

## **Preface**

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## A. The basics of Psychology

### Definition of Psychology

**Psychological Science** studies the mind, brain and behavior of human beings or other animals by conducting research. A psychologist therefore works in the field of understanding, changing or predicting behaviors.

Through biological processes in the *brain*, mental activity occurs. The term *mind* is used when talking about mental activity. All actions that can be observed are called *behavior*.

**Critical thinking** is important for being scientific. It mostly describes evaluating information. Another important term in that context is *amiable skepticism*. This includes broad-mindedness and alertness at the same time. Keeping in mind and balancing out these two sides and thus evaluating the information carefully makes one a critical thinker.

People often have biases or wrong intuitions. *Psychological reasoning* finds out how people think and in what situations they do so. Knowing about some of the typical 'mistakes' most humans make, helps us to become better critical thinkers.

A list of some of the typical mistakes most humans make:

- **Ignoring evidence (confirmation bias):** When new information does not fit to a person's belief, they try to prove it wrong or just don't listen to it;
- **Failing to accurately judge source credibility:** People tend to believe authorities even if they do not justify their statements;
- **Misunderstanding or not using statistics:** People do not believe statistics, because they rather rely on their personal observations;
- **Seeing relationships that do not exist:** Thinking that two events are correlated, because they happen around the same time, even if they are completely independent from each other;
- **Using relative comparisons:** The way in which information is presented (for example the order) influences people a lot;
- **Accepting after-the-fact explanations:** People interpret situations in hindsight, even if they do not actually know the facts;
- **Taking mental shortcuts:** Sometimes *heuristics* define the behavior of humans;
- **Failing to see your own inadequacies (self-serving bias):** People have a positive image of themselves and most of them think that they are better than average.

## The Origins of Psychology

Since psychology originates from philosophy, some recent topics in psychology have already been discussed by wise philosophers in ancient times. One of the two main topics that have been around for a very long time is the **nature/nurture debate**. It is referring to the question whether individual features derive from inherited/biological information or from one's personal environment such as culture and education.

The other one is the **mind/body problem**. A lot of people used to believe that the mind and the body of one person were separate from each other.

Throughout the 1800's psychology developed into its own discipline. The first psychology laboratory and institute was created by the German **Wilhelm Wundt** in 1879. He also founded the method of **introspection**. That is a way of measuring the subjective thoughts of a person, by relying on their own reports of their thoughts and feelings. Different schools of thought have shaped psychology from that point on.

**Structuralism** is the school of thought, in which people believe that conscious experience can and should be broken down into all of its parts. Researchers such as Edward Titchener believed that they would be able to understand the mind if they analyzed all underlying units. He tried to do so by making use of the method of introspection as well.

**William James** was the founding father of the next school of thought, called **functionalism**. Researchers put most emphasis on trying to discover the functions of the mind. James believed that the mind could not be divided into single parts, because it is too complex. The notion of the **stream of consciousness** was also developed by him. It means that the mind contains a never-ending series of thoughts.

The idea of functionalism was also closely related to the **evolutionary theory**. Charles Darwin founded this new way of thinking and promoted that adaptations are passed from one generation to another, because they give the individuals having those adaptations an advantage to the rest of the population. This means that also the mind developed through **natural selection**.

Another approach, which is very different to structuralism is the **Gestalt theory**. It consists of the belief that the sum of all personal experiences is not the same as the whole of personal experience and that perception is subjective.

**Sigmund Freud** is a very famous person in the field of psychology. After he found out that **unconscious** processes have a huge influence on human behavior he developed a method to treat people with mental disorders, called psychoanalysis. Through listening to his patients, he tried to make their problems conscious and thus treat their disorders. When making use of *free association* patients are supposed to just talk about whatever comes to their mind.

