Sensory Processes

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Sensory Processes

Human beings at all times are bombarded with a range of information. Even at the calmest circumstances, a tapestry of information bombards us. Living organisms need to assimilate and interpret at least some of these information to appropriately interact with the world. This is two part process

1)Which aspects of the environmental information register with our senses and which don't?

2)How the sense organs work to effectively acquire the information that is acquirable?

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Sensations – at the psychological level are fundamental, raw experiences associated with stimuli (sensations of sight can register colored, shaped objects). The perceptual level is the integration and meaningful interpretation of these raw sensory experiences.

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Characteristics of Sensory Modality

Two characteristic are common to all sensory modality

1) Sensitivity – describes sensory modalities at a psychological level

2) Sensory Coding – describes sensory modalities at the biological level.

Sensitivity

In psychology sensitivity is expressed using the concept of thresholds. There are two types of threshold

a) ***Absolute threshold*** – the minimum magnitude of a stimulus that can be reliably discriminated from no stimulus at all (e. g., the weakest light that can be discriminated from darkness).

Psychological procedures are experimental techniques for measuring the relation between the physical magnitude of some stimulus (physical intensity of light) and the resulting psychological response (how bright the light appears to be).

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2) ***Differential threshold*** – by how much must stimulus intensity be raised from some standard, defined to be some arbitrary level, to distinguish the new, higher level from the base level.

Just Noticeable Difference (jnd) – is the minimum difference in stimulus magnitude necessary to tell two stimuli apart.

Two German scientists – Heinrich Weber a physiologist and Gustav Fechner a physicist, were one of the first people to conduct experiments on thresholds. Their seminal finding was – *the larger the value of the standard stimulus, the less sensitive the sensory system is to change in intensity*.

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Across a wide range of stimulus circumstances the relationship can be explained as –

..*the intensity by which the standard stimulus must be increased to be noticed is proportional to the intensity of the standard*….

Which leads to

Weber's law : $\Delta s/s = c$; where s is standard, Δs is jnd and c = constant

Fechner's law : $r = c \log (\Delta s/s)$

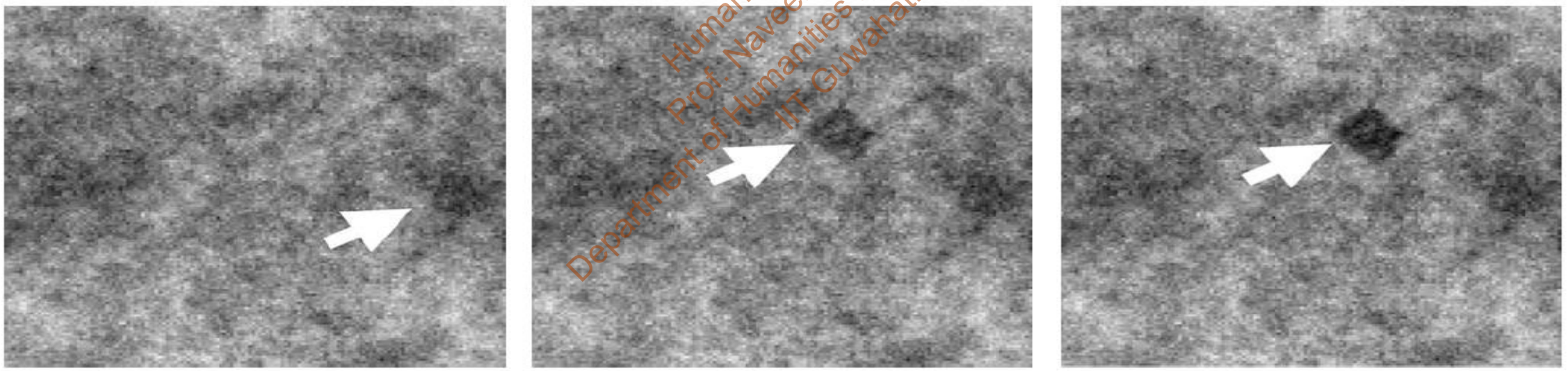
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Characteristics of Sensory Modalities

Signal detection theory

Information consists of *signals* and *noise* where "signal" refers to important aspect of information and "noise" refers to unimportant aspect of information

