Fall 2022

Chapter 12: Perception in Instructional Message Design

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Instructional Message Design:
Theory, Research, and Practice
(Volume 2)

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Citation:

Altantsetseg, S. (2022). Perception in Instructional Message Design. In M. Ramlatchan (Ed.), *Instructional Message Design: Theory, Research, and Practice* (Vol. 2). Kindle Direct Publishing.

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Key Points:

- Perception is the learner's initial conversion of environmental input to working memory
- Well organized instructional message design leads to efficient perception and processing of communication
- Gestalt, neurology, ecology, and computation theories can all be applied to guide instructional message design
- Understanding perception can help instructional designers develop effective augmented reality, virtual reality, and immersive simulations

Abstract

This chapter aims to discuss perception from various academic disciplines and its relations and effects on information processing in instructional message design. Improved awareness of this concept assists instructional designers in conveying their message effectively and improves effective instruction in immersive learning environments. In this chapter, Gestalt, neurological, ecological, and computational perspectives and processes on perception are first discussed and followed by applications in instructional message design and instructional design.

Introduction

The concept of perception is an extensively studied topic in science and philosophy, and its definition without a unique perspective of context is incomplete. From a neurologist's perspective, Efron (1969) defined perception as "man's primary form of cognitive contact with the world around him" (p. 1). While from an ecologist's perspective, Gibson (2014) described this as "the process of information pickup that involves the exploratory activity of looking around, getting around, and looking at things." The Gestalt theory takes a closer look at the core visual pattern of an object, and Wertheimer (1934) said, "the perception is not a product of the sensations, but arose through a dynamic physical process in the brain." (Wagemans et al., 2012). Developments in computer science continue to build on the limits and aspects of human perception (Gordon, 2004). Instructional and message design and technology are prominent examples that are deriving major benefits from this evolution of ideas and theory. How learners become aware of and process communication from visuals is an intrinsic aspect of instructional message design. Instructional message design is the application of instructional design, technology, and theories in the design of learning environments, systems, job aids, and training (Fleming & Levie, 1993).

Historically, the value of perception theory in learning had long been rejected by learning theorists due to the lack of a direct connection to the learning process. It was criticized for paying too much attention to the information processing and being too obscure for the structural level of explanation of an object (Norberg, 1978). In the long run, a common ground between constructivist and cognitive perspectives benefited perception concepts in instructional design and message design processes in various ways, especially at the organizational and structural levels. Based on the perceptual concepts of grouping and picking up information, Bruner (1985) proposed scaffolding which refers to managing a task into components to complete a task. In task organization, this strategy is widely utilized in designing as an attention gaining and cognitive enhancement approach. Chunking is another information organization technique derived from the learner's perception (Miller, 1956). Placing text near pictures or placing similar elements near each other are common approaches we use in instructional message design (Wagemans et al., 2012). We use color as stimuli to attract a learner's attention or use several elements to reduce cognitive load according to the visual learning capacity. The core concept of self-perception and environment perception contribute to building effective simulations and immersive learning environments (Geuss et al., 2010). The role of perception in instructional design and message design is tremendous and ever-evolving.

We will look at perception from four different approaches throughout this chapter, including Gestalt, neurology, ecology, and computation. The sections are ordered in the highest to the lowest relations of perception to instructional and message design. Each section will briefly define perception from a specific area's standpoint to differentiate the approach from one another, followed by theoretical heuristics and instructional and message design applications. Perception research has discovered a broad list of sensory perceptions beyond sight, sound, touch, taste, and smell, but this chapter will focus on visual perception.

