REPUBLIC POLYTECHNIC

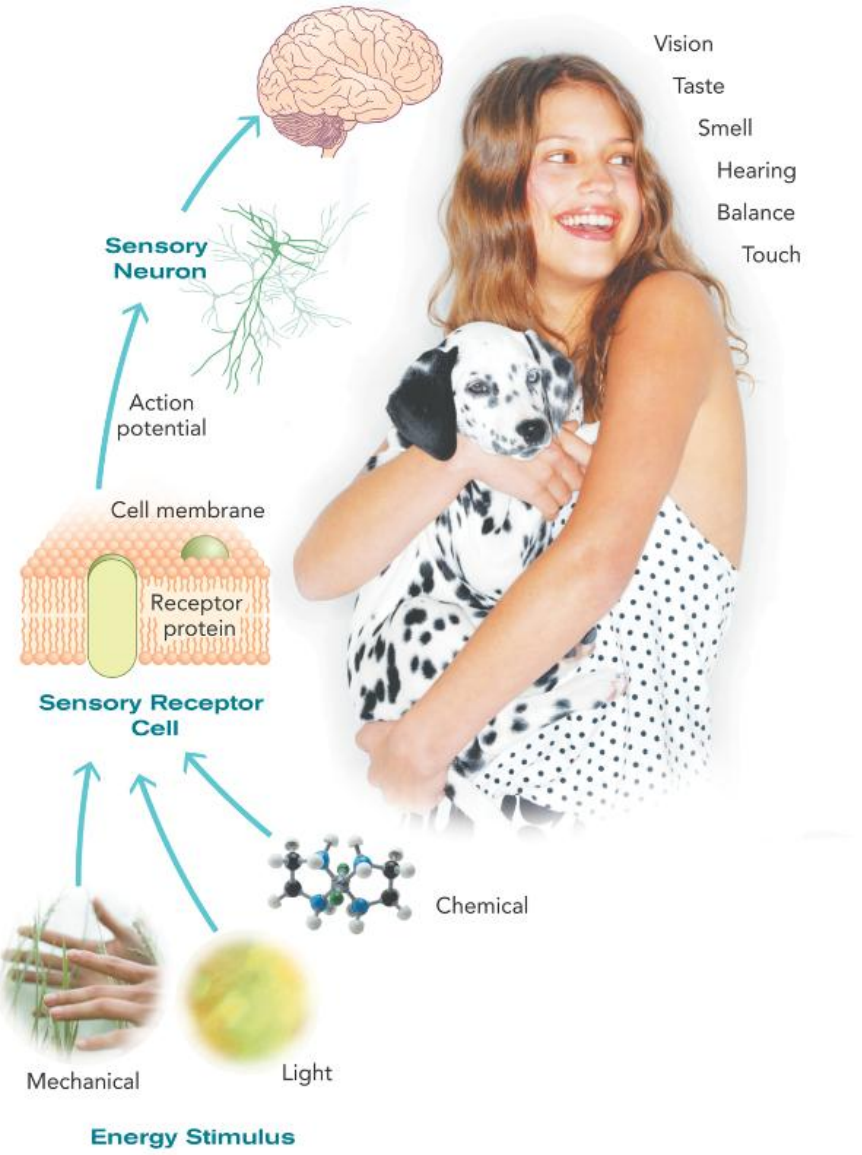
P02
The World In Your Brain

E365 – Aviation Human Factors

SCHOOL OF ENGINEERING

Sensation

- Sensation is the process of receiving stimulus energies from the external environment and transforming those energies into neural energy



Human sensory systems

- Sensory receptors are selective and have different neural pathways.
- They are specialized to absorb a particular type of energy and convert it into an action potential.