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Figure 4.5 Examples of Signals Embedded in Noise. *Each panel shows a background of random noise. In the left panel, there is no signal, although the small blob indicated by the arrow may look like a signal. In the middle panel, there is a low signal added, indicated by the arrow. In the right panel, the signal is strong and obvious.*

Characteristics of Sensory Modalities

Signal detection theory

Hits and false alarms

False alarm – signal falsely detected where there is only noise

Hit – signal correctly detected

Sensitivity of sensory organ indicated by differences in hits and false alarms

Sensitivity and bias

Useful characteristic of signal detection analysis – allows process of detecting stimulus to be separated into two numbers – one representing sensitivity to signal and one representing bias in stating "signal present"

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Characteristics of Sensory Modalities

Sensory coding

Two fundamental issues for sensory systems

1) How to translate incoming physical information and how to encode aspects of physical information to corresponding neural representation

2) Specialized cells called receptors (specialized neurons) detect stimulus (are activated) and pass an electrical signal to connecting neurons through to cortex where the electrical signal results in conscious sensory experience

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Characteristics of Sensory Modalities

Coding of intensity and quality

1) Useful sensory information includes intensity and quality of stimulus
2) Primary means for coding intensity of stimulus is via the rate of neural impulses – greater intensity, greater firing rate and greater firing rate, greater perceived magnitude of stimulus
3) Coding quality is more complex. It is generally agreed that the brain codes qualitative differences between sensory modalities according to the *specific neural pathways* involved. Sensory system may also use a *pattern of neural firing* to code quality of sensation

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Vision

- **Light and vision**
  - Each sense responds to particular form of physical energy, for *vision stimulus – light* (electromagnetic radiation in range 400-700 nanometers)

- **The visual system**
  - The eyes, parts of the brain and pathways between
  - Eyes contain two systems – *image formation and image transduction*

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Vision

- **Rods**
  - Allow humans to see in black, white, and shades of gray in dim light
  - Mostly in the periphery
  - Take 20 – 30 minutes to fully adapt to darkness
- **Cones**
  - Enable humans to see color and fine detail in adequate light, but that do not function in dim light
  - Mostly in the fovea
  - Adapt fully to darkness in 2 – 3 minutes

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Vision

- ...The visual system
  - **Image formation system**
    - Function to focus light reflected from object to form image on retina. Light enters cornea and is focussed on the retina by lens (aided by cornea). Light levels controlled by pupil to maintain image quality
  - **Transduction system**
    - Receptors in retina – rods and cones (rods specialised for night vision, cones for day vision). Absorption of light by photopigments in receptors starts transduction process – result neural impulse travels to brain via neurons

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Vision

- Seeing light
  - **Sensitivity** – determined by rods and cones
  - Three key differences between them
    - Activated under different levels of light
    - Specialized for different tasks
    - Concentrated in different locations on retina

  - **Dark adaptation** – change in ability to see in the dark
    - Two processes account for it – pupil size changes and photochemical changes in receptors

