I M.Sc. Psychology

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UNIT 2: ATTENTION & PERCEPTION

Attention is the behavioral and cognitive process of selectively concentrating on a discrete aspect of information, whether considered subjective or objective, while ignoring other perceivable information. William James (1890) wrote that "Attention is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalization, concentration, of consciousness are of its essence."[1] Attention has also been described as the allocation of limited cognitive processing resources.[2] Attention is manifested by an attentional bottleneck, in terms of the amount of data the brain can process each second; for example, in human vision, only less than 1% of the visual input data (at around one megabyte per second) can enter the bottleneck,[3][4] leading to inattentional blindness.[5]n

Types of Attention

Classification of Attention by Ross: According to Ross, attention can be classified into Non-Volitional (Involuntary attention) and Volitional (Voluntary attention).

1. **Non-Volitional (Involuntary Attention)**: This type of attention does not involve any role of will; instead it is aroused either by instincts and hence called enforced attention or is produced by our sentiments and therefore called as spontaneous non-volitional attention. Examples of non-volitional attention could be attention paid to the members of the opposite gender or a mother's attention on noticing her crying child.
2. **Volitional (Voluntary Attention)**: Volitional attention exercises the will and demands our conscious effort for arriving at a solution or achieving certain goals. Unlike Non Volitional attention, Volitional attention is less spontaneous or automatic. Examples of volitional attention could be paying attention while solving maths problem or attention focused on while answering examination questions.

Attention can further be categorized on the basis of needs or circumstances which we may be faced with:

1. **Sustained Attention**: It is the ability to pay attention to only one task by consciously concentrating on that task only for a long time enough and by avoiding all other forms of distractions or deviations. This kind of attention requires a good deal of focus as well as determination for being able to concentrate on a given task by keeping away all the distractions. Sustained attention examples could be reading a book, memorizing a chapter or following a classroom lecture.
2. **Selective Attention**: In this case, the listener chooses to pay attention to only a specific stimulus which is present in the environment while ignoring the other stimuli. This kind of attention does not depend on the stimulus but depends essentially on the attentive capabilities of an observer.
3. **Divided Attention**: In case of divided attention, the user pays attention to two or more tasks

at the same time and is also sometimes regarded as Multi-tasking which involves juggling between two or more than two tasks at the same time. Its examples could be texting somebody while attending a meeting. Divided attention uses mental focus on a very large scale; hence because of divided attention the user may get exhausted very quickly.

4. **Alternating Attention**: Though this attention can be closely related to divided attention, but is different as in case of divided attention we split our attention between two tasks, while in case of alternating attention, the entire attention is shifted from one task to another or is done alternately.
5. **Visual Attention**: Visual attention makes use of the sensory organ eyes for paying attention to certain details. Visual attention pays attention to the details or inputs which are received by the eyes only and blurs out all the other stimuli which is present in the environment. Visual attention is put to use in case of advertising and reading.

6. **Auditory Attention**: This form of attention pays attention only to the sense of hearing only. Paying attention to an important announcement can be an example of auditory attention. Auditory and visual attention both function in conjunction with each other.

Determinants of Attention

Attention can be influenced by both external and internal factors.

External Factors: These are the factors which are external in nature and are usually governed by the characteristics of the stimuli. These external factors could be related to the nature of the stimuli, the intensity as well as the size of the stimuli, the degree to which contrast, variety or change is present in the stimuli. The extent to which the exposure to a stimulus is repeated will, also determine the strength of the attention. Moreover, a stimulus which is in a state of motion will be able to catch our attention more quickly than a stationery one.

Internal (Subjective) factors: The subjective factors which influence attention are interests, motive, mind set and our attitudes & moods. It is believed that interest is the mother of attention, as we pay attention or focus on those objects about which we have interest. Similarly, our needs or motives equally govern our attention for specific events or objects. Moreover, the mental readiness of a person to respond to certain stimuli or preparedness will also determine the attention level for that person.

Selective and visual

In cognitive psychology there are at least two models which describe how visual attention operates. These models may be considered metaphors which are used to describe internal processes and to generate hypotheses that are falsifiable. Generally speaking, visual attention is thought to operate as a two-stage process.[10] In the first stage, attention is distributed uniformly over the external visual scene and processing of information is performed in parallel. In the second stage, attention is concentrated to a specific area of the visual scene (i.e., it is focused), and processing is performed in a serial fashion.

Multitasking and divided

Multitasking can be defined as the attempt to perform two or more tasks simultaneously; however, research shows that when multitasking, people make more mistakes or perform their tasks more slowly. Attention must be divided among all of the component tasks to perform them. In divided attention, individuals attend or give attention to multiple sources of information at once or perform more than one task at the same time.

Older research involved looking at the limits of people performing simultaneous tasks like reading stories, while listening and writing something else,[22] or listening to two separate messages through different ears (i.e., dichotic listening). Generally, classical research into attention investigated the ability of people to learn new information when there were multiple tasks to be performed, or to probe the limits of our perception (c.f. Donald Broadbent). There is also older literature on people's performance on multiple tasks performed simultaneously, such as driving a car while tuning a radio[23] or driving while being on the phone.[24]

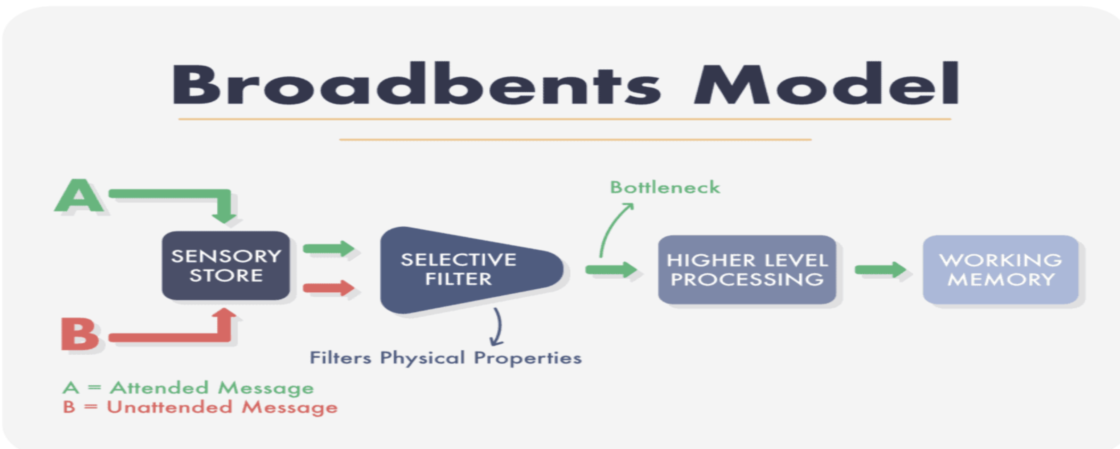
The vast majority of current research on human multitasking is based on performance of doing two tasks simultaneously,[20] usually that involves driving while performing another task, such as texting, eating, or even speaking to passengers in the vehicle, or with a friend over a cellphone. This research reveals that the human attentional system has limits for what it can process: driving performance is worse while engaged in other tasks; drivers make more mistakes, brake harder and later, get into more accidents, veer into other lanes, and/or are less aware of their surroundings when engaged in the previously discussed tasks.[25][26]

Theories of Attention

Broadbent's Filter Model

Broadbent (1958) proposed that physical characteristics of messages are used to select one message for further processing and that all others are lost.