Gestalt Theory of Perception

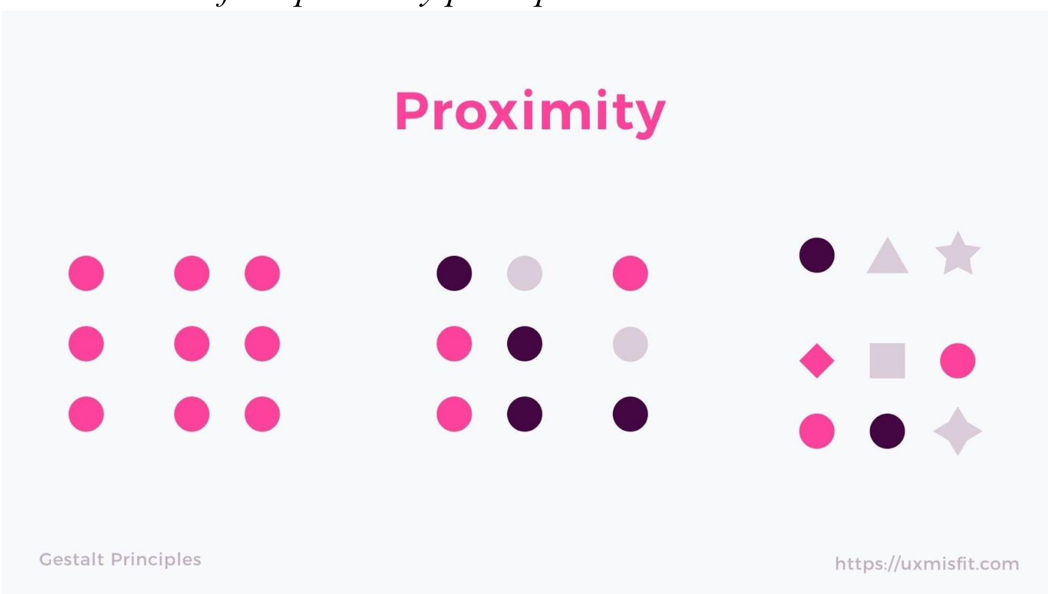
"The whole is greater than the sum of its parts" is the main principle of the gestalt theory of perception. It implies that when a person sees a visualization, a poster for instance, the viewer does not initially perceive text, titles, or paragraphs separately but looks at them as a whole (Wertheimer & Riezler, 1944). Wertheimer and Kurt viewed that the scientific fields created more concepts, assumptions, and principles in various contexts. Unfortunately, they treated the principle as a separate part. This, in turn, restricts a deep and complete explanation of the problem at an advanced level. Therefore, they believed that changing an approach would aid the science in general and proposed the idea of looking into the internal parts of the whole rather than the individual pieces. They believed that there must be the core factors that keep the harmony of the whole and believed in people perceiving a whole as a meaningful structure (Çeliköz, Erisen, & Sahin, 2019; Wagemans et al., 2012; Wertheimer & Riezler, 1944). In terms of visual perception, the gestalt principles consider that awareness is not additive but is rooted in the coherence of the structural characteristics of a whole. That is to say, they deny that the idea of stimuli that arises from the corresponding sensation and the association of sensations produce visual perception. They believed the condition of the whole presented in the brain and their internal cognitive interactions and organizations define perception (Wertheimer & Riezler, 1944; Wagemans et al., 2012). However, some technological advancement and neurology research suggest that sensation is the primary unit of the perceptual system (Wagemans et al., 2012). Nevertheless, the gestalt theory is tied up with learning theories in many aspects. A quick single-stimuli reaction is connected to behaviorism, and structural organization is associated with cognitive load theory (Smith-Gratto & Fisher, 1999). Although the gestalt theories had long been rejected by other fields, some principles, such as grouping and figure-ground perception, are important concepts in psychology, biology, learning, and in the film industry (Wagemans et al., 2012). Moreover, the central concept of the effective structure of visual statics is essential to visual screen design (Smith-Gratto & Fisher, 1999).

Visual screen design is a way of delivering a presentation through software, and it is based on the visual perception of the learner (Smith-Gratto & Fisher, 1999). Screen designers and instructional designers apply the gestalt theory (intentionally or unintentionally) to structure information in multimedia and instructional message design. Its coherence in screen design hugely assists students in interpreting and remembering materials and potentially reduces students' extraneous cognitive load (Smith-Gratto & Fisher, 1999). Chang et al.'s (2002) experiment of redesigning multimedia educational programs based on 12 gestalt principles showed the effectiveness of screen design and learning effectiveness. Out of 114 gestalt principle examples the proximity, similarity, common fate, continuity, closure, and figure-ground were the most effective to aid in organizing visualization, information, and materials (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012). The next section will illustrate how these gestalt principles apply to instructional and message design.

The Gestalt Law of Proximity. Max Wertheimer's first gestalt principle is the law of Proximity. It proposes that the elements placed nearer to each other are perceived as a group, whereas if their spacing is further apart, they are considered separate. Set options include triple, pair, and quartette, and many, many other combinations. However, some combinations require more attention and are perceptually challenging to grasp (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012;).

Figure 1

Variations of the proximity principle:



Note. Modified from https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/

In message design, strengthening the close relationship between the elements by putting them closer is ideal. This includes placing the captions closer to the picture, or headlines closer to the text, or even compound words closer to each other (Graham, 2008). Proximately creates organization, and lack of proximity creates disorganization, such as in the example below:

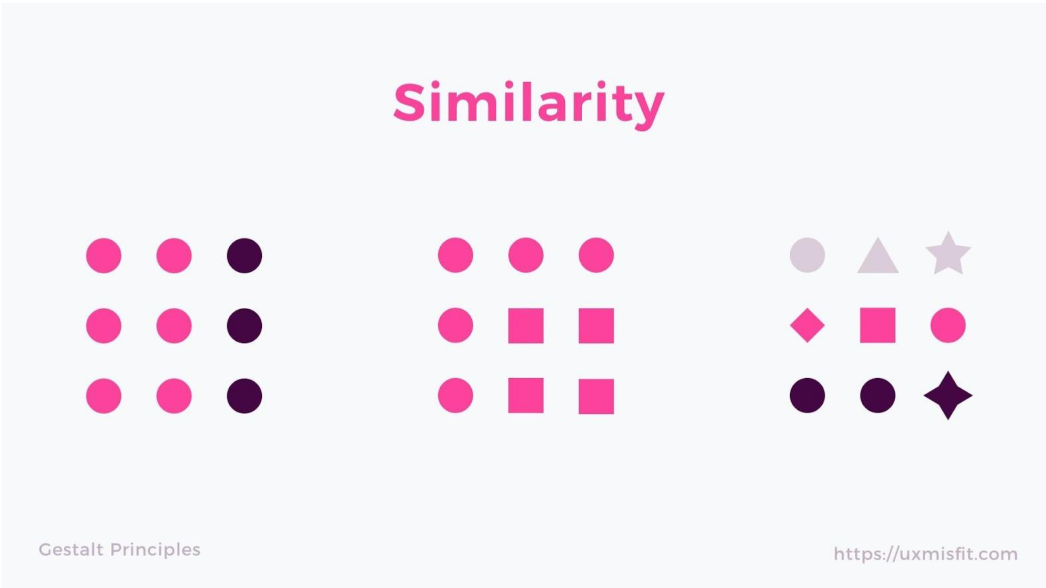
Figure 2
Variations in proximity create variation in disorganization and confusion:

A. The gestalt law of Proximity B. The gestalt law of Proximity

The gestalt law of Proximity The gestalt law of Similarity The gestalt law of Common fate Figure-ground articulation	The gestalt law of Proximity Law of Similarity Common fate Closure Figure-ground

Law of Similarity. The law of Similarity suggests the grouping of the elements with similar properties (color, shape, size, brightness, etc.) despite the spatial location. Integrating Similarity with Proximity makes the effect stronger (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 3
Variations of the Similarity Principle, the group of circles will tend to be the most cohesive group:



Note. the group of circles on the left are the most similar, and so creates the most recognizable visual pattern, https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/

However, if the distance between similar items is too far and placed nearer to the distinct item, it looks like a new group of distinct elements, see Figure 4.

Figure 4
The Similarity Principle and distance, closer objects will appear **associated** *together:*

http://www.scholarpedia.org/w/images/archive/3/33/20081210053322%21Todorovic-Gestalt_principles-Figure_3.jpg

Common Fate. When elements move together, they are perceived as a group, and this phenomenon is called common fate. The main distinction of the Common Fate from the Similarity is the idea that items should be changed in terms of position, size, and luminance. It is mainly used in motion pictures, 3D animation, and logos, see Figure 5 (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 5
The Common Fate Principle

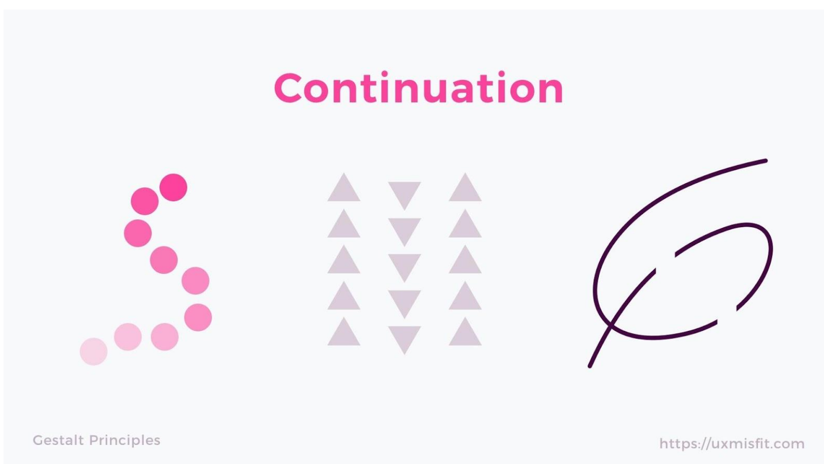
https://userpeek.com/blog/what-are-gestalt-principles/

https://logopond.com/lexlogo40513/showcase/detail/91660

Note. Examples of perceived motion in the Common Fate Principle in the perceived motion of the birds, fish, and golf club swing:

Good continuation. This principle refers to elements that are grouped together in a local pattern. Moreover, patterns can be integrated with the contrasting elements to form another meaning. For example, marketing professionals can create a motion picture or static image that incorporates different elements in message design. The relationship of the segments shows meaning as illustrated in the IBM logo, see Figure 6 (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 6
Examples of the Continuation Principle,



https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/

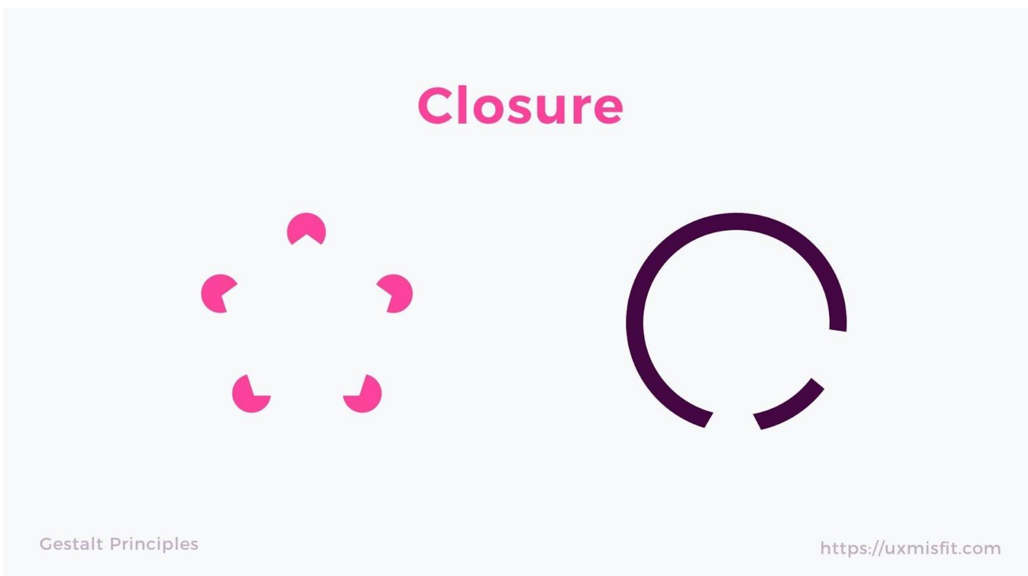
https://www.usertesting.com/blog/gestalt-principles