Sense	Organ	Stimulus	Receptors
Vision	Eye	Electromagnetic energy	Photoreceptors
Hearing	Ear	Air pressure waves	Mechanoreceptors
Touch	Skin, muscle	Tissue distortion	Mechanoreceptors, thermoreceptors
Balance	Vestibular organs	Gravity, acceleration	Mechanoreceptors
Smell/Taste	Nose / Mouth	Chemical composition	Chemoreceptors

Perception

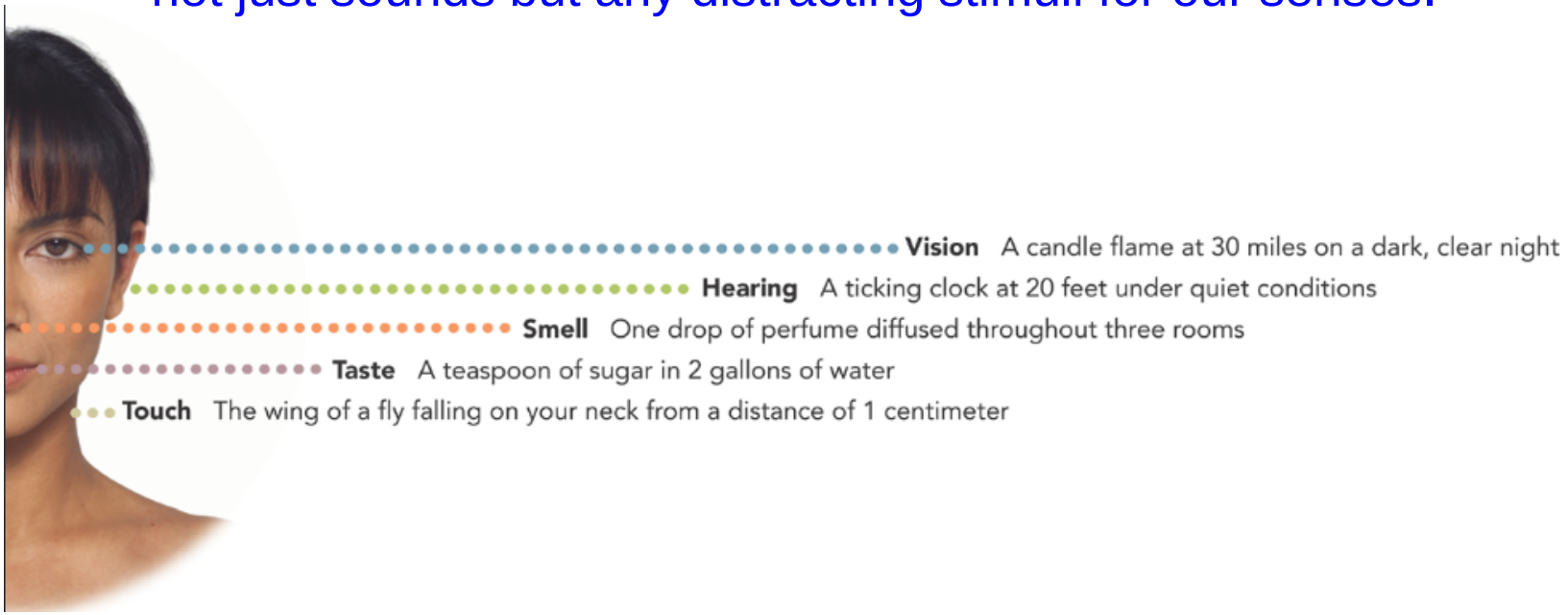
- Perception is the process of organizing and interpreting sensory information so that it has meaning
- A perceptual set is a predisposition or readiness to perceive something in a particular way.
  - Acts as "psychological" filters in processing information about the environment
- Expectations influence perceptions
  - We see what we want to see
  - We hear what we want to hear
- If our perceptions are wrong, then we will have incorrect images of the world around us.
  - All subsequent information processing will be based on incorrect premises.
  - Processes like response selections and executions may then be wrong

Absolute threshold

- There is an absolute threshold, or minimum amount of stimulus energy that a person can detect.
  - When the energy of a stimulus falls below this absolute threshold, we cannot detect its presence.
- Absolute threshold is the point at which the individual detects the stimulus 50 percent of the time.
- Different people have different thresholds.

