Five Functions of Perception

1) Attention is used to make decisions about *which* incoming information is to be further processed and which is to be discarded

2) The system must be able to determine *where* objects of interests are in the external environment

3) The perceptual system must be able to determine *which* objects are out there in the environment

4) The system must be able to *abstract* the critical features of a recognized object

5) The perceptual system must maintain certain inherent features of objects

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Attention

The study of attention concerns primarily the cognitive resources and their limitations. At any given time people have only a certain amount of mental energy to devote to all the possible tasks and all the incoming information confronting them. *Attention is sometimes synonymously used with mental concentration.*

Does people's concentration level change with practice ?

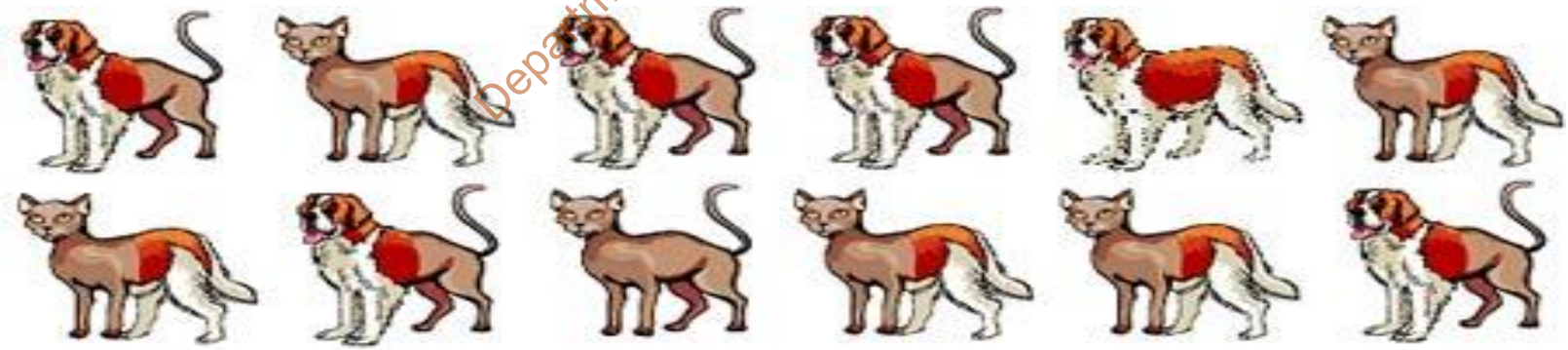
Selective Attention

The term selective attention refers to the fact that we usually focus out attention on one or a few tasks or events rather than on many. We mentally focus our resources implies that we shut out (or atleast process less information from) other competing tasks. As attention researcher Hal Pashle puts it