Information from all of the stimuli presented at any given time enters an unlimited capacity sensory buffer. One of the inputs is then selected on the basis of its physical characteristics for further processing by being allowed to pass through a filter.



Because we have only a limited capacity to process information, this filter is designed to prevent the information-processing system from becoming overloaded.

The inputs not initially selected by the filter remain briefly in the sensory buffer store, and if they are not processed they decay rapidly. Broadbent assumed that the filter rejected the unattended message at an early stage of processing.

According to Broadbent the meaning of any of the messages is not taken into account at all by the filter. All semantic processing is carried out after the filter has selected the message to pay attention to. So whichever message(s) restricted by the bottleneck (i.e. not selective) is not understood.

Broadbent wanted to see how people were able to focus their attention (selectively attend), and to do this he deliberately overloaded them with stimuli.

One of the ways Broadbent achieved this was by simultaneously sending one message to a person's right ear and a different message to their left ear. This is called a split span experiment (also known as the dichotic listening task).

Dichotic Listening Task

The dichotic listening tasks involves simultaneously sending one message (a 3-digit number) to a person's right ear and a different message (a different 3-digit number) to their left ear.

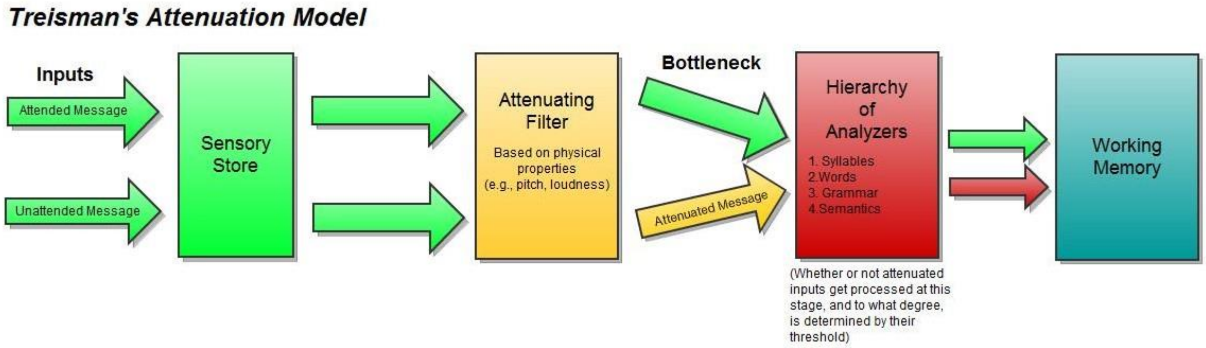
Participants were asked to listen to both messages at the same time and repeat what they heard. This is known as a 'dichotic listening task'.

Broadbent was interested in how these would be repeated back. Would the participant repeat the digits back in the order that they were heard (order of presentation), or repeat back what was heard in one ear followed by the other ear (ear-by-ear).

He actually found that people made fewer mistakes repeating back ear by ear and would usually repeat back this way.

Attenuation theory

Attenuation theory is a model of selective attention proposed by Anne Treisman, and can be seen as a revision of Donald Broadbent's filter model. Treisman proposed attenuation theory as a means to explain how unattended stimuli sometimes came to be processed in a more rigorous manner than what Broadbent's filter model could account for.[1] As a result, attenuation theory added layers of sophistication to Broadbent's original idea of how selective attention might operate: claiming that instead of a filter which barred unattended inputs from ever entering awareness, it was a process of attenuation.[2] Thus, the attenuation of unattended stimuli would make it difficult, but not impossible to extract meaningful content from irrelevant inputs, so long as stimuli still possessed sufficient "strength" after attenuation to make it through a hierarchical analysis process.[2]



How attenuation occurs

Treisman's attenuation model of selective attention retains both the idea of an early selection process, as well as the mechanism by which physical cues are used as the primary point of discrimination.[3] However, unlike Broadbent's model, the filter now attenuates unattended information instead of filtering it out completely.[1] Treisman further elaborated upon this model by introducing the concept of a threshold to explain how some words came to be heard in the unattended channel with greater frequency than others. Every word was believed to contain its own threshold that dictated the likelihood that it would be perceived after attenuation.[15]

After the initial phase of attenuation, information is then passed on to a hierarchy of analyzers that perform higher level processes to extract more meaningful content (see "Hierarchical analyzers" section below).[1] The crucial aspect of attenuation theory is that attended inputs will always undergo full processing, whereas irrelevant stimuli often lack a sufficiently low threshold to be fully analyzed, resulting in only physical qualities being remembered rather than semantics.[3] Additionally, attenuation and then subsequent stimuli processing is dictated by the current demands on the processing system. It is often the case that not enough resources are present to thoroughly process unattended inputs.[15]

Recognition threshold

The operation of the recognition threshold is simple: for every possible input, an individual has a certain threshold or "amount of activation required" in order to perceive it. The lower this threshold, the more easily and likely an input is to be perceived, even after undergoing attenuation.[16]

Threshold affectors

Context and priming

Context plays a key role in reducing the threshold required to recognize stimuli by creating an expectancy for related information.[9] Context acts by a mechanism of priming, wherein related information becomes momentarily more pertinent and accessible – lowering the threshold for recognition in the process.[3] An example of this can be seen in the statement *"the recess bell **rang**"*, where the word rang and its synonyms would experience a lowered threshold due to the priming facilitated by the words that precede it.

