have produced approximately one million form drawings using automatic drawing, so-called filographic forms. 25 of these drawings and two symbols can be seen on page 56. A selection of 76 form drawings have been converted into objects, paintings and graphics. We call the study of the combinations between them Filographie; this name is derived from philosophy and graphics.
By studying the results of automatic drawing, we simultaneously investigate the connection between thought and matter, the part of thinking that is difficult to access directly for knowledge acquisition.
In filographic research, the filographic game, the use of chance and experiment have an important function. Part of the filographic game are twelve so-called basic forms. These are "randomly" stacked and combined with the other 64 form drawings and with the objects, paintings and graphics. We compare these combinations and examine them for properties.
In filographic research, a connection is established between forms, space, matter and thought. Research into this connection may provide more knowledge about this area about which little is known yet. Study of the filographic world seems to indicate unknown properties of our world. The filographic forms have been chosen in such a way that they do not resemble anything recognizable from everyday life, because associations with them would hinder research.
The collages in this essay represent the study of the layering of perception with filographic forms. Three-dimensional objects, photos of these objects, drawings and symbols are combined with each other and the combinations between them are mixed together, creating and making visible a layering of imaginary spaces and forms. The pictures reflect the composition, changeability and ambiguity of perception.

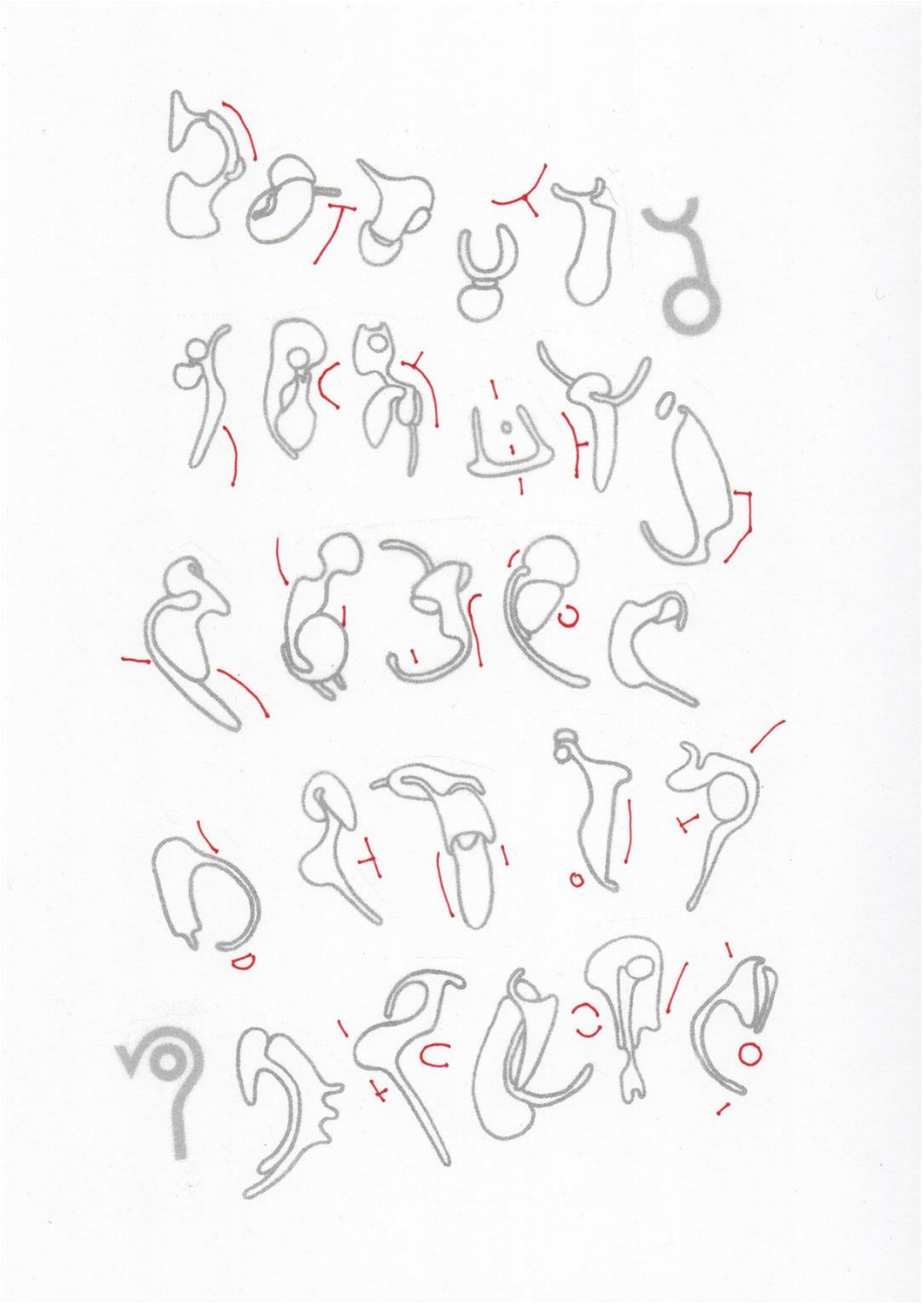
## Viewing guidelines for the pictures

p. 5. repetition and perspective
p. 7. transparent combination of two forms

p. 9. spatial inflections of two combined forms
p. 11. two forms in space, one curving around the other
p. 13. layered curved forms
p. 15. cut curved forms mixed in space
p. 17. parts of white cut-out forms
p. 19. recordings of three-dimensional forms mixed with line forms
p. 21. three-dimensional object mixed with image of three-dimensional form and mixing of line forms
p. 23. mix with recording of white line form and three-dimensional object, and mix of white and black line forms
p. 25. three-dimensional object mixed with recording of three-dimensional object and mixed line forms
p. 27. three-dimensional object with recordings of mixes of three-dimensional objects and line forms