at any given moment [people's] awareness encompasses only a tiny proportion

of the stimuli impringing on their sensory systems

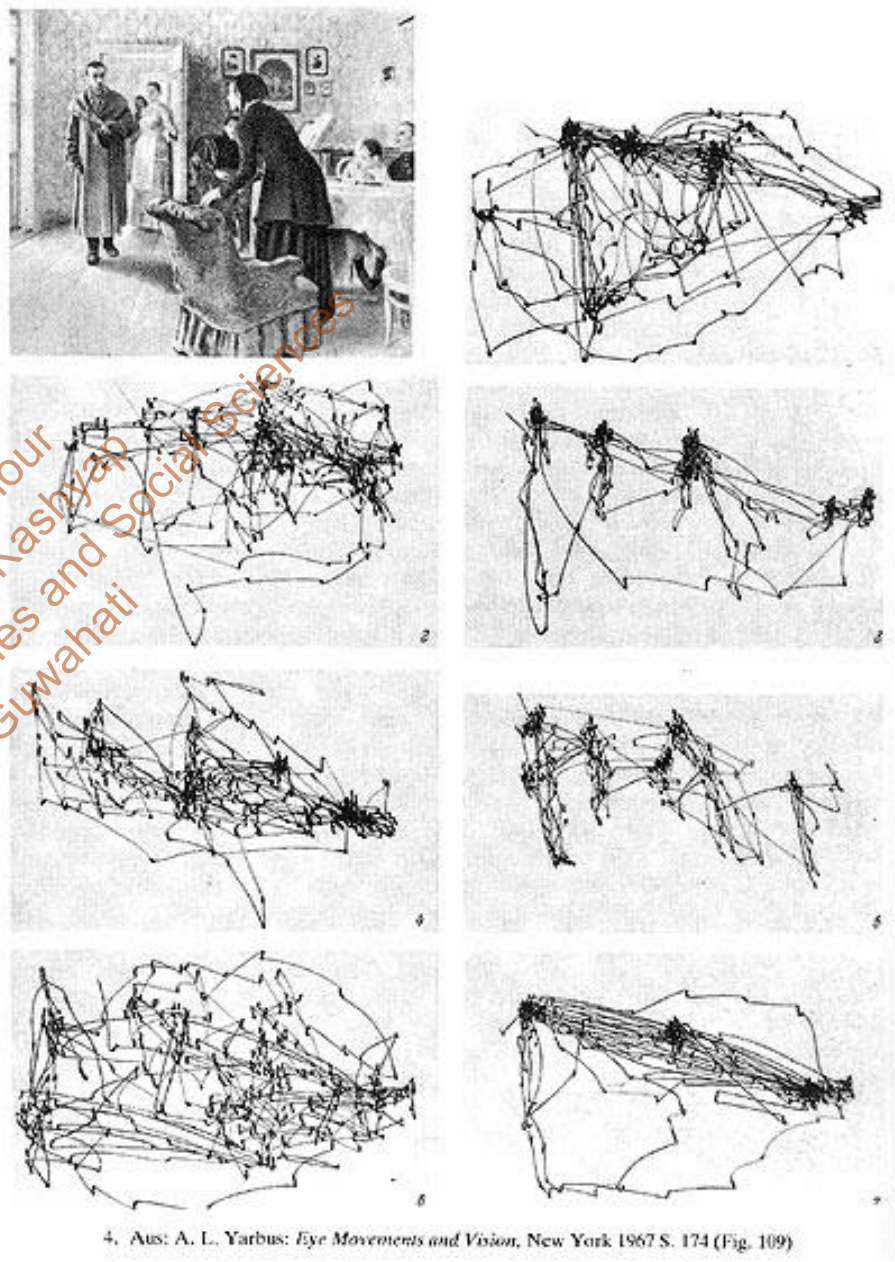
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Eye Movements

The process of *seeing* starts with visual scanning in the form of ***fixations***, which are – *brief periods during which the eyes are relatively stationary,* separated by ***saccades***, which are – *quick jumps of the eye from one place to the next*.

The points on which the eyes fixate are not random, but rather are the areas of scene that contains the most information Experiments to verify this stated by showing scenes of a farmyard with either a tractor / octopus in the middle. It was found that eye fixations were directed earlier and more frequently to the un-usual object (tractor).



4. Aus: A. L. Yarbus: *Eye Movements and Vision*, New York 1967 S. 174 (Fig. 109)

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Divided Attention Without Eye Movements

Humans can also selectively attend to some visual stimulus without moving their eyes. In experiments that demonstrate this, observers have to detect when an object occurs. On each trial, the person stares at a blank field and then sees a brief cue, which is a *directing stimulus such as a small arrow that directs the subject to attend wither to the left or to the right*. An object is then presented either in a location indicated by the cue or the opposite location. The interval between the cue and the object is too brief for observers to move their eyes, yet then can detect the object faster in the cued location than when it occurs than elsewhere.

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Localization

Localization of information in the external environment is essential for solving the following problems

1) Navigating our way through the ever cluttered environment
2) Grasping an object

Localization is achieved by first separating the objects from one another and the separating each from the background

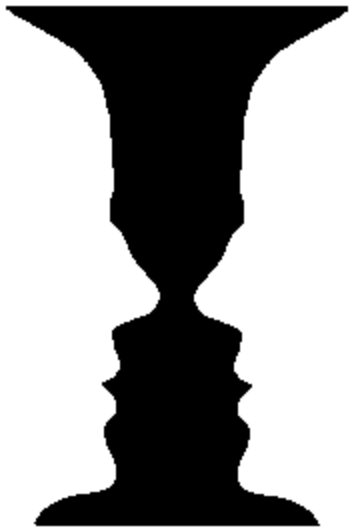
Separation of Objects

Figure and Background – the most elementary form of perceptual organization is that in the a stimulus with two or more distinct regions, we usually see part of it as a *figure* and the rest as *background.*

The regions seen as figure contains *the objects of interest, which appear more solid than the ground and appear in front of it.* The ground is *the region that appears to be behind the figure.*

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Figure Ground Relationship



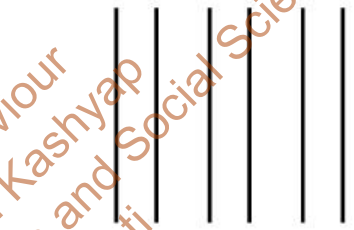
Our first perceptual decision is what is the image is the figure and what is the background.