Subjective importance

Words that possess subjective importance (e.g., help, fire) will have a lower threshold than those that do not.[2] Words of great individual importance, such as your own name, will have a permanently low threshold and will be able to come into awareness under almost all circumstances.[17] On the other hand, some words are more variable in their individual meaning, and rely upon their frequency of use, context, and continuity with the attended message in order to be perceived.[17]

Degree of attenuation

The degree of attenuation can change in relation to the content of the underlying message; with larger amounts of attenuation taking place for incoherent messages that possess little benefit to the person hearing them.[1] Incoherent messages receive the greatest amounts of attenuation because any interference they might exhibit upon the attended message would be more detrimental than that of comprehensible, or complimentary information.[1] The level of attenuation can have a profound impact on whether an input will be perceived or not, and can dynamically vary depending upon attentional demands.[18]

Hierarchy of analyzers*]*

The hierarchical system of analysis is one of maximal economy: while facilitating the potential for important, unexpected, or unattended stimuli to be perceived, it ensures that those messages sufficiently attenuated do not get through much more than the earliest stages of analysis, preventing an overburden on sensory processing capacity.[2] If attentional demands (and subsequent processing demands) are low, full hierarchy processing takes place. If demands are high, attenuation becomes more aggressive, and only allows important or relevant information from the unattended message to be processed.[1] The hierarchical analysis process is characterized by a serial nature, yielding a unique result for each word or piece of data analyzed.[17] Attenuated information passes through all the analyzers only if the threshold has been lowered in their favor, if not, information only passes insofar as its threshold allows.[17]

The nervous system sequentially analyzes an input, starting with the general physical features such as pitch and loudness, followed by identifications of words and meaning (e.g., syllables, words, grammar and semantics).[8] The hierarchical process also serves an essential purpose if inputs are identical in terms of voice, amplitude, and spatial cues. Should all of these physical characteristics be identical between messages, then attenuation can not effectively take place at an early level based on these properties. Instead, attenuation will occur during the identification of words and meaning, and this is where the capacity to handle information can be scarce.[8]

PERCEPTION

Perception (from Latin *perceptio* 'gathering, receiving') is the organization, identification, and interpretation of sensory information in order to represent and understand the presented information or environment. All perception involves signals that go through the nervous system, which in turn result from physical or chemical stimulation of the sensory system.[3] Vision involves light striking the retina of the eye; smell is mediated by odor molecules; and hearing involves pressure waves.

Perception is not only the passive receipt of these signals, but it is also shaped by the recipient's learning, memory, expectation, and attention. Sensory input is a process that transforms this low-level information to higher-level information (e.g., extracts shapes for object recognition).[5] The process that follows connects a person's concepts and expectations (or knowledge), restorative and selective mechanisms (such as attention) that influence perception.

Perception depends on complex functions of the nervous system, but subjectively seems mostly effortless because this processing happens outside conscious awareness.[3] Since the rise of experimental psychology in the 19th century, psychology's understanding of perception has progressed by combining a variety of techniques.[4] Psychophysics quantitatively describes the relationships between the physical qualities of the sensory input and perception.[6] Sensory neuroscience studies the neural mechanisms underlying perception. Perceptual systems can also be studied computationally, in terms of the information they process. Perceptual issues in philosophy include the extent to which sensory qualities such as sound, smell or color exist in objective reality rather than in the mind of the perceiver.[4]

Although people traditionally viewed the senses as passive receptors, the study of illusions and ambiguous images has demonstrated that the brain's perceptual systems actively and pre-consciously attempt to make sense of their input.[4] There is still active debate about the extent to which perception is an active process of hypothesis testing, analogous to science, or whether realistic sensory information is rich enough to make this process unnecessary.[4]

The perceptual systems of the brain enable individuals to see the world around them as stable, even though the sensory information is typically incomplete and rapidly varying. Human and animal brains are structured in a modular way, with different areas processing different kinds of sensory information. Some of these modules take the form of sensory maps, mapping some aspect of the world across part of the brain's surface. These different modules are interconnected and influence each other. For instance, taste is strongly influenced by smell.[7]

Bottom-Up Processing

Take-home Messages

- Bottom-up processing focuses on interpreting sensory information in real-time (Gibson, 1966).
- Bottom-up processing occurs as our sensory receptors receive new sensory information and does not require the use of prior knowledge or experiences.
- Bottom-up processing is data-driven and emphasize the importance of the stimulus itself, the raw data of the direct experience.

- Bottom-up processing would function in a series of events that began with the intake of new sensory information, then our sensory receptors sending signals to the brain, where the brain would then process these signals and finally construct a perception based off the signals that were received.

The bottom-up process involves information traveling 'up' from the stimuli, via the senses, to the brain which then interprets it, relatively passively. Bottom-up processing is also known as data-driven processing, because the processing of information begins with environmental stimuli, and perceptions are built from sensory input.

Bottom-Up vs. Top-Down Processing

Bottom-up processing begins with the retrieval of sensory information from our external environment to build perceptions based on the current input of sensory information (Gibson, 1966).

Top-down processing is the interpretation of incoming information based on prior knowledge, experiences, and expectations (Gregory, 1970)

- Data-driven
- Relies on sensory information
- Takes place in real-time

- Schema driven
- Relies on knowledge and experiences

Bottom-up processing begins with the retrieval of sensory information from our external environment to build perceptions based on the current input of sensory information. Top-down processing is the interpretation of incoming information based on prior knowledge, experiences, and expectations.

In top-down processing we know that previous knowledge, experience, and expectations are essential in creating perceptions about new stimuli, so the driving force in top-down perception is one’s previous knowledge, experience, and expectations (Gregory, 1974).

Whereas in bottom-up processing, no learning is required, and perceptions are solely based on new stimuli from one’s current external environment, meaning that the driving force of perception in bottom-up processing is the stimulus that is currently being experienced within one’s external environment (Gibson, 1972).

Sensation vs. Perception

Bottom-up processing is the process of ‘sensation’ and top-down is the process of ‘perception’.

Sensation is the input of sensory information from our external environment that is received by our sensory receptors. Bottom-up processing is the process of ‘sensation’, whereby the input of sensory information from the external environment is received by our sensory receptors.

Perception is how our brains choose, organize, and interpret these sensations.

Perception is unique to each individual as we are interpreting these sensations based on our individual schemas that are constructed from previous knowledge, experiences, and expectations (Jandt, 2020).

How Bottom-Up Processing Works

Bottom-up processing starts with minute sensory details that are then used to construct larger ideas or perceptions about one’s external environment.

Processing is carried out in one direction from the retina to the visual cortex, with each successive stage in the visual pathway carrying out ever more complex analysis of the input.
Bottom-up processing works like this:

1. We start with an analysis of sensory inputs such as patterns of light.
2. This information is replayed to the retina where the process of transduction into the electrical impulses begin.
3. These impulses are passed into the brain where they trigger further responses along the visual pathways until they arrive at the visual cortex for final processing.