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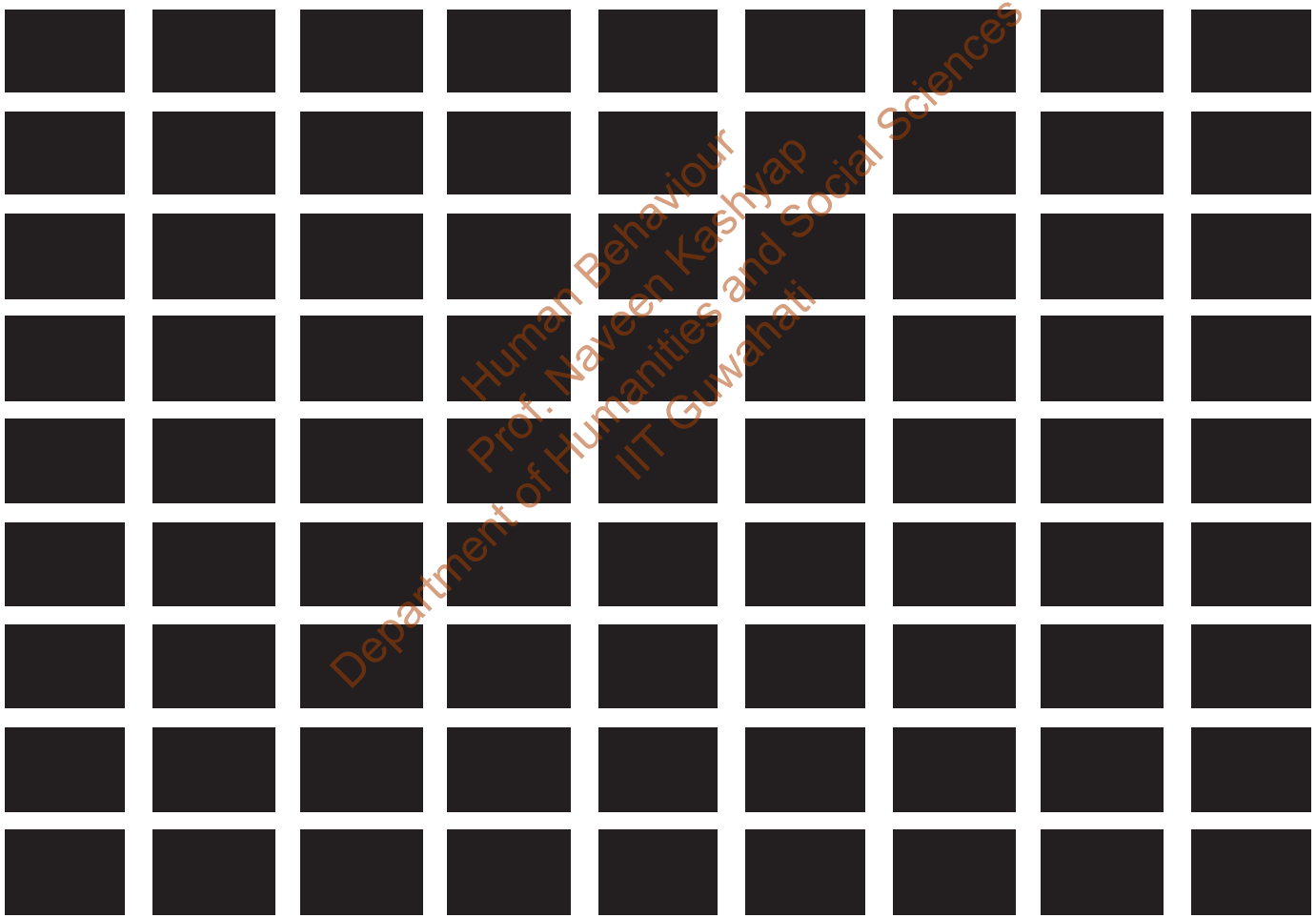
Vision

- **Seeing patterns**
  - **Visual acuity** – the eye's ability to resolve details
    - Measurement commonly optician's eye chart – method cannot distinguish between *spatial acuity* (ability to see details of form) & *contrast acuity* (ability to see differences in brightness)
  - Sensory experience associated with viewing patterns determined by way neurons register light and dark
    - Example: the Hermann Grid (see next slide)

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Vision

- ...Seeing patterns



Vision

- **Seeing color**
  - Visible light is alike except for the wavelength which the visual system turns into color
    - Wavelengths – short (blue), medium (green), long (red)

- **Color appearance**
  - Seeing color is subjective in the sense that color is a construction of brain but also objective in the sense that any two viewers appear to construct color in same way
  - Three dimensions – hue (color's name), brightness (quantity light reflected) & saturation (color purity)