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Gestalt Psychology

- Gestalt psychologists focused on how we GROUP objects together.
- We innately look at things in groups and not as isolated elements.
- **Proximity** (group objects that are close together as being part of same group)
- **Similarity** (objects similar in appearance are perceived as being part of same group)
- **Continuity** (objects that form a continuous form are perceived as same group)
- **Closure** (like top-down processing…we fill gaps in if we can recognize it)



Proximity



Similarity



Continuity



Connectedness

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Perceiving Distance

Perceiving distance requires depth cues, *different kinds of visual information that, logically or mathematically, provide information about some objects depth.*

Monocular Cues

1) Relative Size – If an image contains an array of similar objects that differ in size, the viewer intercepts the smaller objects as being farther away

2) Interposition – If an object is positioned so that it obstructs the view of the other, the viewer perceives the overlapping object as being nearer

3) Relative Height – Among similar objects, those that appear closer to the horizon are perceived as being farther away

4) Perspective – When parallel lines in a scene appear to converge in the image, they are perceived as vanishing in the distance

5) Shading & Shadows – the configuration if shading and shadows provides information about an objects depth

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Perceiving Distance

Perceiving distance requires depth cues, *different kinds of visual information that, logically or mathematically, provide information about some objects depth*

Depth Cues



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- Eleanor Gibson and her **Visual Cliff Experiment**.
- If you are old enough to crawl, you are old enough to see depth perception.
- We see depth by using two cues that researchers have put in two categories:
- Monocular Cues
- Binocular Cues

Monocular Cues

1) Relative Size – If an image contains an array of similar objects that differ in size, the viewer intercepts the smaller objects as being farther away

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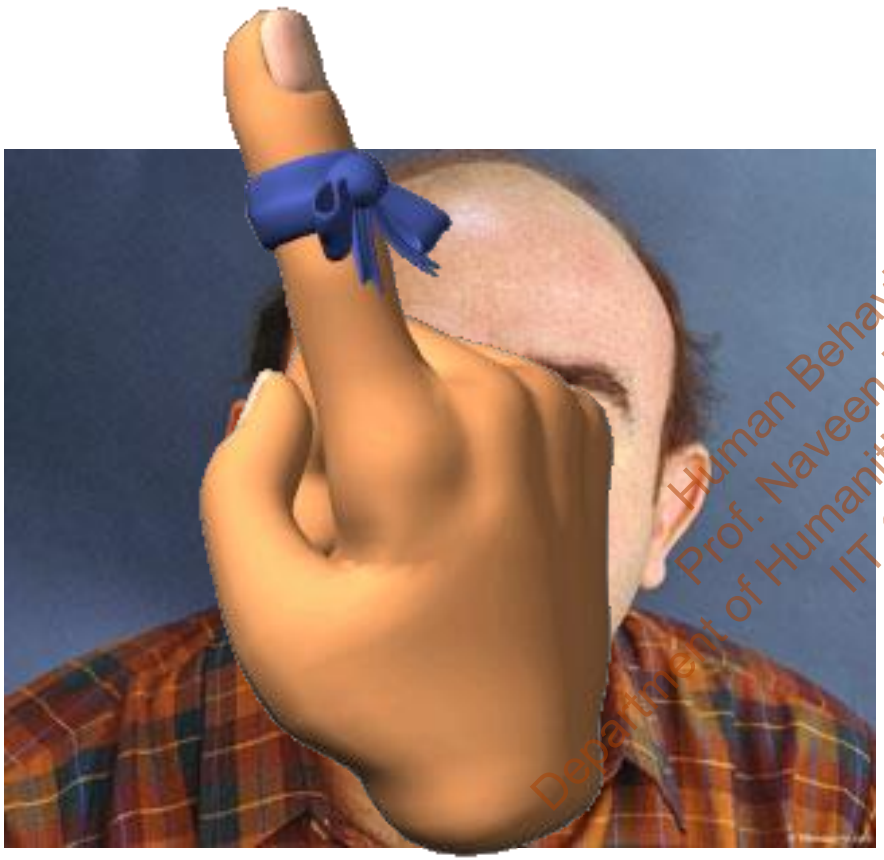
5) Shading & Shadows – the configuration if shading and shadows

