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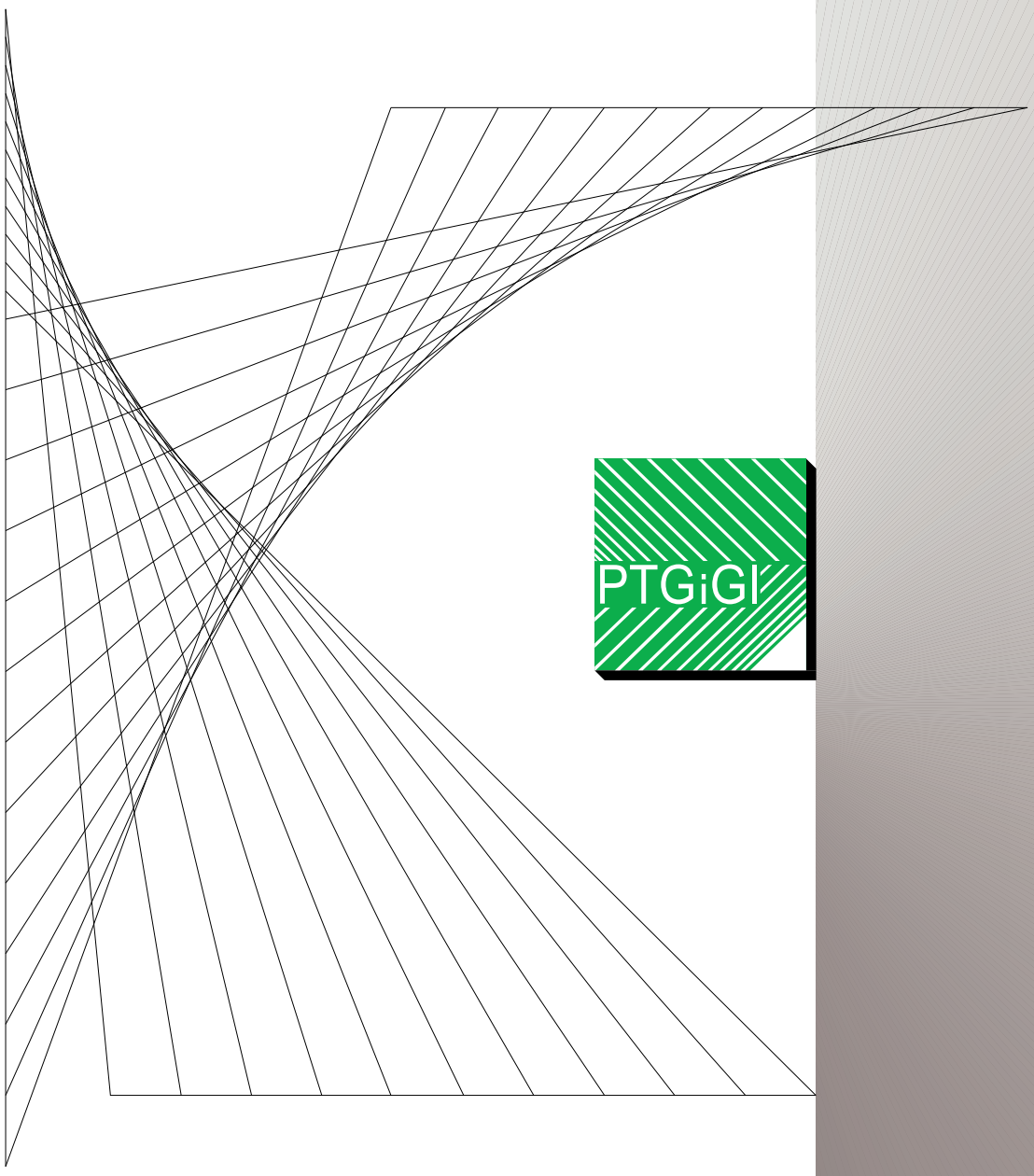

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SENSORY IMPRESSION SIGNAL DETECTION AND OPTIC ILLUSION

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Abstract. Perception of stimuli from a surrounding environment starts with activation of receptor surface in a given sensory analyzer. This activation results from the so-called transduction process, i.e. transforming energy of the stimulus, e.g. intensity of light, sound, smell or touch, into neuronal activity. Anatomical coding distinguishes solely between the stimuli that belong to various sense modalities.
The two competitive concepts exist in the field of research on the processes of visual perception:
- informative approach, explaining the process of reality creation solely on the basis of sensory data,
- ecological approach, focused on identifying stable properties of perceived objects, that can facilitate further adjustment to environmental conditions. The perceived objects are arranged in a given order – we perceive the sense and logic of both their spatial distribution, i.e. distinction, size and location, and the temporal distribution, also with regards to their movement. The logic of perception combines processes that extend far beyond the scope defined by the specificity of sensory analyzers. The resulting image is usually characterized by a figure with well-defined shape and spatial location, and its background, which is typically amorphous and serves as a localization aid. Focusing solely on the figure or "confounding effect of background", afterimage continuing to appear in one's vision for a while after the stimulation has ceased, color or even movement of an observed object are sometimes reflected by a "distortion" of perceived image. The presentation will focus on examples of "optical illusions" and an attempt to explain the origin thereof. Moreover, potential practical application of these phenomena, for example in fashion design, interior design and advertising industry, will be discussed.