Bottom-up processing states that we begin to perceive new stimuli through the process of sensation and the use of our schemas is not required. James J. Gibson (1966) argued that no learning was required to perceive new stimuli.

Gibson looked at perception as more of a ‘what you see is what you get’ kind of situation. Meaning that Gibson’s theory argues that perception functions as a straight line, we experience new stimuli through our sensations and then directly analyze their meaning.

Unlike Gregory’s theory (1970), Gibson believed that the environment holds all of the necessary tools to create accurate perceptions of incoming stimuli.

Real-Life Applications

You can compare how bottom-up processing works to how top-down processing works by considering examples of how each process works.

Stubbing your Toe

However painful, imagine you have just stubbed your pinky toe on the corner of the bed. Upon stubbing your pinky toe, the pain receptors in your toe would have immediately recognized the sensation of pain and sent these very pain signals to your brain where they are processed.

This would be considered bottom-up processing as your brain is receiving signals of pain sent by your pinky toe's sensory receptors.

However, now that you have experienced the horrifying pain caused by stubbing your pinky toe, you are now extra careful to avoid the corners of your bed because you remember how painful that experience was and do not wish to repeat it, which would be an example of top-down processing.

To put it simply, the sensation of pain and the subsequent signals sent to your brain that detected the pain caused by stubbing your pinky toe occurred through bottom-up processing.

Blind Food Taste Challenge

A blind taste testing challenge focuses on isolating all but one of the five senses, taste. Participants are asked to place a blindfold on and determine different characteristics about the food and/or drink items that are presented in front of them.

For example, in the study by Lowengart (2013) researchers sought to understand whether branding made a difference in consumer purchases by conducting a blind taste test challenge asking participants to determine which wine was better by tasting a variety of wines while being blindfolded.

This study intended to eliminate the possibility of participants being influenced by any senses other than taste. Meaning that bottom-up processing was actively at work as participants relied solely on their sense of taste to determine which wines best suited their preferences without having any other information about the wine they are drinking.

If the participants were asked to name the brand of wine, this would have included their utilization of their memory therefore meaning that bottom-up and top-down processing would have been used.

However, since participants were only asked to select the wines that best suited their preferences, only bottom-up processing was used in this study.

Prosopagnosia

Prosopagnosia (phonetically pronounced, praa-suh-pag-now-zhuh), is a visual form of agnosia where individuals are unable to recognize faces or facial differences (Harris & Aguirre, 2017). Prosopagnosia or often referred to as face blindness, is a rare condition where patients who are affected cannot recognize whether they have seen someone's face before or not.

In cases such as these, top-down processing is not possible to distinguish one face to the next, individuals must rely on taking in what they are seeing in the moment when analyzing someone's face.

This is because individuals with prosopagnosia are able to recognize different facial features but are not able to use their memory to put a name to a face. In essence, individuals with prosopagnosia are unable to detect familiar faces because they are not able to combine facial features into complete faces that they are then able to recognize in the future.

"Imagine that every person has a camera inside their head. Every time they meet somebody for the first time, they take a picture with their camera, develop the picture, and file it away for future use For me, I take a picture with my camera, but I never store it away" (Lewis, 2013).

As patients affected by prosopagnosia are unable to mentally store the faces of individuals they know, using top-down processing to build perceptions is inherently impossible as these individuals have no memory of the faces of people that they have met in their lifetime.

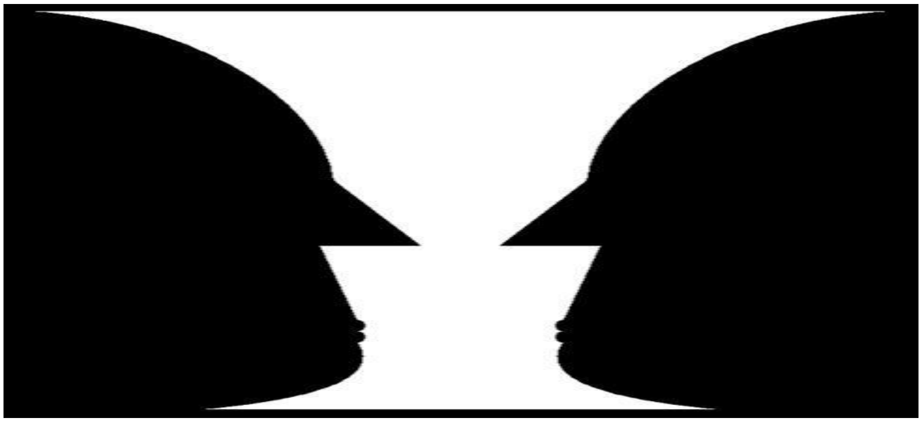
Each and every encounter forces individuals with prosopagnosia to place a name with a face with the new sensory information presented within each encounter.

The Gestalt Principles of Perception

In the early part of the 20th century, Max Wertheimer published a paper demonstrating that individuals perceived motion in rapidly flickering static images—an insight that came to him as he used a child's toy tachistoscope. Wertheimer, and his assistants Wolfgang Köhler and Kurt Koffka, who later became his partners, believed that perception involved more than simply combining sensory stimuli. This belief led to a new movement within the field of psychology known as Gestalt psychology. The word *gestalt* literally means form or pattern, but its use reflects the idea that the whole is different from the sum of its parts. In other words, the brain creates a perception that is more than simply the sum of available sensory inputs, and it does so in predictable ways. Gestalt psychologists translated these predictable ways into principles by which we organize sensory information. As a result, Gestalt psychology has been extremely influential in the area of sensation and perception (Rock & Palmer, 1990).

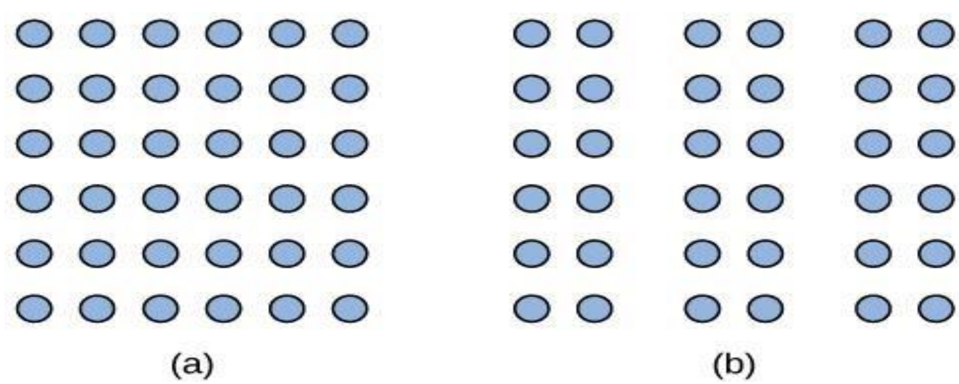
Gestalt perspectives in psychology represent investigations into ambiguous stimuli to determine where and how these ambiguities are being resolved by the brain. They are also aimed at understanding sensory and perception as processing information as groups or wholes instead of constructed wholes from many small parts. This perspective has been supported by modern cognitive science through fMRI research demonstrating that some parts of the brain, specifically the lateral occipital lobe, and the fusiform gyrus, are involved in the processing of whole objects, as opposed to the primary occipital areas that process individual elements of stimuli (Kubilius, Wagemans & Op de Beeck, 2011).