Note. Elements grouped together to create a visual pattern, the "IBM" logo is a classic example that is made up of rectangles, a few trapezoids, and a triangle:

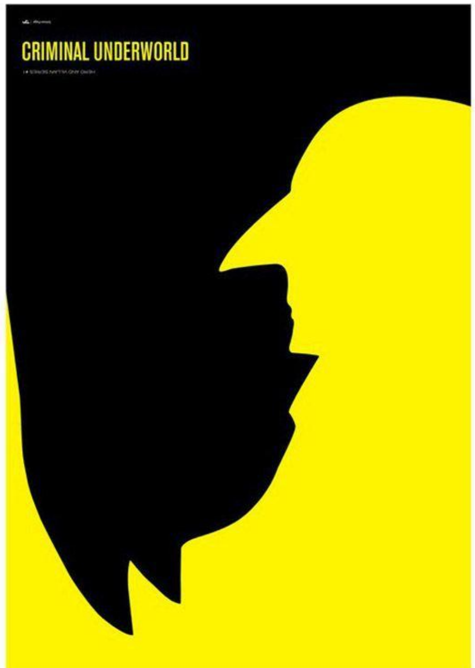
Closure. Elements like lines and dots are grouped together to show the end of the figure. Our natural visual perception tendency is to set boundaries in patterns and to create a mental closure based on given visible elements (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 7

Examples of the Closure Principle, lines and dots creating the perception of visual boundaries:



https://uxmisfit.com/2019/04/23/ui-design-in-practice-gestalt-principles/

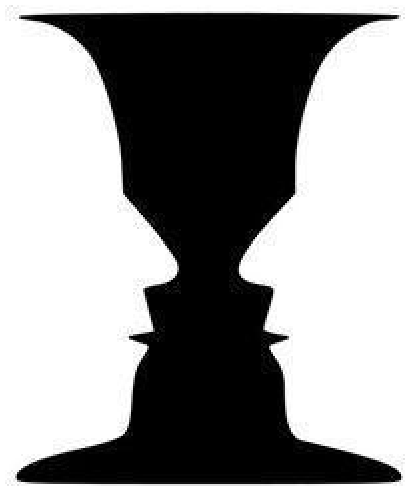


https://visme.co/blog/gestalt-design-principles/

The Law of Figure/Ground. The law of figure-ground describes two distinct parts in the visual field. A figure is mainly an object placed in the front part of the field, which primarily attracts the perceiver's attention. The figure's color, shape, and pattern separate it from the background. The object is closed mainly by the border to also show the separation from the background. In comparison, the ground having an irrelevant shape is simply a background placed at the back of the field, see Figure 8 (Graham, 2008; O'Connor, 2015; Todorovic, 2008; Wagemans et al., 2012).

Figure 8

Examples *of the Law of Figure, the perceived separation of a figure from its background:*



https://www.interaction-design.org/literature/article/the-laws-of-figure-ground-praegnanz-closure-and-common-fate-gestalt-principles-3

The Neurological Approach to Perception

While the gestalt theory approached perception from a structural level and highlighted the core organization of the object, the neurological approach looks more into identifying how the information from light or vibration is interpreted into meaning in the brain. It also explains the main tasks of neurons in the visual system and their connections to cognitive and behavioral activities (Barry, 2020; Gordon, 2004). Because humans are thinking and feeling creatures, their internal thoughts and feelings are not directly observable. The inner and cognitive processes are therefore hard to detect (Winn, 1993). To understand the effects of perception, it is necessary to understand human cognitive activity and the visual perceptual system.

Perception in neurology is a dynamic interactive system that arranges information from multiple channels through the optical system where millions of sequenced nerve cells work individually and in groups to activate responses based on feedback loops of an image (Barry, 2020). Visual perception starts when light lands on an observer's eye and is captured by photoreceptors in the retina, which has cells that respond to the light. The rod cells of photoreceptors are activated in light to provide black-white vision, and the cone cells of photoreceptors respond to highlights and perceive color. Together these cells convert the light into impulses and sends them to subsequent pathways in various areas of the brain for processing (Goldstein, 1999; O'Connor, 2015).