Another huge school of thought in psychology is **behaviorism**. **John B. Watson** demanded that psychology needs to examine observable behavior in order to be a real science. He and his peers believed that animals learn by reacting to environmental experiences or *stimuli*. Therefore they were trying to predict behavioral *responses* to a stimuli. Mental states, feelings or thoughts were basically of no interest to behaviorists, as long as you could not observe them. **B.F. Skinner** is also known very well for his research in this branch of psychology.

The cognitive revolution in the 1960's placed a big emphasis on mental states. Psychologists now focused on memory, language and child development. **Cognitive psychology** first only dealt with different mental functions, such as thought processes, but when technology advanced, the brain became a big field of interest for cognitive psychologists, such as George A. Miller. **Cognitive neuroscience** developed as cognitive psychologists teamed up with neuroscientists, computer scientists and philosophers.

**Social psychology** appeared around the time of World War II. Psychologists wanted to figure out how people behave when they are in certain social contexts. The way people influence other people differs from person to person. With those individual differences is dealt with in the field of **personality psychology**.

The **psychological treatments** of disorders were usually determined by the current school of thought. Due to the fast progress in psychology, lots of diseases can now be treated through different approaches (e.g. biological and environmental) and therefore the treatments have better chances of being more effective.

## Current Research in Psychology

There are four main fields which arouse a lot of interest in the world of psychology at the moment.

**Biology** is very important for explaining the basic processes in our bodies which cause our behavior. For example there is a lot of research dealing with **brain chemistry**, to find out which substances cause what effects. Also, **neuroscience** makes use of brain imaging methods to discover the neural procedures within the brain.

It also figures out whether there is *localization* for specific tasks. Analyzing the **human genome** is another important part considering this point. Scientists can find out which genes are responsible for what and connect that knowledge to the treatment of disorders.

**Evolutionary thinking** is the next big topic in current psychology. The knowledge that the brain has developed for such a long time makes it possible to explain certain behaviors with the need for this behavior in our ancestors. Some functions of our brain might thus be adaptations from former times and researcher also found that even the mind adapts to different cultures.

Research in the field of **culture** is also quite popular, because interactions between groups are really special in human beings. Oftentimes adaptive solutions are presented by a culture, because previous generations figured out that this certain method worked very well. In general, culture has a big influence on people's minds and their way of living, but the *norms* vary from culture to culture.

Research in psychology now combines **different levels of analysis**. The major levels of analysis walk together with the most popular research methods and are called the *biological level of analysis*, the *individual level of analysis*, the *social level of analysis* and the *cultural level of analysis*. By using multiple levels of analysis for one topic a broader understanding of this topic is possible. Sometimes psychologists even work together with scientists from different fields to create *interdisciplinary* knowledge and more insight.

Depending on the subfield in psychology, psychologists make use of different levels of analysis. Some also focus on science and some on practice. Some subfields of psychology are: *neuroscience/biological psychologists, cognitive psychologists, developmental psychologists, personality psychologists, social psychologists, cultural psychologists, clinical psychologists, counseling psychologists, school psychologists, industrial and organizational psychologists*.

## B. From Senses To Impressions

### How We Recognize Our Environment

The detection of environmental stimuli by our sensory organs and the transmission of this information to the brain is called **sensation**. Then the brain evaluates and organizes this information and this process is named **perception**. The term **bottom-up processing** refers to perceiving a certain image due to adding up different sensory information. **Top-down processing** means that our expectations guide our interpretation of stimuli.

When external stimuli are translated into signals that the brain can understand, we talk about **transduction**. The stimuli is registered at a sensory organ and then transmitted to the brain by neurons. To perceive this incoming information correctly, the brain also needs *qualitative* and *quantitative* information. Qualitative differences are represented by different receptors/neurons firing and quantitative information is given by the frequency of neural firing.

Psychophysics examine the human sensory system and found out that there are sensory thresholds. The **absolute threshold** is the minimum intensity of a stimulus which is detected correctly 50 percent of the time. The **difference threshold** is the minimum change in a stimulus required for a person to notice the difference. *Weber's law* says the noticeable difference depends on the proportion to the original stimulus rather than a set measure of difference.