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Binocular Cues

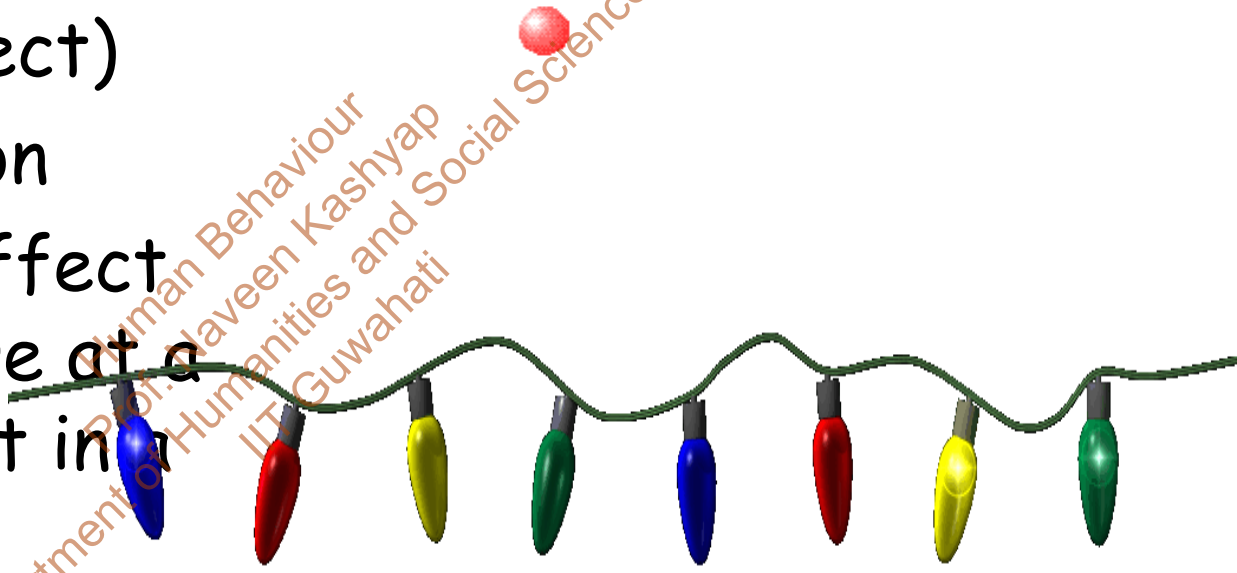


- We need both of our eyes to use these cues.
- **Retinal Disparity** (as an object comes closer to us, the differences in images between our eyes becomes greater.
- **Convergence** (as an object comes closer our eyes have to come together to keep focused on the object).

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Perceived Motion

- Stroboscopic effect (flip book effect)
- Phi phenomenon
- Autokinetic Effect (if people stare at a white spotlight in a dark room, it appears to move.)



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Recognition

Recognizing an object entails several sub-problems –

a) Acquire fundamental or *primitive* bits and pieces of information from the environment and assemble them properly

b) Figure out what the objects actually are

Fundamental information assembly starts with the binding problem: *how activity in different parts of the brain, corresponding to different primitives such as color and shape, are combined into coherent perception of an object.*

The Binding Problem: Pre-attentive and Attentive Process

Feature Integration Theory - states that information from the visual world is *pre-attentively* encoded along separate dimensions – *(shape & color are encoded separately)* – and then integrated in a subsequent *attentive* processing stage. The theory was proposed by Anne Treisman.

the general idea is that in a first **pre-attentive stage primitive features** *qualities such as shape & color are perceived and in the second* **attentive stage** *focused attention properly "glues" the feature to form integrated wholes*

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Figuring out what an object is –

This problem has ***shape*** of an object, playing a major role in the identification process. The process is a two part system where

a) In early stages the perceptual system uses information on the retina, particularly variation in intensity to describe the object in terms of primitive components such as ***lines, edges and angles.***

b) In the later stages, the system compares this description to those of various categories of objects stored in visual memory and select the best match.