One Gestalt principle is the figure-ground relationship. According to this principle, we tend to segment our visual world into figure and ground. Figure is the object or person that is the focus of the visual field, while the ground is the background. As the figure below shows, our perception can vary tremendously, depending on what is perceived as figure and what is perceived as ground. Presumably, our ability to interpret sensory information depends on what we label as figure and what we label as ground in any particular case, although this assumption has been called into question (Peterson & Gibson, 1994; Vecera & O'Reilly, 1998).



The concept of figure-ground relationship explains why this image can be perceived either as a vase or as a pair of faces.

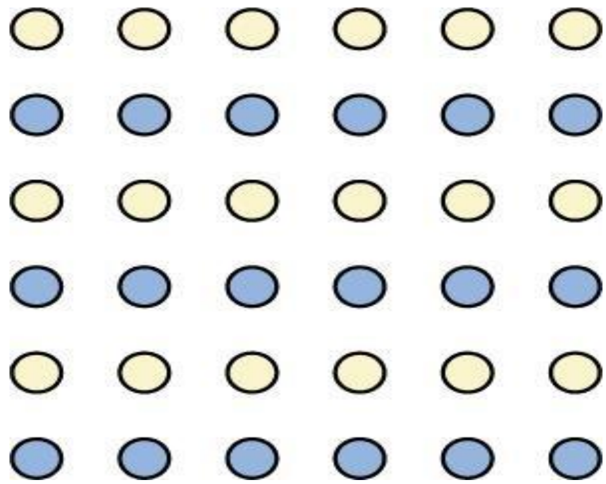
Another Gestalt principle for organizing sensory stimuli into meaningful perception is **proximity**. This principle asserts that things that are close to one another tend to be grouped together, as the figure below illustrates.



The Gestalt principle of proximity suggests that you see (a) one block of dots on the left side and (b) three columns on the right side.

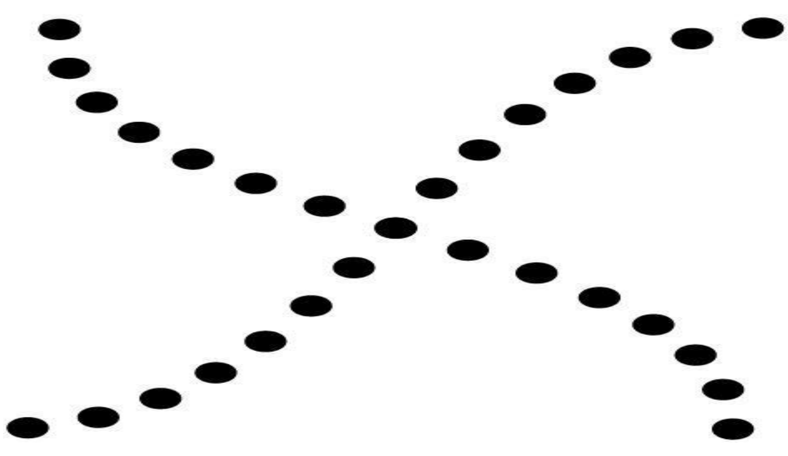
How we read something provides another illustration of the proximity concept. For example, we read this sentence like this, notl iket hiso rt hat. We group the letters of a given word together because there are no spaces between the letters, and we perceive words because there are spaces between each word. Here are some more examples: Cany oum akes enseo ft hiss entence? What doth es e wor dsmea n?

We might also use the principle of **similarity** to group things in our visual fields. According to this principle, things that are alike tend to be grouped together (figure below). For example, when watching a football game, we tend to group individuals based on the colors of their uniforms. When watching an offensive drive, we can get a sense of the two teams simply by grouping along this dimension.

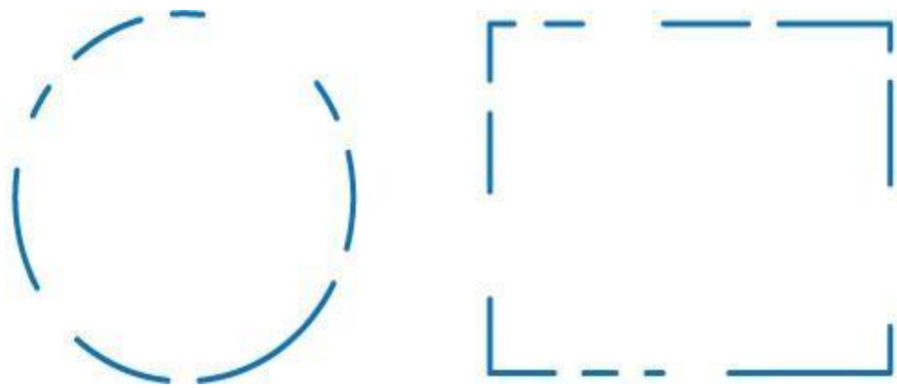


When looking at this array of dots, we likely perceive alternating rows of colors. We are grouping these dots according to the principle of similarity.

Two additional Gestalt principles are the law of **continuity** (or good continuation) and **closure.** The law of continuity suggests that we are more likely to perceive continuous, smooth flowing lines rather than jagged, broken lines (figure below). The principle of closure states that we organize our perceptions into complete objects rather than as a series of parts (figure below).



Good continuation would suggest that we are more likely to perceive this as two overlapping lines, rather than four lines meeting in the center.