The **signal detection theory (SDT)** states that it is subjective whether a stimulus is detected or not. It is dependent on the sensitivity to the stimulus and the principles used to make a decision. To test signal detection, participants have to report whether they noticed a stimulus, not knowing if the stimulus was even on. The possible outcomes are *hit, miss, false alarm and correct rejection*.

Continuing stimuli are usually not noticed as much over time. **Sensory adaption** describes the decline of sensitivity in that case.

The brain puts together all sensory inputs to create a stable representation of our environment. Our sensory organs receive and transmit different information than we actually perceive. In the following we will have a look into the five major senses.

## Vision

Seeing is the most important sense for us humans, because it allows us to detect objects in a broad range of distance. With the help of different structures in the eye, our brain is able to form an image and thus we see. The *cornea* and the *lens* have the task to bend the light rays so that they hit the **retina**. The retina is located at the back of the eyeball and contains the sensory receptors for seeing. In the eye there are two different kinds of receptors, namely **rods** and **cones**. Both are able to translate the physical light waves into electrical neural impulses. The rods however are responsible for seeing in the dark. They do not allow color vision or details and are mostly located at the edges of the retina. The cones let us see in bright conditions make us able to see colors and details. The density of them is especially high in a small region in the middle of the retina, which is called **fovea**.

The first step in transmitting the visual information from the receptors to the brain is that *photopigments* in the receptors split up which causes a change in the membrane potential of the photopigments. Other cells in the retina react to that and the ganglion *cells* in the retina are the first cells to produce a neural firing. Those produced action potentials are then transmitted to the thalamus via the *optic nerve*. We have a blind spot in our retina, where the optic nerve exits the retina. Some axons of the two optic nerves cross at the *optic chiasm* which leads to the fact that our left visual field is represented in our right hemisphere and the other way around. From the thalamus the visual information is transmitted to *the primary visual cortex* in the occipital lobes.

A common theory about vision states that there are two different streams in the visual area of the brain besides the primary visual cortex. The lower, *ventral stream* is also known as "what" stream, because it is responsible for detecting objects. The upper, *dorsal stream*, or in other words the "where" stream, is associated with spatial perception.

The color we see is determined by the wavelengths of the electromagnetic waves that are reflected by the object. This means that color is actually created within our visual system. There are different theories on how this exactly works.

*Trichromatic theory*: There are three different types of cones which are called "S", "M" and "L" cones. They either respond to short wavelengths, medium wavelengths or long wavelengths. Depending on which cones are stimulated, we see a variety of different colors. When people have a *color-blindness*, they are missing photopigments sensitive to a certain length of waves.

*Opponent-process theory*: This theory states that colors such as red and green or blue and yellow are opponent colors. This may be due to different ganglion cells which are excited by one kind of cones and inhibited by other types of cones.

Color has three dimensions: *Hue* refers to the general spectrum of a color such as blueness. The mixture of different wavelengths in a stimulus determine the *saturation*, or in other word pureness, of a color. The intensity of a color is its *brightness*. The lightness of a color on the other hand is determined by its surrounding.

Researchers find out more about perceptual systems and visual brain processes by making use of optical illusions.

There are five *Gestalt* principles which try to explain why we see objects in its entirety and not the different parts they are made up from:

- **Proximity**: If features are close to each other, we tend to group them together;
- **Similarity**: If items look similar to each other, we often think that they belong together;
- **Continuity**: We tend to cluster or complement features that have the same direction. This is also called good continuation;
- **Closure**: We tend to supplement items, if they have gaps;
- **Illusory contours**: We sometimes see shapes that are not actually there.

Our visual perception system always has to separate between figure and ground. However, the perception of these two parts can switch and is individual.