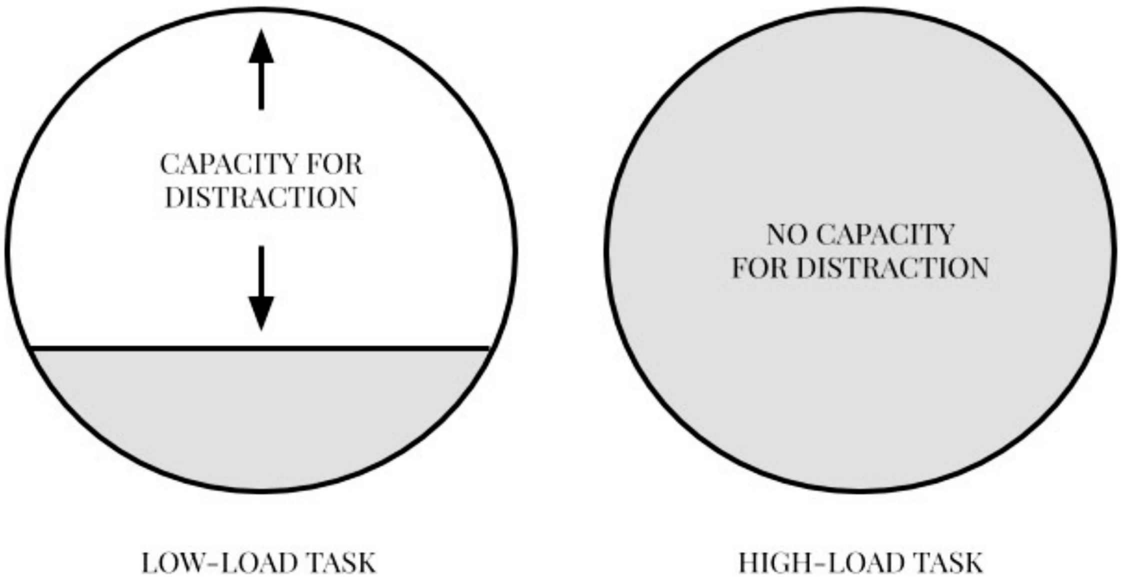
Impulses of visual information from the retina travel through multiple pathways in the brain to reach the visual cortex to be interpreted for their meaning. First, it passes through the thalamus path, passing the motor and sensory signal to the cerebral cortex, where all sensation, perception, and memory processes are held and processed (Pollen, 1999). Then the sensory information moves through to the cortical pathway and is finally transferred to the visual cortex areas. The visual cortex is composed of many interconnected regions and is where all light comes through the eyes and finds its meaning. Here, signals are transformed in hierarchical patterns and create visual perception. All information related to the object and its characteristics, including color, shape, and size, is processed in the visual area called the ventral stream (the "what" does this information mean stream).

In contrast, movement, location, and depth data are processed in the dorsal stream area (the "where" stream). Different areas in the distinct streams exchange information about the particular signal, make arrangements, and create the final perception (Pollen, 1999; Ungerleider et al., 1998). Moreover, while the information from the light is hierarchically identified in the ventral and dorsal streams to make meaning, it is also passed through the interconnected feedforward and feedback projections which play an essential role in keeping attention on the target information and discouraging the distracters caused by the eye movements and sensory-related stimuli (Dijkstra et al., 2017). Once the interpreted information is paid selective attention, it is transferred to short-term cognitive memory.

Perceptual load theory is a part of attention theory, and it refers to the amount of external information used in the perceptual processing of tasks in an attentive process (Lavie & Tsal, 1994). The perceptual load theory aims to describe how we diminish the distractors in learning, but it has a limited capacity (Lavie, 1995). When the high perceptual load is assigned to the task, the irrelevant information is ignored because perceptual information fully occupies the capacity and leaves no space for the distractors. The level of perceptual load decides if task-irrelevant objects are disregarded (Lavia et al., 2009). This process allows humans to focus their attention.

Regarding visual perceptual load, this concept includes the recognition of items such as color, shape, and patterns. The complexity of the items, including the integration and usages, are applied to the image, text, and task (Bahrami et al., 1995; Lavia et al., 2009). In multimedia instructional design scenarios, the perceptual load extends to visual, auditory, and cross-modals and it illustrates how their correlation removes the focus or supports one another (Norberg, 1978). Although the interactions between the perceptual and cognitive loads are unclear, their role in attention processes is enormous. Figure 9 illustrates this idea:

Figure 9
Low-load tasks may leave a margin for distraction without interrupting overall learning:



https://nesslabs.com/focused-mind

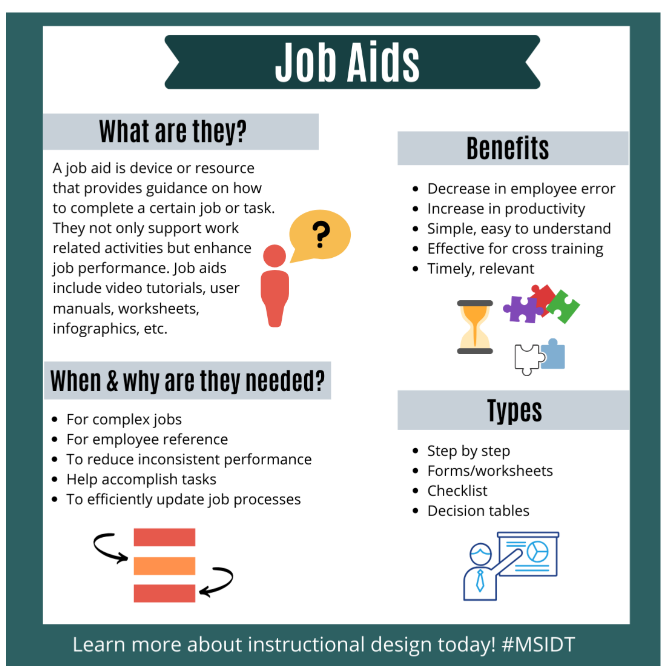
Applications in Instructional Message Design

In the designing process, a visual perceptual load can be controlled in three different ways by adding or reducing task difficulty (Murphy, Groeger & Greene, 2016). The first strategy is to vary the number of items. For instance, displaying only text leads to a low-load perception giving distractors more space, or the learner more opportunity to be distracted. In contrast, text with pictures and graphics is considered a high load perception, which reduces the impact of the distractors. Furthermore, the ultimate capacity for stimuli detection is hard to define due to shared capacity modalities, including motion, size, spatial, and duration (Eayrs & Lavie, 2018). Thus, it is safe to say that designers should avoid overuse of the same pattern in their message design and vary the objects (but not to the point that it causes distractions), see Figure 10.

Figure 10

Examples of low-load (top) which is a text-heavy design and high-load (bottom) which diversified items in the design perception in message design through diversifying *items:*

https://marketbusinessnews.com/financial-glossary/job-aids/

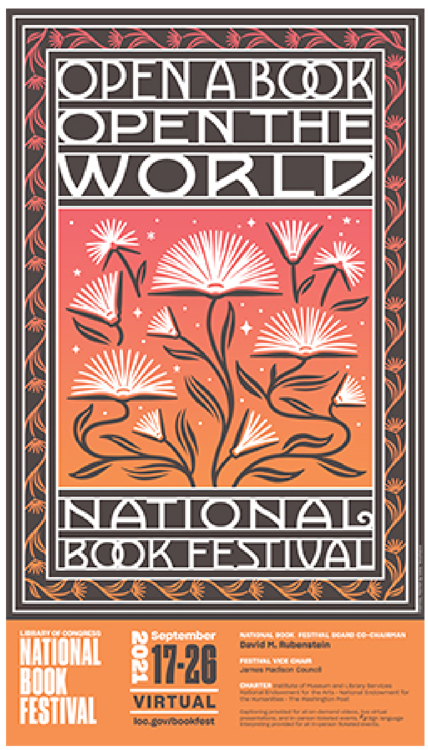


https://www.pinterest.com/pin/157344580719230237/

The second way to manipulate visual perceptual load is to apply similarity and dissimilarity concepts to the items (Murphy et al., 2016). Looking at an example of text and a picture on the same poster, the picture can be surrounded by texts with the same size, space, and angle to create a low-level perception example. Whereas in a high-level perception example, a picture can be flanked by the text of different sizes, possibly with the title text bigger, text with different colors highlighting information, and text in a different location, see Figure 11.

Figure 11

Examples of high-load perception (top example) of low-load (bottom example) and in message design through Similarity and Dissimilarity:



https://www.loc.gov/static/programs/national-book-festival/images/posters/nbf2021poster.pdf

https://templates.office.com/en-ie/supportive-posters-tm22888552

The third one is more of a strategic intervention in manipulating the perceptual load of a visual design by maintaining display consistency. Unlike previous methods, this approach requires participants' judgment of an item or object (Murphy, Groeger & Greene, 2016). Asking a perceiver to identify or differentiate an item that belongs to a specific category is an example of this method. For instance, inquiring which picture contained more color is a low level-perceptual task strategy, while asking which image had more blue or bluish color (asking a more complex question) is a high-level perceptual task strategy.

Although the core concept of perceptual load theory is minimizing distractors, instructional message designers should note that it does not always lead to greater outcomes. For instance, Lavie & De Fockert's (2003) experiments on the relationships between the high-level perceptual load and task difficulty resulted in improved task performance when reducing contrast and presentation duration; size and contrast of the target item; and reducing the eccentric position, resulted in decreased processing of irrelevant distractors.