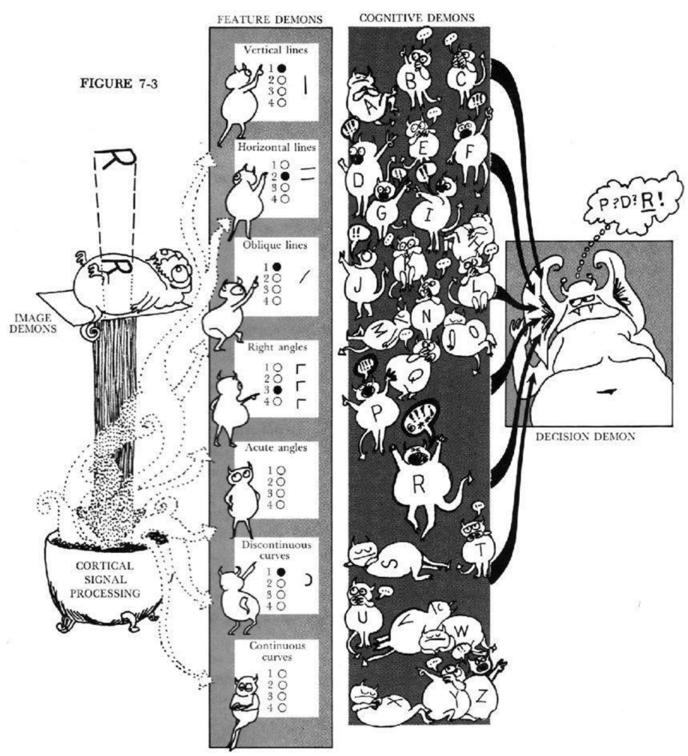
Closure suggests that we will perceive a complete circle and rectangle rather than a series of segments.

According to Gestalt theorists, pattern perception, or our ability to discriminate among different figures and shapes, occurs by following the principles described above. You probably feel fairly certain that your perception accurately matches the real world, but this is not always the case. Our perceptions are based on perceptual hypotheses: educated guesses that we make while interpreting sensory information. These hypotheses are informed by a number of factors, including our personalities, experiences, and expectations. We use these hypotheses to generate our perceptual set. For instance, research has demonstrated that those who are given verbal priming produce a biased interpretation of complex ambiguous figures (Goolkasian & Woodbury, 2010).

Template Approach

Ulrich Neisser (1967), author of one of the first cognitive psychology textbook suggested pattern recognition would be simplified, although abilities would still exist, if all the patterns we experienced were identical. According to this theory, it would be easier for us to recognize something if it matched exactly with what we had perceived before. Obviously the real environment is infinitely dynamic producing countless combinations of orientation, size. So how is it that we can still read a letter g whether it is capitalized, non-capitalized or in someone else hand writing? Neisser suggested that categorization of information is performed by way of the brain creating mental **templates**, stored models of all possible categorizable patterns (Radvansky & Ashcraft, 2014). When a computer reads your debt card information it is comparing the information you enter to a template of what the number should look like (has a specific amount of numbers, no letters or symbols…). The template view perception is able to easily explain how we recognize pieces of our environment, but it is not able to explain why we are still able to recognize things when it is not viewed from the same angle, distance, or in the same context.

In order to address the shortfalls of the template model of perception, the **feature detection** approach to visual perception suggests we recognize specific features of what we are looking at, for example the straight lines in an H versus the curved line of a letter C. Rather than matching an entire template-like pattern for the capital letter H, we identify the elemental features that are present in the H. Several people have suggested theories of feature-based pattern recognition, one of which was described by Selfridge (1959) and is known as the **pandemonium** model suggesting that information being perceived is processed through various stages by what Selfridge described as mental demons, who shout out loud as they attempt to identify patterns in the stimuli. These pattern demons are at the lowest level of perception so after they are able to identify patterns, computational demons further analyze features to match to templates such as straight or curved lines. Finally at the highest level of discrimination, cognitive demons which allow stimuli to be categorized in terms of context and other higher order classifications, and the decisions demon decides among all the demons shouting about what the stimuli is which while be selected for interpretation.



Selfridge’s pandemonium model showing the various levels of demons which make estimations and pass the information on to the next level before the decision demon makes the best estimation to what the stimuli is. Adapted from Lindsay and Norman (1972).

Although Selfridges ideas regarding layers of shouting demons that make up our ability to discriminate features of our environment, the model actually incorporates several ideas that are important for pattern recognition. First, at its foundation, this model is a feature detection model that incorporates higher levels of processing as the information is processed in time. Second, the Selfridge model of many different shouting demons incorporates ideas of parallel processing suggesting many different forms of stimuli can be analyzed and processed to some extent at the same time. Third and finally, the model suggests that perception in a very real sense is a series of problem solving procedures where we are able to take bits of information and piece it all together to create something we are able to recognize and classify as something meaningful.

In addition to sounding initially improbable by being based on a series of shouting fictional demons, one of the main critiques of Selfridge's demon model of feature detection is that it is primarily a **bottom-up**, or **data-driven** processing system. This means the feature detection and processing for discrimination all comes from what we get out of the environment. Modern progress in cognitive science has argued against strictly bottom-up processing models suggesting that context plays an extremely important role in determining what you are perceiving and discriminating between stimuli. To build off previous models, cognitive scientist suggested an additional **top-down**, or **conceptually-driven** account in which context and higher level knowledge such as context something tends to occur in or a persons expectations influence lower-level processes.

Finally the most modern theories that attempt to describe how information is processed for our perception and discrimination are known as **connectionist models.** Connectionist models incorporate an enormous amount of mathematical computations which work in parallel and across series of interrelated web like structures using top-down and bottom-up processes to narrow down what the most probably solution for the discrimination would be. Each unit in a connectionist layer is massively connected in a giant web with many or al the units in the next layer of discrimination. Within these models, even if there is not many features present in the stimulus, the number of computations in a single run for discrimination become incredibly large because of all the connections that exist between each unit and layer.

The Depths of Perception: Bias, Prejudice, and Cultural Factors

In this chapter, you have learned that perception is a complex process. Built from sensations, but influenced by our own experiences, biases, prejudices, and cultures, perceptions can be very different from person to person. Research suggests that implicit racial prejudice and stereotypes affect perception. For instance, several studies have demonstrated that non-Black participants identify weapons faster and are more likely to identify non-weapons as weapons when the image of the weapon is paired with the image of a Black person (Payne, 2001; Payne, Shimizu, & Jacoby, 2005). Furthermore, White individuals' decisions to shoot an armed target in a video game is made more quickly when the target is Black (Correll, Park, Judd, & Wittenbrink, 2002; Correll, Urland, & Ito, 2006). This research is important, considering the number of very high-profile cases in the last few decades in which young Blacks were killed by people who claimed to believe that the unarmed individuals were armed and/or represented some threat to their personal safety.

SUMMARY

Gestalt theorists have been incredibly influential in the areas of sensation and perception. Gestalt principles such as figure-ground relationship, grouping by proximity or similarity, the law of good continuation, and closure are all used to help explain how we organize sensory information. Our perceptions are not infallible, and they can be influenced by bias, prejudice, and other factors.