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Vision

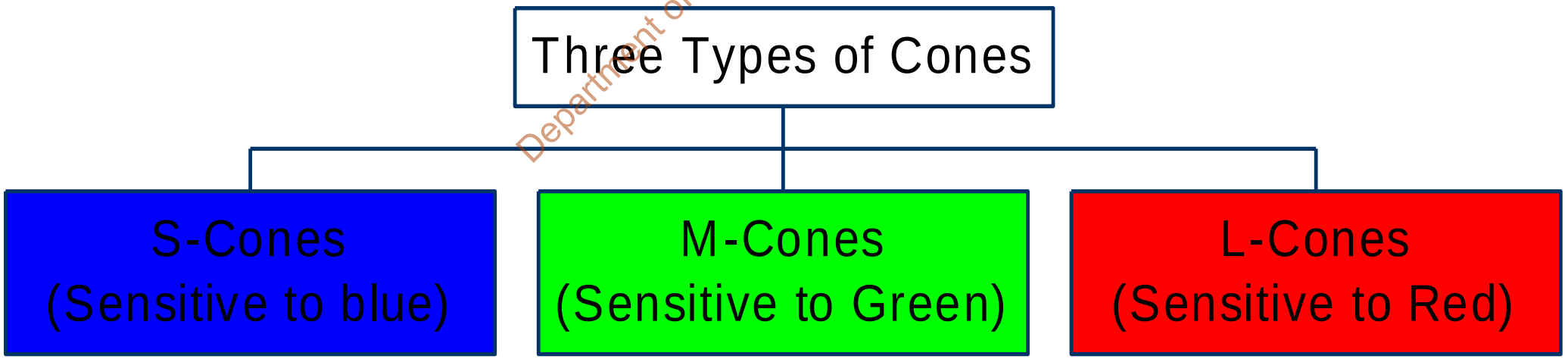
- ***Hue***
  - The property of light commonly referred to as color, determined primarily by the wavelength of light reflected from a surface
- ***Saturation***
  - The degree to which light waves producing a color are of the same wavelength; the purity of a color
- ***Brightness***
  - The dimension of visual sensation that is dependent on the intensity of light reflected from a surface and that corresponds to the amplitude of the light wave

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Vision

- …Seeing color
  - **Theories of color vision**
    - ***Trichromatic theory*** – only three types of receptors for color (cones) & quality of color coded by activity pattern of receptors. For deficiency one or more type receptor missing

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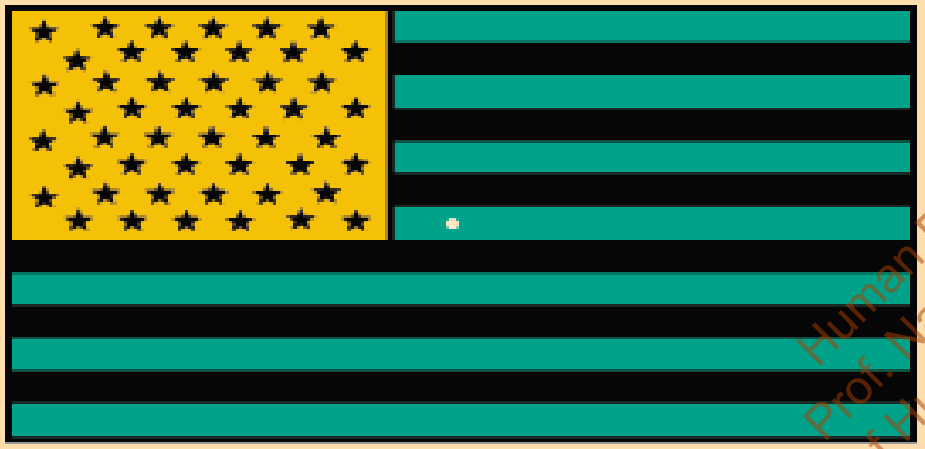
Opponent color theory – developed from findings not explained by trichromatic theory. Argues that two types of color-sensitive units exist (red-green & blue-yellow) & each responds in opposite ways to opponent colors

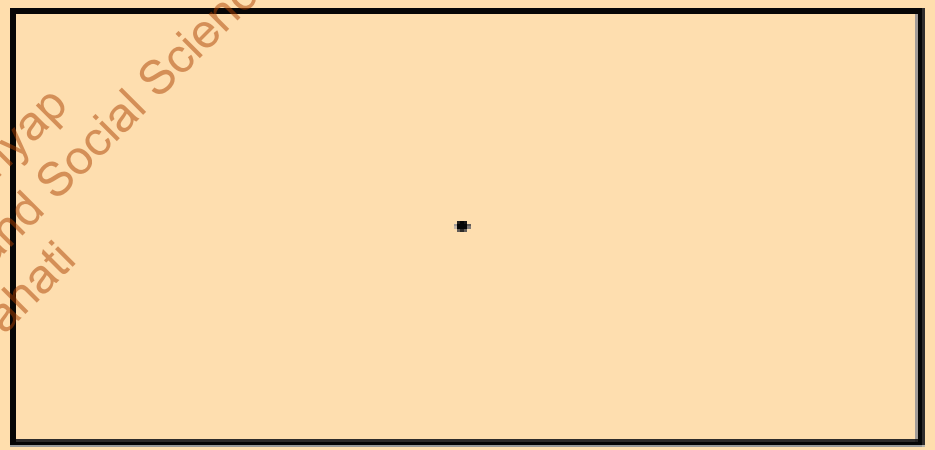
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Afterimage