In his book *Perception Principle*, Winn (1993) excellently integrated the gestalt theory and cognitive load theory. Due to behavioral changes, what is happening in cognition is hard to detect, and how people perceive messages can also deviate from the original one. So manipulating messages in the early stage was encouraged by Winn (1993) to direct a perceiver to interpret the message correctly. He recommended many direct applications categorized as pre-attentive, attentive, and interpretation levels and added recommendations on visual elements such as text and charts. Some of Winn's suggestions include:

In the preattentive process,

- The receiver does not employ any cognitive resource to interpret visuals, so overall, visuals are organized and interpreted based solely on the receiver's direct experience, and there is a chance of misinterpretation. So instructional message designers should take into account the organization of the visuals considering the pre-attentive process to deliver a message appropriately.
- When an abrupt change appears in the message design, neurons are activated and cognitive resources utlized. Changes can be illustrated from light to dark, one color to another, or one texture to another texture. So message designers should ensure to make clear changes such as color, contrast.
- Design elements such as dots, lines, and edges represent the visuals' width, length, and position. When this boundary is lost or becomes vague, a well-structured and interpretation of message design also fails. So the boundaries have to be clearly shown.
- If the image is big in size, a perceiver sees the details first, whereas if the picture is small, they see the bigger picture of the image. Also, when looking at the details, people look at the middle-level of details first, and from this point, they focus on small details or enlarge the picture. So message designers should carefully choose a picture size and details depending on which they emphasize.
- Human vision processes information horizontally and vertically, then diagonally.
- Generally, images are read from left to right.

In the attentive process,

- At an attentive level, perception is selective due to limited memory capacity, so designers should avoid too many details and be considerate of which information in the selection should look important.
- Contrasting color, brightness, shape, size, type, and motion cultivate attention. So some color in a black and white picture, bold typing, and color highlights can effectively draw the attention of a perceiver.
- When the overall brightness of the picture is either high or low, it is difficult to see the changes and differences, but if the overall brightness is kept moderate, changes are easy to detect.
- Too little time for the sequences from item to item prevents the perceiver from reading the message and too much time distracts the perceiver's attention, so balancing the pace of the sequence is crucial.
- Items such as lines and arrows are used to guide and maintain attention.
- Pictures tend to be read like text, left to right and top to bottom.
- When information is chunked and organized hierarchically, it is more easily remembered and processed.

Ecological and Computational Approach to Perception

The ecological approach to perception directly interprets what we see via ambient light (Gibson, 2014). Because many concepts discuss information processes from the environment and animals' interaction to it; they are not directly applied to instructional design and message design. However, the latest technology-driven learning has allowed ecological concepts, including environmental and self-perception, affordance, and locomotion, to be implemented in instructional simulation, simulation games, games, and virtual reality as a theoretical framework. This evolving ecological framework also includes a computational and computer science perspective, especially using artificial intelligence (Roman & Racek, 2019; Geuss et al., 2010). The computational approach uses mathematical, geometrical, computational methods, and an interface design approach to make abstract ideas of vision visible in reality (Stevens, 2012; Kitcher, 1988). The central role of integrating these approaches to perception is creating a learning environment in an immersive, virtual world (Roman & Racek, 2019). Learning environment design requires considerations of pedagogy, epistemology, methodology, and environmental attributes consisting of representations of real-life systems, such as objects, backgrounds, actions, and motions (Frey, 2018).

Allowing learner interaction with representations of a specific content area enables them to be involved in the make-believe world, create their own internal representation, and develop skills in a safe environment (Frey, 2018). However, this notion of having a real-life experience from a virtual one depends on the experiential modes. Schutz (1945) termed the experiential mode in media reception as the primary experience with humans' direct perception of a representation, activity, or condition without judgmental attitudes. Authenticity in experiences in the learning environment should transfer to learning effectiveness when those skills are transferred to the real world (Frey, 2018). Concepts offered by ecological approaches are used in an immersive environment to fulfill learners' experiential modes.

The Ecological Approach to Perception

According to Gibson's definition, the terrestrial environment, and ambient light are the keys to all interactions between living and nonliving things and information creation in ecology. The medium, substance, and surface are the primary source of information and allow visually oriented animals to interact with their environments through ambient light. He added that the information is enriched by events such as motion and surface changes. A single event becomes a basis or a unit of longer events, implying that longer events and activities have more information that needs to be processed (Gibson, 2014; James, 1981)

Gibson also distinguished self-perception from environmental perception in an optic array of light (Gordon, 2004; James, 1981). When a creature looks towards a specific location, it only sees certain angles through the light, not the whole surrounding. However, the angles of points are changed following the locational changes, resulting in a clearer and larger visibility of objects in the environment. This change in viewing angle is called the perspective structure change. Also, a shadow structure change is created due to the sun's movement, which leads to changes in the angle of the point observation even without the subject moving (Gibson, 2014; Gordon, 2004). So, the ambient optic array allows us to perceive information from 360 degrees and describes the visual scenario of when one object becomes visible, other objects or parts of objects become invisible or shadowed. As a result, environmental perception is created. For self-perception, when the head turns, part of the optical view or structure is removed, and an opposite view is visible. As a result, the viewer has a sense of their location within the environment. Also, a flow is a change in the perspective structure; in other words, shifts and movements in the environment, such as indoors and outdoors, impact how we perceive information. Gibson stressed that these two ways of receiving information, or environmental and self perception always follow each other and can not be treated separately (Gibson, 2014 ch: 5-7). The main reason the perception of the ecological units should be considered is that it allows instructional message designers a context to consider when designing virtual immersive environments.