Relations Among Feature

There is more to a description of a shape than just its features: The relations among features must also be specified.

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Later stage of Recognition Network Models

Simple Networks – Most research on the matching stage has used simple patterns, specifically handwritten or printed letters or words. The basic idea is that *letters are described in terms of certain features, and the knowledge about what features goes with what letter is contained in a network of connections.*

Networks with Feedback – A letter is easier to perceive when it is presented as a part of a word than when it is presented alone. This finding has led to the certain features in the Simple Network Model.

a) *A level of word is added to the simple network and along with its excitatory and inhibitory connection that go now from letters to words*

b) *New addition of excitatory connections that go from words down to letters are now added. These connections easily explain the word superiority effect.*

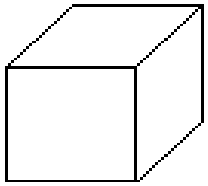
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Recognizing natural objects and Top-Down Processing

Features of Natural Objects – *it has been suggested that features of objects include a number of geometric forms, such as arcs, cylinders, cones, blocks and wedges. These features referred to as "**(Geometric Ions) geons**" were identified by Biederman (1987). There are 36 geons that explain almost all shapes in the physical world.*

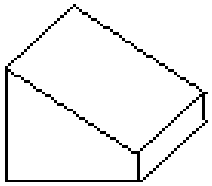
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Cube



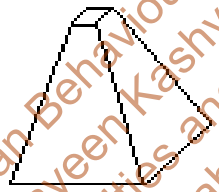
Straight Edge
Straight Axis
Constant

Wedge



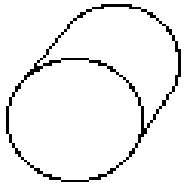
Straight Edge
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Expanded

Pyramid



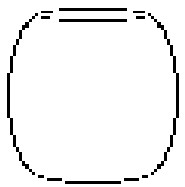
Straight Edge
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Cylinder



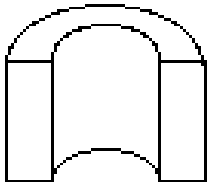
Curved Edge
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Constant

Barrel



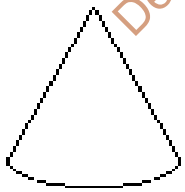
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Arch



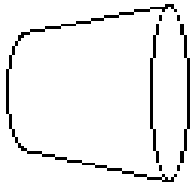
Straight Edge
Curved Axis
Constant

Cone



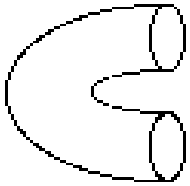
Curved Edge
Straight Axis
Expanded

Expanded Cylinder



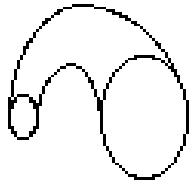
Curved Edge
Straight Axis
Expanded

Handle



Curved Edge
Curved Axis
Constant

Expanded Handle



Curved Edge
Curved Axis
Expanded

The Importance of Context – *Top down processing are driven by a person's knowledge, experience, attention and expectation. These processes in addition to the geons (bottom up processing) make up for most of the perception of complex stimuli in our physical environment.*

Figure 2



Impressions resist change.

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Bottom-Up Processing

- Also called feature analysis.
- We use the features on the object itself to build a perception.
- Takes longer that top-down but is more accurate.

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Kids.exe

Click to see an example of bottom –up processing.

Top-Down Processing



- We perceive by filling
- the gaps in what we sense.

I _ant ch_co_ate ic_ cr_am.