Keywords: sensory impression, optic illusion

1 Introduction

Perception of stimuli from a surrounding environment starts with activation of receptor surface in a given sensory analyzer. This activation results from the so-called transduction process, i.e. transforming energy of the stimulus, e.g. intensity of light, sound, smell or touch, into neuronal activity. Anatomical coding distinguishes solely between the stimuli that belong to various sense modalities. Afterimage observed in the case of visual stimulation resembles sensory memory, as the sensory analyzer remains activated for a while after the stimulation has ceased. Specificity of this phenomenon – namely, a feature distinguishing it from the sensory buffer – was shown by Massaro [3] on the example of the following demonstration. If a one-second flashlight appears in a darkened room, an examined person, although still in darkness, will be able to "see" the objects present in this room for a period of time.

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2 Identification of features

An attempt to deconstruct a perceived object into simple components seems to be an obvious first step in the analysis of surrounding environment. Such analysis underlies a research perspective based on an integrative character of perception processes. The simple components can be combined in a complex image of the perceived object. Such research perspective fits into informative approach to perception process, explaining the process of reality creation on the basis of sensory data. In contrast, a competitive ecological approach is based on identification of stable properties of perceived objects, that can facilitate further adjustment to environmental conditions.

Various groups of neurons respond to specific characteristics of a perceived object, e.g. its shape, orientation, movement in a given direction or color. Therefore, various categories of neurons respond to different (either simple or complex) elements of perceived environment. These neurons are referred to as feature detectors.

According to Konorski's [2] perception theory, the integrative role of sensory analyzers in the process of synthesizing features results in creation of images in form of unitary perceptions, represented by gnostic units located in the so-called gnostic areas. The process of integrating features into complete representation of an object likely takes place during eye movements of an observer.

2.1 Stable features of objects

One function of the perceptual system is registration of invariants, i.e. stable characteristics identified during smooth change of a perspective resulting from movement of an observer in relation to an observed object (extracting invariants under transformation).

2.2 Perceptual synthesis

The perceived objects are arranged in a given order – we perceive the sense and logic of both their spatial distribution, i.e. distinction, size and location, and the temporal distribution, also with regards to their movement. The logic of perception combines processes that extend far beyond the scope defined by the specificity of sensory analyzers.

2.3 Organization of perception processes

The perceptual ability to implement order and symmetry into registered stimuli is particularly emphasized in one of perception research concepts, referred to as gestalt psychology. Perceiving an object by extracting it from an array of other stimuli is possible due to dividing a cognitive area into figure and background. The figure is usually well defined by its shape and spatial location. The background is typically amorphous and serves mostly as a localization aid (Fig.1).

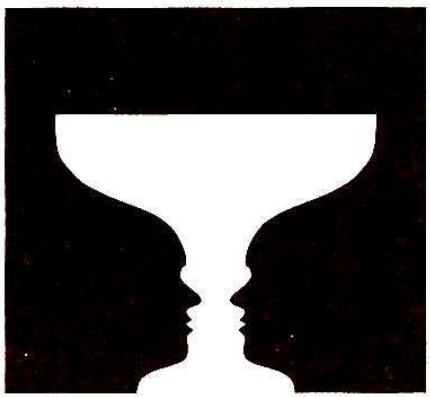

Figure 1: Profiles and goblet as alternating figures and backgrounds

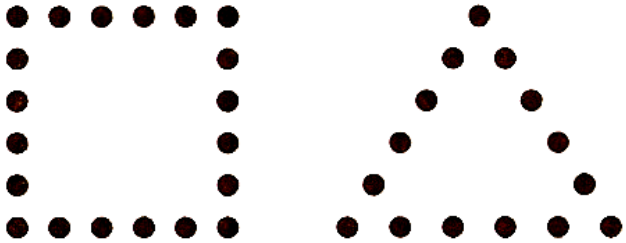

Figure 2: Examples of figures that can be perceived due to perceptual grouping of elements

The examples (Fig. 1 and Fig. 2) presented on the figures suggest that one can create reality. He/she can recognize various figures, i.e. organize perceived stimuli in a freely selected manner. Such approach to perception research was reflected by development of a concept referred to as constructivism [4]. Constructivism constitutes a foundation for the principles of gestalt psychology:

- organization of perceived reality
- perceptual grouping

These principles refer to a phenomenon that enables extraction of a figure from its background (Fig. 3):

1. Principle of proximity states that elements being close together, rather than those being far apart, form the same object.
2. Principle of similarity states the same with regards to objects that are similar to each other.
3. Principle of closure states that the perceptual system adds lacking elements, thus ”closing” the shape of an incomplete figure.
4. The so-called ”good figure” or ”good continuation” principle corresponds to a simplicity of a perceived object, manifesting mostly by its symmetry and regularity of its shape.
5. The principle of ”common fate” states that elements seen moving in the same direction are perceived together and form the same figure.

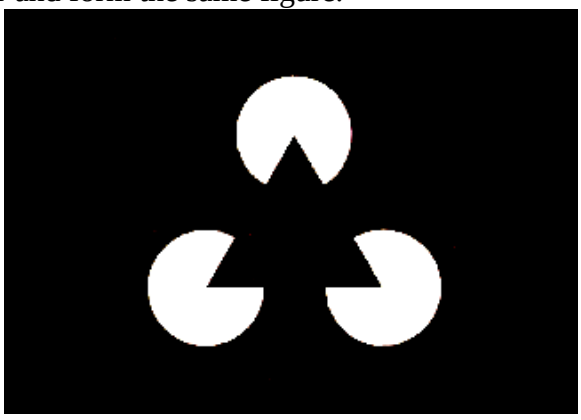

Figure 3: Illusory contour of a triangle

2.4 Perceptual organization in view of the informative approach

The concept of perceptual organization is linked to the informative approach to perception. This approach describes a human being as an active individual, who stores, processes and updates information, both originating from surrounding environment and recalled from his/her memory.

3 Perceptual illusion

3.1 Perceptual illusion in spatial perception

Although the horizontal lines presented on the figure are of equal length, one perceives the upper line longer than the lower one (Fig. 4). One possible explanation of this phenomenon is unwitting inference based on the following two premises:
1. From a perspective, the objects producing retinal images of different sizes are interpreted as being of the same size if a farther object is larger than a nearer one.
2. The lines presented on the figure produce retinal images of the same size as the larger line is located farther from the shorter one.

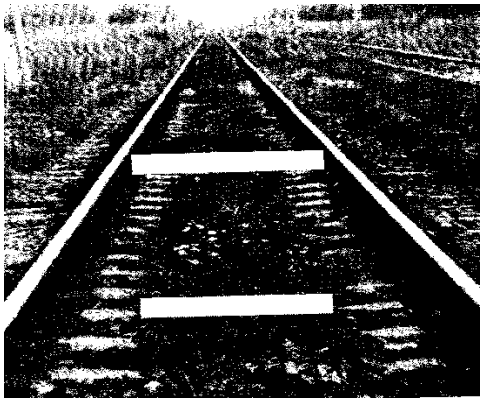

Figure 4: Ponzo (railway track) illusion [5]

Two oblique lines (Fig.4) forming a railway track activate cognitive representation of three-dimensional space. This internal context creates expectations with regards to perception of objects and events. Other examples (Fig. 5 and Fig. 6).

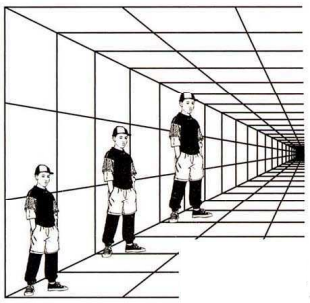

Figure 5: Is the boy in the back truly the largest one?

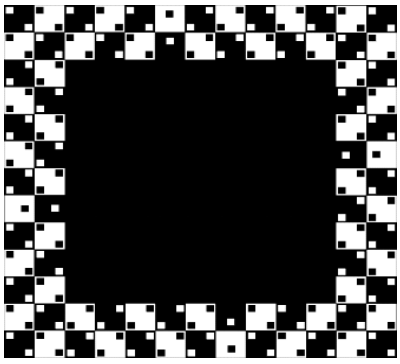

Figure 6: These are ideal squares

Looking at all the hereby presented figures, one may clearly notice that they do not have much in common with true objects and events from a surrounding environment.
Moreover, an observer can see an object from only one, isolated perspective.
Thus an observer is deprived of the elementary behavioral function, i.e. movement.

3.2 Role of movement in perception: ecological approach

Such limitation leads to unnatural situations, promoting perceptual errors, and subsequent creation of psychological theories of perception that are based on the erroneous assumptions (Fig. 7).