Absolute threshold

- Under ideal circumstances, our senses have very low absolute thresholds, so we can be remarkably good at detecting small amounts of stimulus energy
- Our environment seldom gives us ideal conditions with which to detect stimuli
  - Noise is the term given to irrelevant and competing stimuli—not just sounds but any distracting stimuli for our senses.



Difference threshold

- Difference threshold is the degree of difference that must exist between two stimuli before the difference is detected
  - Just noticeable difference.
- Difference thresholds increase as a stimulus becomes stronger.
  - At very low levels of stimulation, small changes can be detected, but at very high levels, small changes are less noticeable.
- Weber's Law
  - ratio of the just noticeable difference (*jnd*) of a stimulus to the intensity of this stimulus (*I*) is a constant (*k*). That is,

$$\frac{jnd}{I} = k$$

Signal detection theory

- Signal detection theory focuses on decision making about stimuli under conditions of uncertainty.
- Detection of sensory stimuli depends on
  - physical intensity of the stimulus
  - sensory abilities of the observer.
  - individual and contextual variations such as expectations and the urgency of the moment.
- Allows the consideration of the mistakes a perceiver might make and the reasons behind those errors.

Signal detection theory

- Four possible outcomes:

	Observer's Response	
	"Yes, I see the signal"	*"No, I don't see the signal"*
Signal Present	Hit (correct)	Miss (mistake)
Signal Absent	False alarm (mistake)	Correct rejection (correct)

Sensory adaptation

- Sensory adaptation is a change in the responsiveness of the sensory system based on the average level of surrounding stimulation
- Although sensory adaptation reduces our sensitivity, it enables us to focus on informative changes in our environment without being distracted by the uninformative constant stimulation.
- Our sensory receptors are alert to novelty
  - Bore them with repetition and they free our attention for more important things.
- We perceive the world not exactly as it is, but as it is useful for us to perceive it.
- Adaptation is not immediate but gradual.

Information

- Classification of information
  - Quantitative (value)
  - Qualitative (rate of change, direction of change)
  - Status (on/off, stop-caution-go)
  - Warning and Signals (emergency, unsafe)
  - Representational (pictorial, graphic)
  - Identification (hazards, traffic signs)
  - Alphanumeric and symbolic (signs, instruction)
  - Time-phased (duration controlled signals)
- Transmission to human sensory systems
  - Direct information (observation of actual event)
  - Indirect information (through intervening mechanism or device, e.g., Radar or telescope)
    - Coded (visual or auditory displays)
    - Reproduced (TV, radio, photographs)

Characteristics of coding systems

- Detectability of codes
  - Absolute threshold
- Discriminability of codes
  - Difference threshold
- Meaningfulness of codes
  - how meaningful the codes and symbols are to the people who must use them
- Standardization of codes
  - Allows the same information to be perceived in the same way by different people in different situations
- Use of Multidimensional codes
  - Increases the number and discriminability of coding stimuli used (shapes, color, loudness, pitch, etc.)

Compatibility

- Relationship of stimuli and responses to expectations
- Conceptual compatibility
  - the degree to which codes and symbols correspond to the conceptual associations people have
- Movement compatibility
  - the relationship between the movement of displays and controls and the response of the system being displayed or controlled
- Spatial compatibility
  - the physical arrangement in space of controls and their associated displays
- Modality compatibility
  - certain stimulus-response modality combinations are more compatible with some tasks than with others

Learning Objectives

- Human sensory systems
- Definition and purpose of sensation and perception
- Perceptual set
- Absolute and difference thresholds
- Signal detection theory
- Sensory adaptation
- Classification of information
- Characteristics of coding systems
- Stimuli-responses-expectations compatibility