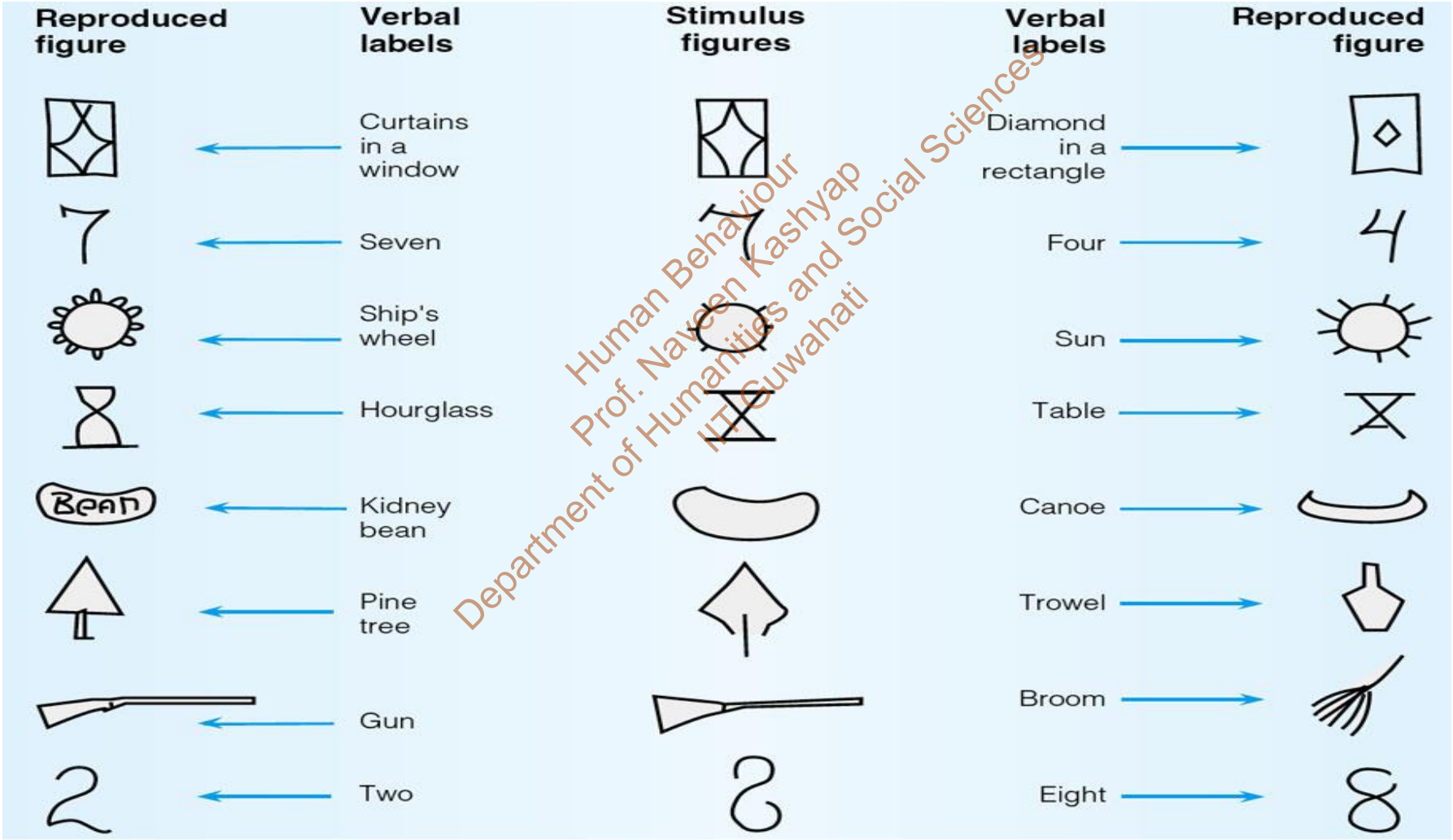
Based on our experiences and schemas.

If you see many old men in glasses, you are more apt to process a picture of an old man (even when you may be in error).

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Abstraction

Abstraction – *is the process of reducing the vast amount of information that comes in from the physical world through our senses to a more manageable set of categories*



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Perceptual Constancies

A remarkable ability of the perceptual systems, is to maintain, ***Constancy****, which refers to the brain's ability to maintain a perception of the underlying physical characteristics of an object, such as* ***shape, size or color****, even when the sensory manifestation of these objects change drastically.*

Color and Brightness constancy

Color constancy – is the ability of the visual system to perceive the reflectance characteristics – an inherent property of an object – no matter what the source wavelength.