After you have stared at one color in an opponent-process pair (red/green, yellow/blue, black/white), the cell responding to that color tires and the opponent cell begins to fire, producing the afterimage

► Seeing Afterimages



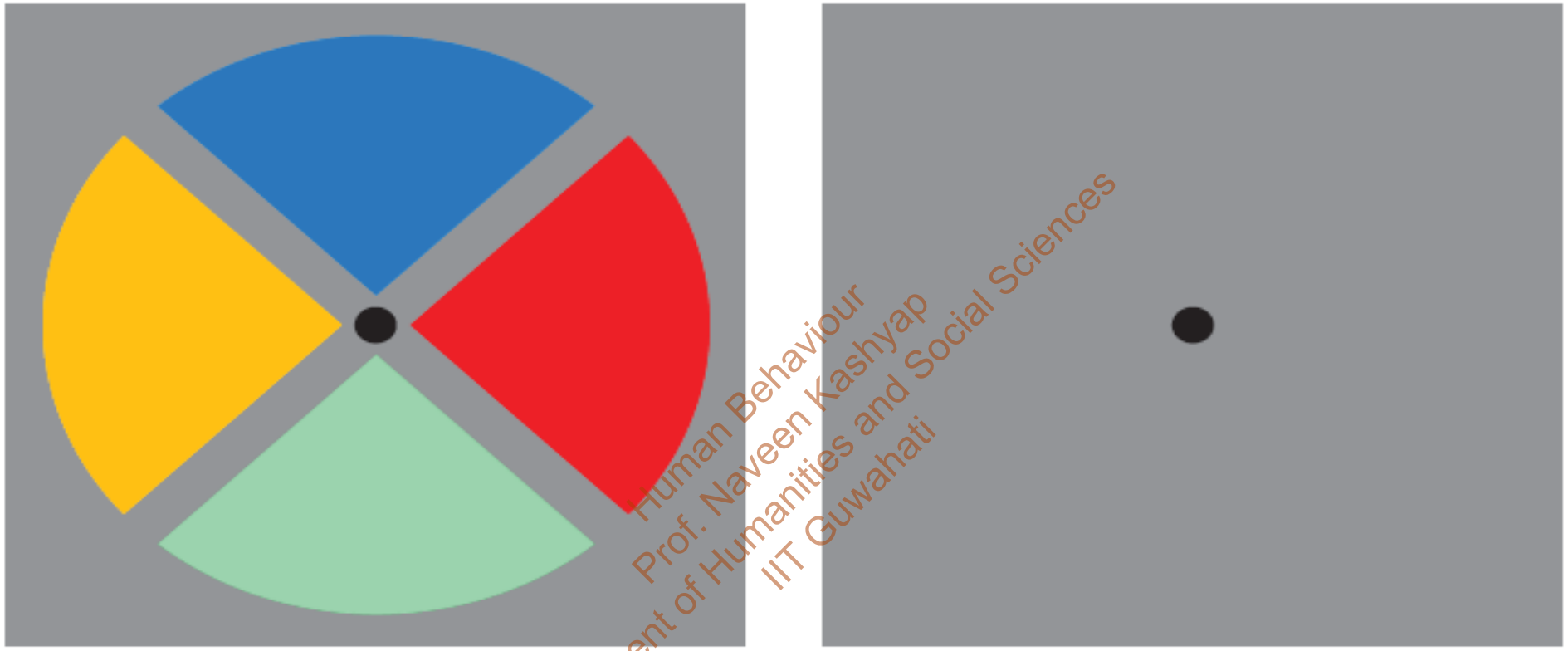


Does this flag look strange to you? Stare at the dot in the center for about 60 seconds in a bright light, and then look at the blank space. You should see a brilliant afterimage of Old Glory, with red and white stripes and a blue field.

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Vision



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- …Seeing color
  - ...Theories of color vision
    - now integrated into two-stage theory