p. 29. three-dimensional object of line form visible in the picture, combined with two other mixes
p. 31. different views of one of the forms of picture on page 29 in different mixes
p. 33. recording of line form from picture on page 31 converted into an object and mixed with other line form mixes
p. 35. recording in a mix combined with a recording of the same object in a mix
p. 37. two mixes of the same two objects with a line form
p. 39. Combination of two cut up mixes with opening to the background
p. 41. combination of mixes with object and its symbol
p. 43. same symbol and form as in picture on page 41 mixed with part of picture on page 39
p. 45. Combination of three mixes with similarities
p. 47. mix of parts of pictures on page in 45
p. 49. Great mix of various earlier mixes with three dimensional object and its symbol
p. 51. Three twisted perspective mixes with geometric figure
p. 53. Cutted up apparent globe perspective

The pictures can be interpreted in different ways, and the pictures contain hidden similarities and hidden differences.

Page 56 shows a depiction of pencil-drawn filographic forms with red accents that bind the forms with space, and two symbols of two of these drawings.



## About the authors

Gabor Lodi graduated from Art and Art History at the University of Novi Sad and from Art Academy Minerva in Groningen. Afterwards he studied theoretical mathematics. He is a sworn interpreter-translator and worked on a PhD research project on philosophy of visual arts at the University of Leiden. He participates in international art projects and is the author of, among others, *Visual Art Philosophy* and *Filography, Philosophy of Thinking in forms*. As a visual artist and philosopher he works on the space and form research Filographie. More information about his work can be found on www.gaborlodi.nl, facebook.com/ Lódi Gábor and facebook.com/Lidwien Schuitemaker.

Lidwien Schuitemaker has completed her studies in social sciences and philosophy at the University of Groningen. She then worked on a PhD research in philosophy of visual arts at the University of Leiden. She is a philosophical researcher, publicist, teacher and graphic artist. She participates in international art projects and is the author of, among others, *Relative Art Criteria Visual Art Reality*, *Philosophy of Thinking*, *Visual Art Philosophy*, *World without Rich and Poor, Truth* and *Filography, Philosophy of Thinking in Forms*. She investigates the materiality of thought both theoretically and through practical experiments with shapes and space. More information about her work can be found on www.lidwienschuitemaker.nl and www.facebook.com/Lidwien Schuitemaker.