Depth perception

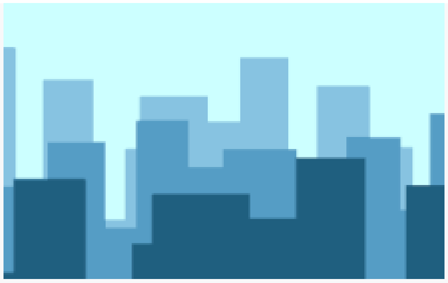
Perspective, relative size, occultation and texture gradients all contribute to the three-dimensional appearance of this photo.

Depth perception is the ability to perceive distance to objects in the world using the visual system and visual perception. It is a major factor in perceiving the world in three dimensions. Depth perception happens primarily due to stereopsis and accommodation of the eye.

Depth sensation is the corresponding term for non-human animals, since although it is known that they can sense the distance of an object, it is not known whether they perceive it in the same way that humans do.[1]

Depth perception arises from a variety of depth cues. These are typically classified into binocular cues and monocular cues. Binocular cues are based on the receipt of sensory information in three dimensions from both eyes and monocular cues can be observed with just one eye.[2][3] Binocular cues include retinal disparity, which exploits parallax and vergence. Stereopsis is made possible with binocular vision. Monocular cues include relative size (distant objects subtend smaller visual angles than near objects), texture gradient, occlusion, linear perspective, contrast differences, and motion parallax.[4]

Monocular cues



Motion parallax

Monocular cues provide depth information when viewing a scene with one eye.

Motion parallax

When an observer moves, the apparent relative motion of several stationary objects against a background gives hints about their relative distance. If information about the direction and velocity of movement is known, motion parallax can provide absolute depth information.[5] This effect can be seen clearly when driving in a car. Nearby things pass quickly, while far off objects appear stationary. Some animals that lack binocular vision due to their eyes having little common field-of-view employ motion parallax more explicitly than humans for depth cueing (for example, some types of birds, which bob their heads to achieve motion parallax, and squirrels, which move in lines orthogonal to an object of interest to do the same[6]).[note 1]

Depth from motion

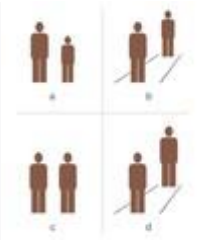
When an object moves toward the observer, the retinal projection of an object expands over a period of time, which leads to the perception of movement in a line toward the observer. Another name for this phenomenon is *depth from optical expansion*.[7] The dynamic stimulus change enables the observer not only to see the object as moving, but to perceive the distance of the moving object. Thus, in this context, the changing size serves as a distance cue.[8] A related phenomenon is the visual system's capacity to calculate time-to-contact (TTC) of an approaching object from the rate of optical expansion – a useful ability in contexts ranging from driving a car to playing a ball game. However, calculation of TTC is, strictly speaking, perception of velocity rather than depth.

Kinetic depth effect

If a stationary rigid figure (for example, a wire cube) is placed in front of a point source of light so that its shadow falls on a translucent screen, an observer on the other side of the screen will see a two-dimensional pattern of lines. But if the cube rotates, the visual system will extract the necessary information for perception of the third dimension from the movements of the lines, and a cube is seen. This is an example of the *kinetic depth effect*.[9] The effect also occurs when the rotating object is solid (rather than an outline figure), provided that the projected shadow consists of lines which have definite corners or end points, and that these lines change in both length and orientation during the rotation.[10]

Perspective

The property of parallel lines converging in the distance, at infinity, allows us to reconstruct the relative distance of two parts of an object, or of landscape features. An example would be standing on a straight road, looking down the road, and noticing the road narrows as it goes off in the distance. Visual perception of perspective in real space, for instance in rooms, in settlements and in nature, is a result of several optical impressions and the interpretation by the visual system. The angle of vision is important for the apparent size. A nearby object is imaged on a larger area on the retina, the same object or an object of the same size further away on a smaller area.[11] The perception of perspective is possible when looking with one eye only, but stereoscopic vision enhances the impression of the spatial. Regardless of whether the light rays entering the eye come from a three-dimensional space or from a two-dimensional image, they hit the inside of the eye on the retina as a surface. What a person sees, is based on the reconstruction by their visual system, in which one and the same image on the retina can be interpreted both two-dimensionally and three-dimensionally. If a three-dimensional interpretation has been recognised, it receives preference and determines the perception.[12]

- 

  Context-dependent interpretation of the size.

- 

  Shots at different distances

- 

  The horizon line is at the height of the armrests.

- 

  View from a window on the 2nd floor of a house.

- 

  Mountain peak near the snow line and several mountain peaks above the snow line.

- 

  Earth curvature

In spatial vision, the horizontal line of sight can play a role. In the picture taken from the window of a house, the horizontal line of sight is at the level of the second floor (yellow line). Below this line, the further away objects are, the higher up in the visual field they appear. Above the horizontal line of sight, objects that are further away appear lower than those that are closer. To represent spatial impressions in graphical perspective, one can use a vanishing point.[13] When looking at long geographical distances, perspective effects also partially result by the angle of vision, but not only by this. In picture 5 of the series, in the background is Mont Blanc, the highest mountain in the Alps. It appears lower than the mountain in front in the center of the picture. Measurements and calculations can be used to determine the proportion of the curvature of Earth in the subjectively perceived proportions.

Relative size

If two objects are known to be the same size (for example, two trees) but their absolute size is unknown, relative size cues can provide information about the relative depth of the two objects. If one subtends a larger visual angle on the retina than the other, the object which subtends the larger visual angle appears closer.

Familiar size

Since the visual angle of an object projected onto the retina decreases with distance, this information can be combined with previous knowledge of the object's size to determine the absolute depth of the object. For example, people are generally familiar with the size of an average automobile. This prior knowledge can be combined with information about the angle it subtends on the retina to determine the absolute depth of an automobile in a scene.

Absolute size

Even if the actual size of the object is unknown and there is only one object visible, a smaller object seems further away than a large object that is presented at the same location.[14]

Aerial perspective

Main article: Aerial perspective

Due to light scattering by the atmosphere, objects that are a great distance away have lower luminance contrast and lower color saturation. Due to this, images seem hazy the farther they are away from a person's point of view. In computer graphics, this is often called "distance fog". The foreground has high contrast; the background has low contrast. Objects differing only in their contrast with a background appear to be at different depths.[15] The color of distant objects are also shifted toward the blue end of the spectrum (for example, distant mountains). Some painters, notably Cézanne, employ "warm" pigments (red, yellow and orange) to bring features forward towards the viewer, and "cool" ones (blue, violet, and blue-green) to indicate the part of a form that curves away from the picture plane.