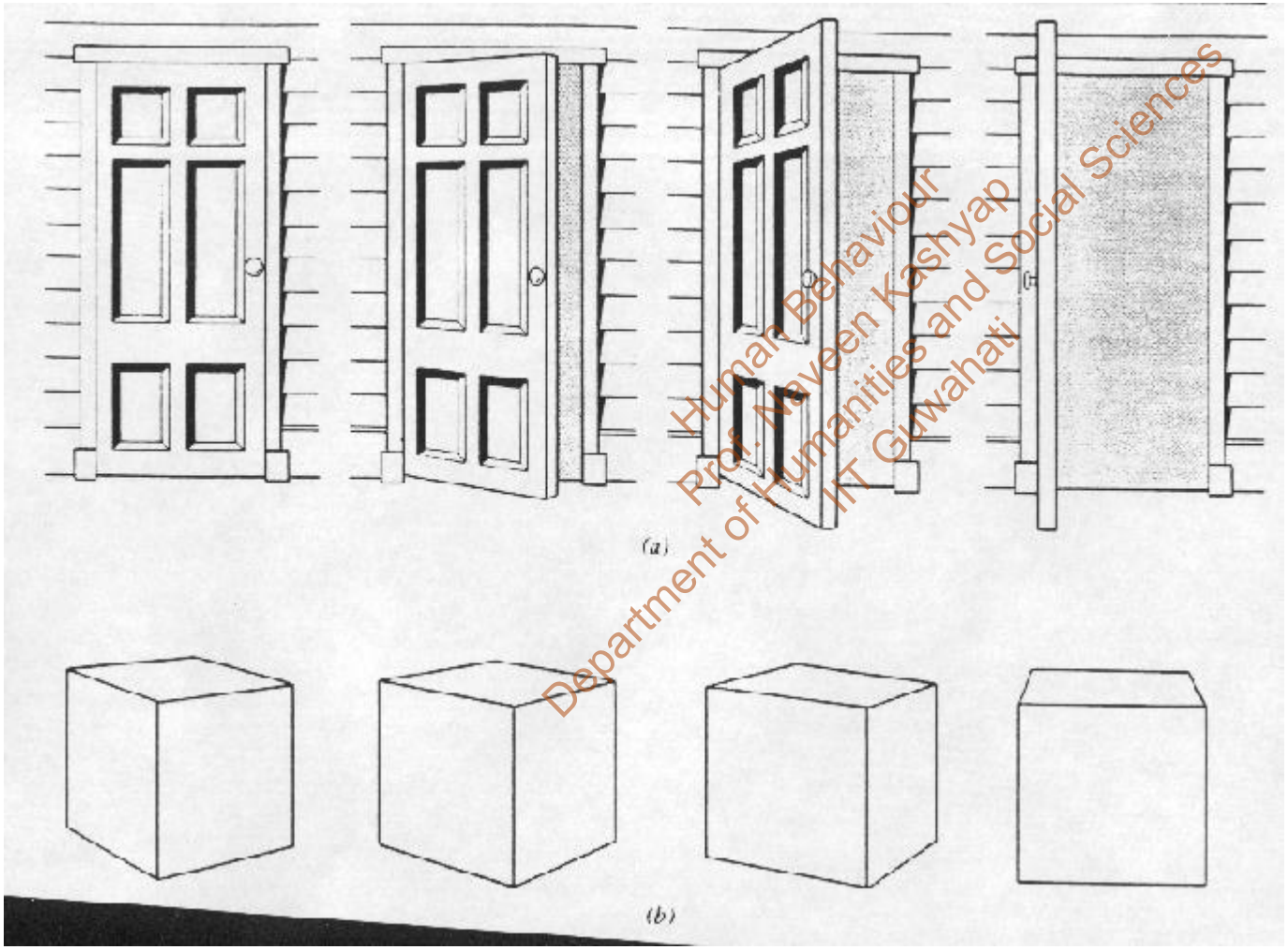
Brightness constancy – refers to the fact that the perceived lightness of a particular object changes very little, if at all, even when the intensity of the source changes dramatically.

Color and brightness constancy depends on the relations among the intensities of the light reflected from the different objects

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Shape Constancy – *refers to the ability of the perceptual system to main shape of objects in the external environment*

Size Constancy – *is the ability of the perceptual system to maintain the objects perceived size relatively constant no matter how far away it is*



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Constancy





- Objects change in our eyes constantly as we or they move….but we are able to maintain content perception
- Shape Constancy
- Size Constancy
- Brightness Constancy

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