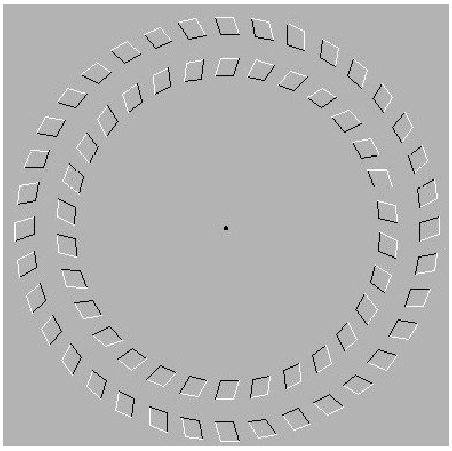

Figure 7: Looking at the dot one can (from different distances) see moving wheels

3.3 Perception of the unrealistic shape

Let's have a look at the Penrose triangle (Fig. 8). Although the "true" construction of this triangle is clearly visible, cognitive curiosity stimulated by unrealistic shape of this object forces one to detailed analysis of this phenomenon from various perceptual perspectives. Changing the perspective leading to perception of the unrealistic shape into another one, one will immediately reveal the true construction of the triangle.

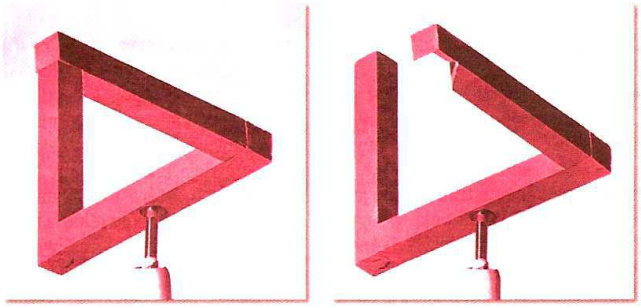

Figure 8: Construction of a Penrose triangle [1]

4 Conclusion

We presented a perception at the level of sensory impressions, i.e. a sensory processing of simple characteristics of stimuli, along with a perception at the level of experiencing and recognizing specific complex objects in a surrounding environment.

The analysis of perception of complex objects started from characterization of an ultra short-term memory, referred to as a sensory buffer and determining perception of any kind. The processes of perception were presented with regards to identification of features, emphasizing the importance of integrating simple components of a stimulus into a given

structure, as well as in terms of perceptual synthesis, highlighting the role of expectations and possessed knowledge in the process of perceptual organization. This analysis points to possibility of potential practical application of these phenomena, for example in fashion design, interior design and advertising industry.

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WRAŻENIA ZMYSŁOWE I DETEKCJA SYGNAŁÓW A ZŁUDZENIA OPTYCZNE

Odbiór bodźców z otaczającego środowiska rozpoczyna się od pobudzenia powierzchni recepcyjnej danego analizatora zmysłowego. To pobudzenie jest wynikiem tak zwanego procesu transdukcji, czyli przetworzenia energii działającego bodźca, odpowiadającej na przykład intensywności światła, dźwięku, zapachu czy dotyku, na aktywność neuronalną. Kodowanie anatomiczne rozróżnia tylko bodźce należące do różnych modalności zmysłowych.
W przypadku zmysłu wzrokowego rozróżnia się dwie konkurencyjne perspektywy badawcze w odniesieniu do procesów spostrzegania:
- podejście informacyjne, wyjaśniające proces tworzenia rzeczywistości na podstawie jedynie danych zmysłowych,
- podejście ekologiczne, zwracające uwagę na wyodrębnianie w spostrzeganiu stałych właściwości przedmiotów, które umożliwiają przystosowanie się do środowiska.
Spostrzegane przedmioty są zorganizowane w określonym porządku — dostrzegamy sens logikę zarówno w układzie przestrzennym, dotyczącym ich wyodrębniania, wielkości I lokalizacji, jak i czasowym, dotyczącym również ruchu przedmiotów. Logika percepcji łączy w sobie procesy daleko wykraczające poza te określone specyficznością analizatorów zmysłowych. Powstały obraz wyróżnia zwykle dobrze określona swoim kształtem i miejscem w przestrzeni figurę oraz tło, z reguły w swojej istocie bezkształtne i służące głównie pomocą w lokalizacji.
Koncentrowanie się jedynie na figurze albo „zaburzający wpływ tła", powidok jako obraz następczy spostrzegania, trwający jeszcze przez chwilę po zakończeniu działania bodźca, kolor a nawet ruch obserwowanego przedmiotu powodują niekiedy występowanie „przekłamania" odbieranego obrazu. W prezentowanym wystąpieniu zostaną przedstawione przykłady „złudzeń optycznych" z próbą wyjaśnienia przyczyn ich powstawania. Ponadto poddana analizie będzie możliwość praktycznego wykorzystania tych zjawisk na przykład w projektowaniu ubiorów, aranżacji wnętrz i branży reklamowej.