Application in Instructional Message Design

Understanding perception and how learners interact with their learning environments is a key aspect of instructional message design. The ecological approach of processing information and developing an environmental and individual perception can be used to benefit the gamification and game-based designing process. In the video game world, a player's main activity is to receive information from the layout and then to quickly react to it to achieve a task. To receive information from the environment in a situation, a player can either turn their video game character's head (ambient vision) or move the head and body (ambulatory vision) through the environment. Conversely, the objects in the environmental layout could be changed by the designer according to these movements and to give further information. In either case, a player will react according to the information received. For example, when racing a car from the first-person point of view, the player gets data from the side banners and other cues, which are the motions in the layout. Simultaneously, they are also steering the which changes their view (Meldgaard, 2012). The player receives visual input from the environment and the motion of the car through that environment.

In virtual reality, the concept of general spatial perception in three-dimensional space becomes even more important (Geuss et al., 2010, Grabarczyk & Pokropski, 2016). Lately, numerous experiments have been conducted on various perceptual tasks, including sight, height, and kinesthesia (or the self perception of the location of the body) (Fath & Fajen, 2011; Kelly et al., 2017; Bhargava et al., 2020). These studies help illustrate the importance of authenticity. However, Linderoth (2012) notes that good games do not mean a great learning experience, and care has to be taken to be sure the learning experience matches the learning objectives.

Computational Approach to Perception

Marr (1976) first introduced the computational perception approach and initially aimed to figure out why a raw picture draft matches the people's anticipation of the actual picture. Marr's computational theory describes human vision processes as being analogous to how a computer system works, by taking inputs, processing them, and creating meaningful outputs. Computational theorists started off understanding the beginning point and process of the “primal sketch”, then shifted their gaze to 2-½ dimension (D) and 3 dimension (3-D). Later, it was broadened into a perception of each element, such as depth and spatial perception (Marr, 1976).

The primal sketch is the first initial representation of visual information. Marr and his fellow researchers first analyze the process of drawing/sketching, hoping to see whether the tokens of the sketch could match the retinal array of primitive (Gordon, 2004). Their experiment revealed the first layer fundamentals were types of edge, lines, thin bars, and blobs, called "primitives/tokens," and a combination of tokens builds up the bigger part and finally forms an image like a line. Once the individual lines become larger, the picture's intensity value becomes more vivid, leading to the primal sketch of an object like a black drawing. The importance of this finding is that visual analysis is possible to be seen on the screen through a separate symbolic entity, which is computed and measured separately from the image and cooperates with other geometry shapes, which results in removing a considerable burden of handling the mass of data (Marr, 1976).

The primary sketch leads to a 2-½ D sketch which is an internal transitory phase of cognitive information processing to create visualization. The 2-½ D sketch keeps the concept of the viewer-centered visualization. At this stage, the optical surface of the picture becomes visible; however, it only shows the side a viewer is seeing, not the whole surrounding 3-D object or environment. So the hypothesis based on this idea was that our vision could not imagine the entire surrounding environment, whereas this is more likely a mental process, meaning we create the 3-D process in the brain; it has nothing to do with our eyes (Kitcher, 1988; Stevens, 2012).

The last stage of the computational process is the cognitive representations of 3-D dimensional shapes created from the 2-½ D forms (Marr & Nishihara, 1978). The 3-D representation in a learner’s mind is formed by the initial primitive objects consisting of the types of shapes, their size, and placement in an object-centered coordinate system for computing. The integration of these conceptual phases, from primitive mental sketches, to 2-½ D concepts, that coalesce into

3-D mental representations of what the learner sees, plays a crucial role in the creation of an immersive environment.

Application in Instructional Message Design

Instructional message design and computational processing concepts can be applied to the evolving fields of artificial intelligence and machine learning. Recent studies related to visual perception and computation have led to tremendous advancements in various fields such as manufacturing, agriculture, intelligent driving, and image synthesis (Yang et al., 2020). *Machine vision* is the technology that enables computer vision algorithms, with image capture systems, and the robotic instructions for the inspection of an object or process (Perez et al., 2018). The use of machine vision significantly improved the quality and accuracy of the industry works (Yang et al., 2020). Namely, automatic detection and classification of surface textile defects based on machine vision remarkably lowered manufacturing surface defects such as spots, holes, and stains on metal and non-metal surfaces (Yang et al., 2020). By segregating extraneous objects from a target one, perceiving movements, and defining and completing desired actions, robots are able to perform daily and specialized tasks in the real world (Haazebroek et al., 2011; Perez et al., 2018). For example, agricultural robots using similar visual perception processes as humans, are used to distinguish fully grown apples from immature ones, even at night (Wei et al., 2018). Automatic vehicle driving is another example of how visual-based environmental perception becomes a source of information for safe autonomous driving (Yang et al., 2018). Future research will give us further insight into how instructional message design for human learners can be applied to help artificial learners learn.

Conclusion

Perception is the learner's initial sensory input and the subsequent processing of that information for meaning. Perception becomes an essential principle for multiple theories consisting of Gestalt, neurology, ecology, and computation and can all be applied to guide instructional message design. Understanding how humans process visual information can be applied to make more effective and efficient message designs. Moreover, understanding perception can help instructional designers develop and create augmented reality, virtual reality, and immersive simulations. In general, well-organized instructional message design leads to efficient perception and processing of communication.

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