Accommodation

Main article: Accommodation (eye)

This is an oculomotor cue for depth perception. When humans try to focus on distant objects, the ciliary muscles stretch the eye lens, making it thinner, and hence changing the focal length. The kinesthetic sensations of the contracting and relaxing ciliary muscles (intraocular muscles) is sent to the visual cortex where it is used for interpreting distance and depth. Accommodation is only effective for distances greater than 2 meters.

Occultation

Main article: Occultation

Occultation (also referred to as *interposition*) happens when near surfaces overlap far surfaces.[16] If one object partially blocks the view of another object, humans perceive it as closer. However, this information only allows the observer to make a "ranking" of relative nearness. The presence of monocular ambient occlusions consist of the object's texture and geometry. These phenomena are able to reduce the depth perception latency both in natural and artificial stimuli.[17][18]

Curvilinear perspective

Main article: Curvilinear perspective

At the outer extremes of the visual field, parallel lines become curved, as in a photo taken through a fisheye lens. This effect, although it is usually eliminated from both art and photos by the cropping or framing of a picture, greatly enhances the viewer's sense of being positioned within a real, three-dimensional space. (Classical perspective has no use for this so-called "distortion", although in fact the "distortions" strictly obey optical laws and provide perfectly valid visual information, just as classical perspective does for the part of the field of vision that falls within its frame.)

Texture gradient

Main article: Texture gradient

Fine details on nearby objects can be seen clearly, whereas such details are not visible on faraway objects. Texture gradients are grains of an item. For example, on a long gravel road, the gravel near the observer can be clearly seen of shape, size and colour. In the distance, the road's texture cannot be clearly differentiated.

Lighting and shading

Main articles: Lighting and Shading

The way that light falls on an object and reflects off its surfaces, and the shadows that are cast by objects provide an effective cue for the brain to determine the shape of objects and their position in space.[19]

Defocus blur

Main article: Depth of field

Selective image blurring is very commonly used in photographic and video for establishing the impression of depth. This can act as a monocular cue even when all other cues are removed. It may contribute to the depth perception in natural retinal images, because the depth of focus of the human eye is limited. In addition, there are several depth estimation algorithms based on defocus and blurring.[20] Some jumping spiders are known to use image defocus to judge depth.[21]

Elevation

When an object is visible relative to the horizon, humans tend to perceive objects which are closer to the horizon as being farther away from them, and objects which are farther from the horizon as being closer to them.[22] In addition, if an object moves from a position close the horizon to a position higher or lower than the horizon, it will appear to move closer to the viewer.

Binocular cues[edit]

Binocular cues provide depth information when viewing a scene with both eyes.

Stereopsis, or retinal (binocular) disparity, or binocular parallax

Main article: Stereopsis

Animals that have their eyes placed frontally can also use information derived from the different projection of objects onto each retina to judge depth. By using two images of the same scene obtained from slightly different angles, it is possible to triangulate the distance to an object with a high degree of accuracy. Each eye views a slightly different angle of an object seen by the left and right eyes. This happens because of the horizontal separation parallax of the eyes. If an object is far away, the disparity of that image falling on both retinas will be small. If the object is close or near, the disparity will be large. It is stereopsis that tricks people into thinking they perceive depth when viewing Magic Eyes, Autostereograms, 3-D movies, and stereoscopic photos.

Convergence

Main article: Convergence (eye)

This is a binocular oculomotor cue for distance and depth perception. Because of stereopsis, the two eyeballs focus on the same object; in doing so they converge. The convergence will stretch the extraocular muscles – the receptors for this are muscle spindles. As happens with the monocular accommodation cue, kinesthetic sensations from these extraocular muscles also help in distance and depth perception. The angle of convergence is smaller when the eye is fixating on objects which are far away. Convergence is effective for distances less than 10 meters.[23]

Shadow stereopsis

Antonio Medina Puerta demonstrated that retinal images with no parallax disparity but with different shadows are fused stereoscopically, imparting depth perception to the imaged scene. He named the phenomenon "shadow stereopsis". Shadows are therefore an important, stereoscopic cue for depth perception.[24]

Of these various cues, only convergence, accommodation and familiar size provide absolute distance information. All other cues are relative (as in, they can only be used to tell which objects are closer relative to others). Stereopsis is merely relative because a greater or lesser disparity for nearby objects could either mean that those objects differ more or less substantially in relative depth or that the foveated object is nearer or further away (the further away a scene is, the smaller is the retinal disparity indicating the same depth difference).

SUBLIMINAL PERCEPTION

Subliminal perception is the perception of a series of stimulus which the person is not consciously aware of and gets under the influence involuntarily, in addition to the perception with the five sense organs.

The word ‘subliminal’, which consists of the Latin words ‘sub’ and ‘limen’ (threshold), is usually used for subconscious or sub-threshold. Subliminal can be defined as the whole mental activity that occurs under the threshold of the conscious, and it also acts as a storage for experiences and perceptions to remember and use later. Subliminal perception can be defined as the influence of a series of external stimulus on emotions or actions involuntarily, or in other words, subconsciously.

Messages for subliminal perception can be sent via advertorials, movies, television channels and radios as well as via new media instruments that are probably the most effective ways for affecting today’s informative (cognitive) society. These messages, which remain under the conscious perception level and progress at a stage where only senses and mind can perceive, aim to influence the consumers subconsciously. In fact, consumers are subject to an involuntary perception.

Today, neuromarketing and creating subliminal messages to induce a targeted consumer perception are used as two similar concepts. However, these two concepts are only similar in terms of their field of interest –subconscious interaction. Apart from that, these concepts are completely different from each other.

The most apparent purpose of creating subliminal perception is to persuade and win the consumer at the subconscious level. Indeed, the purpose is to push the purchase button in the brain and bring the consumer into action without realizing by way of sending hidden messages. The main mission of subliminal messages is to leave some positive or negative marks in the minds of consumers, and to make them remember these when necessary. However, neuromarketing does not aim to send such messages or direct consumers towards a certain course of action. On the contrary, it works for explaining how the brain functions of consumers are affected by external factors. In other words, its purpose is not to switch on the purchasing motive in the customers' brain and put them into action, but to help understand which stimulants make them take the purchasing decision via special techniques (see: https://www.neuroscience.org.uk/contributing-tools-neuromarketing-studies/). Therefore, neuromarketing is a barometer which helps businesses understand and see the preferences of consumers, and measures the level of their needs, desires and demands.