The perception of faces is especially important when we perceive our environment. We are able to make precise distinctions of facial expressions and there is even an area in our brain, called the fusiform gyrus, that is devoted to perceiving faces. Faces of other ethnic groups or inverted faces are much harder to identify for us.

The most important function of our vision is to locate objects. Our brain does so by creating a three-dimensional image of the two-dimensional visual input. There are cues that help the visual system to detect depth. **Binocular depth cues** come from both eyes. One is **binocular disparity**, which means that there are two slightly different images on the two retinas of our eyes. These images are compared and therefore we see depths. There is also **convergence**. This depth cue has to do with the movement of eye muscles. The brain can calculate the distance from the convergence of eye muscles. **Monocular depth cues** come from one single eye and are also called pictorial depth cues.

**Occlusion** refers to an object being in front of an object which is further in distance. Distant objects produce a smaller image than close objects and this is described in the term **relative-size**.

Through knowing how big objects are from experience we can assume how far away they are considering the retinal image. This is called **familiar size**. **Linear perspective** means that parallel lines appear to meet in the distance. The **texture gradient** describes that texture becomes denser as a textured surface fades. Last but not least the **position relative to horizon** is important. Objects below the horizon appear further away when they are higher in the visual field than other objects below the horizon.

The size of an object is usually calculated with the help of the object's distance. Nevertheless both depth perception and distance perception can be tricked. This happens when wrong depth clues are given or the brain perceives certain features as depth cues even if they aren't any.

We have to consider two phenomena when we try to understand how our visual system perceives motion:

*Motion aftereffects* describe the illusion that objects seem to move the opposite way when you watched an object moving in one direction for a longer time. This can be explained by the existence of neurons in the visual cortex that are sensitive to a special movement. When one kind of neurons has been stimulated for a longer time, the other neurons are more sensitive when the given stimuli suddenly stops.

*Stroboscopic motion perception* refers to slightly different images being shown directly after each other.

When we talk about **object constancy** we mean that we correctly perceive an object as constant, even though sensory input might say differently. There is *size constancy*, *shape constancy*, *color constancy* and *lightness constancy*. To perceive these constancies we have to have more information about the object such as distance.

Thus the visual system sometimes allows us to see a stable world and sometimes we are tricked by illusions.

## Hearing

Similar to vision, hearing, or in other words **audition**, is actually created within the brain. It all starts with objects being moved and therefore causing air molecules to diffuse. As a result of that, the air pressure changes and this pressure change travelling through the air is called a **sound wave**.

The higher the *amplitude* of a sound wave is, the louder the sound. The *frequency* describes the pitch of the emerging sound. The measurement of the frequency is called *hertz* (Hz).

The ear is divided into the *outer ear*, *middle ear* and *inner ear*. At first, the sound wave arrives at the outer ear and reaches the **eardrum** through the auditory canal. The eardrum is a membrane, which starts to vibrate when a sound wave hits it.

This movement is then carried to the *ossicles*, which are three very small bones inside the middle ear. They in turn make the *oval window* vibrate, which is a membrane, located in the inner ear. It is surrounded by the *cochlea*, which contains fluid and has the shape of a winding tube. At the end of the cochlea, there is another membrane called the *round window*. Inside the cochlea there is the *basilar membrane* which has got *hair cells* on it. So when the round window vibrates, the fluid inside the cochlea also moves, causing the hair cells on the basilar membrane to bend. The hair cells are the primary auditory receptors, which convert the stimuli into a neural signal that is sent through the *auditory nerve*. When the neural firings of the hair cells reached the thalamus, they are then transferred to the *primary auditory cortex* in the temporal lobes.

To locate where a sound comes from, the brain determines the time it took for the sound to reach each ear and the magnitude of the sound in each ear. The difference of the sound in the two ears is especially important for this.

Ears are not only the sensory organ for hearing, but also for balancing. The **vestibular system** also makes use of receptors inside the ear, namely from receptors in the semicircular canals, to measure the movement of a liquid.