## Bronnen


Bais, S., N*ooit meer rechtdoor. Over het wankel evenwicht tussen waarneming en verbeelding*, Etty Hillesumlezing, uitgeverij Thieme Deventer 2004.

Bais, S., *Keerpunten. Momenten van waarheid in de natuurwetenschap*, Amsterdam University Press 2009

Ball. P., *The elements: A very short introduction*, Oxford University Press 2004.

Clark. A., *Being there: Putting Brain, Body and World together again*, Massachusetts Institute of Technology 1997.

Devlin, K., *Goodbye Descartes. The end of logic and the search for a new cosmology of the mind*, John Wiley and Sons Canada 1997.

Devlin, K., *Mathematics: The Science of Patterns*, Holt and Company 1996.

Edelman, G., Tononi, G., *A Universe of Consciousness. How matter becomes imagination*, Basic Books New York 2000.

Feenstra, L., *Zintuigen*, Amsterdam University Press 2016.

Greene, B., *The Fabric of the Cosmos: Space, Time and the Texture of Reality*, Penguin 2005.

Guerrero, G., *Gödel. Mathematische waarheid en logische paradoxen* [2001], Natuur, Wetenschap & Techniek, Veen 2004.

Hall, van G., *Elastisch universum. ABC van de baanbrekende ideeën van Erik Verlinde*, Fontaine uitgevers 2016.

Heisenberg, W., *Ordnung der Wirklichkeit* [1941], Piper München 1989.

Hubel, D.H., *Eye, Brain and Vision*, The Scientific Library New York 1988.

Icke, V. *Zwaartekracht bestaat niet. Een vraagstuk voor de 21e eeuw*, Amsterdam University Press 2016.

Lodi G., Schuitemaker L., *Beeldende Kunst Filosofie* [1997], uitgeverij Filograph Groningen 2016.

Lodi G., Schuitemaker L., *Filographie, filosofie van denken in vormen* [2008], uitgeverij Filograph Groningen 2016.

Mitsch, J., (directing) *Der Blob: Schleimiger Superorganismus*, documentaire, Frankrijk 2019.

Neumann, von J.,*The Computer and the Brain* [1958], Yale University Press 2012.

Noë A., Thompson E. (ed.), *Vision and Mind*, Massachusetts Institute of Technology 2002.

Noë A., *Action in Perception*, Massachusetts Institute of Technology 2004.

Pallotta, T., Wolting, F. (directing), *Wir sind die Roboter*, documentaire, Duitsland Nederland Frankrijk 2015.

Penrose, R., *The Large, the Small and the Human Mind*, Cambridge University Press 2000.

Ponty, M., De wereld waarnemen [1945], Boom Amsterdam 2003.

Rovelli, C., *Reality is not what it seems. The Journey to Quantum Gravity*, Penguin 2017.

Rovelli, C., *Seven Brief Lessons on Physics*, Penguin 2016.

Rovelli, C., *The Order of Time*, Penguin 2018.

Sautoy, du M, *What We Cannot Know. From consciousness to the cosmos, the cutting edge of science explained*, Harper Collins Publishers 2017.

Schuitemaker L., *Philosophy of Thinking* [2002], uitgeverij Filograph Groningen 2005.

Schuitemaker L., *Wereld zonder arm en rijk*, uitgeverij Filograph Groningen 2013.

Schuitemaker L., *Waarheid*, uitgeverij Filograph Groningen 2018.

Schwartz., R., (ed.) *Blackwell's Handbook of Perception*, Blackwell Publishing Oxford 2004.

Verlinde, E.P., *Een nieuwe kijk op de kosmos*, Haarlemse voordrachten, Koninklijke Hollandsche maatschappij der wetenschappen Haarlem 2014.

Wiesing, L., (ed.) *Philosopie der Wahrnehmung, Modelle und Reflexionen*, Suhrkamp Frankfurt am Main 2002.

Zeki, S., *A Vision of the Brain*, Blackwell Science Oxford 1993.


Publisher Filograph
ISBN/EAN 9789077913321