To achieve the variety of pitches we are able to hear from stimuli there are two important mechanisms that take place in the basilar membrane.

**Temporal coding** means that the firing of the hair cells has the same frequency as the sound wave. This is mainly used for low frequencies.

**Place coding** describes the procedure that different frequencies are encoded by hair cells in different regions of the basilar membrane. At the base of the cochlea or the basilar membrane, high-frequency waves are registered and at the tip low-frequency sounds are recorded, because these parts of the membrane vibrate most for those frequencies.

Cochlear implants help people who suffer from severe hearing impairments. It is an electronic device that directly activates the auditory nerve, without needing hair cells as receptors.

### **Taste**

The sensory system of taste is called **gustation**. In your mouth the substances you consumed dissolve in saliva. The taste receptors are located in **taste buds**.

Most of them are in areas of the tongue which are called *papillae*, but there are also taste buds in other areas of the mouth and the throat. The taste receptors receive the chemical stimuli and transmit that signal to the thalamus via neural firing. From there the information is transferred to the frontal lobe. Our brain then perceives whether a food is good or bad or dangerous.

There are five basic tastes, namely sweet, sour, salty, bitter and *umami* (translates to "savory"). Different taste buds correspond to different stimuli. Our actual taste experience is created through the combination of different taste buds being activated and also smell and texture of food play an important role.

Supertasters have more taste buds than an average person. This causes them to dislike many foods. People actually lose taste receptors as they age.

Taste preferences are determined on the one side by the amount of certain taste receptors and on the other side by cultural influences, such as eating habits of the mother.

### **Smell**

The sense of smell is also called **olfaction**. Chemical particles called *odorants* need to pass our noses in order for us to be able to smell something. When we sniff, the odorants get into our nasal cavity where the **olfactory epithelium** is located. This is a structure in the nasal cavity that contains the smell receptors. Different receptors are activated by different kinds of odorants. The smell receptors transfer the signal directly to the **olfactory bulb** and from there, the olfactory nerve transmits the signal to other parts of the brain such as the prefrontal cortex and amygdala. Olfaction is thus the only sensory system that does not go through the thalamus. The prefrontal cortex determines whether a smell is nice or not and other parts of the brain evoke memories and emotions connected to certain smells. For humans it is usually hard to name or describe a smell. *Pheromones* are chemicals that play an important role in social behavior of many animals. They are processed similar to other odorants, but we are not conscious of them.

## Touch

The sensory system of touch is called **haptic sense** and deals with the sensation of pressure, temperature and pain. The **kinesthetic sense** is related to it and lets us perceive the place or movement our body parts are in.

There are multiple receptors to *tactile stimulation* in our skin. For temperature and pressure, the receptors are sensory neurons that are located in the skin's outer layer. For temperature there are receptors for cold and warmth and there are five types of pressure receptors, such as receptors that react to the movement of hair follicles.

The neural receptors transmit the signal to the thalamus through cranial or spinal nerves. From there the touch information reaches the primary somatosensory cortex in the parietal lobe. Body parts differ in sensitivity regarding touch. This depends on the amount of cortical tissue that represents this body part.

Pain protects the body from dangerous activity. Pain receptors occur everywhere in the body. These nerves are thinner than the other haptic receptors and can be split into two different nerve fibers. There are *fast fibers* which have myelinated axons. They deliver sharp and sudden pain activated by intense pressure and temperature. *Slow fibers* have nonmyelinated axons and cause steady pain. They start to fire when there are chemical changes in tissue.

The perception of pain is determined by biological, psychological and cultural factors. The *gate control theory* states that pain signals can be blocked from entering the brain when there are other, larger sensory nerves firing. This happens at the spinal cord. Several methods may lead to a perception of less pain. Positive mental states, music, distraction and techniques to think of brain differently help to reduce the sensation of pain. Pain medication alter or stop the transmission of neural firings.