King Saud University

College of Engineering

IE – 341: "Human Factors Engineering"

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Chapter 3. Information Input and Processing

Part 1: Information Display – Coding

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Chapter Overview

Information Processing and Compatibility

1. Information Display – Coding (Ch. 3)
2. Fitts' Law (Ch. 3, Ch. 9)
3. Hick Hyman Law (Ch. 3)
4. Signal Detection Theory (Ch. 3)
5. Memory - Attention (Ch. 3)
6. Compatibility - Part 1 - Spatial Compatibility (Ch. 10)
7. Compatibility - Part 2 - Movement - Modality Compatibility (Ch. 10, Ch.3)

Lesson Overview

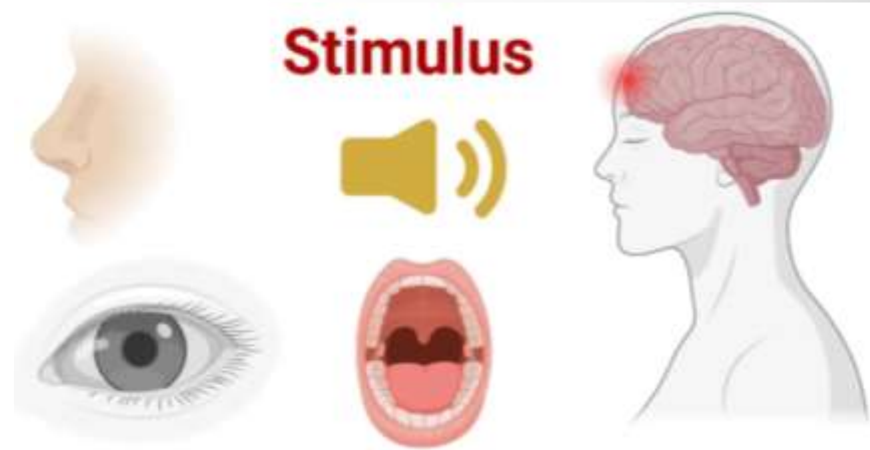
1. Information Display and Coding (Chapter 3)

- Displaying Information
  - Information Presented by Displays
  - Selection of Display Modality

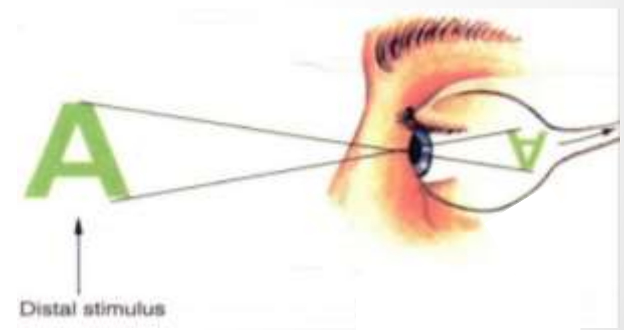
- Coding of Information
  - Coding
  - Characteristics of a Good Coding System
- Compatibility
  - Conceptual Compatibility
  - Movement Compatibility
  - Spatial Compatibility
  - Modality Compatibility

DISPLAYING INFORMATION

- Human information input and processing depends on the sensory reception of relevant **external stimuli** which contain the information



- The original source of information (the **distal stimulus**) is some object, event, or environmental condition



- Information from the distal stimulus may come to us:
  - **directly** (e.g. direct observation of plane), or
  - **indirectly** (e.g. radar or telescope)

Cont. DISPLAYING INFORMATION

- In the case of **indirect sensing**, the new distal stimuli may be
  - **coded stimuli** (e.g. visual or auditory displays), or:
  - **reproduced stimuli** (e.g. TV, radio, hearing aids)
  - In both cases the coded or reproduced stimuli become the *actual* distal stimuli to the human sensory receptors

- Human factors are required when *indirect* sensing applies

- **Display** is a term that applies to any indirect method of presenting information (e.g. highway traffic sign, radio)

INFORMATION PRESENTED BY DISPLAYS (General)

- Information presented by displays can be **dynamic** or **static**.

- **Dynamic information:**
    - changes continuously or is subject to change through time
    - e.g.: traffic lights, radar displays, temperature gauges

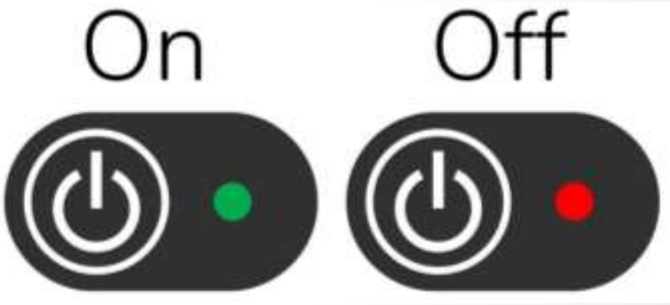
- **Static information:**
    - remains fixed over time
    - e.g.: alphanumeric data, traffic signs, charts, graphs, labels
    - Note that static information presented through **VDT**’s (video display terminals) is considered static information.

INFORMATION PRESENTED BY DISPLAYS (Detailed)

- **Quantitative**: such as temperature or speed

- **Qualitative**: represents approximate value, trend or rate of change

- **Status**: reflects the condition of a system
  - e.g.: on or off, traffic lights



- **Warning and signal**: indicating danger or emergency

INFORMATION PRESENTED BY DISPLAYS (Detailed)

- **Representational**: pictorial or graphical representation of objects, areas, or other configurations
  - e.g. photographs, maps, heartbeat oscilloscope

- **Identification**: used to identify a condition, situation or object
  - e.g. traffic lanes, colored pipes

- **Alphanumeric* and symbolic**:
  - e.g. signs, labels, printed material, computer printouts

- **Time-phased**:
  - display of pulsed or time-phased signals
  - the duration and inter-signal intervals are controlled

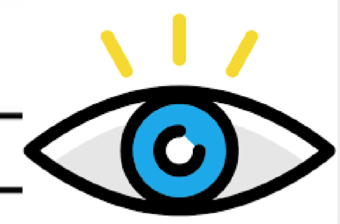
SELECTION OF DISPLAY MODALITY

- Visual or auditory displays? Tactual sense?
  The selection of the **sensory modality** depends on a number of considerations
- Table 3.1 helps in making a decision regarding visual or auditory presentation of information*

TABLE 3-1
WHEN TO USE THE AUDITORY OR VISUAL FORM OF PRESENTATION

Use auditory presentation if:	Use visual presentation if:
1 The message is simple.	1 The message is complex.
2 The message is short.	2 The message is long.
3 The message will not be referred to later.	3 The message will be referred to later.
4 The message deals with events in time.	4 The message deals with location in space.
S The message calls for immediate action.	S The message does not call for immediate action.
6 The visual system of the person is overburdened.	6 The auditory system of the person is overburdened.
7 The receiving location is too bright or dark-adaptation integrity is necessary.	7 The receiving location is too noisy.
8 The person's job requires moving about continually.	8 The person's job allows him or her to remain in one position.

Source: Deatherage, 1972, p. 124, Table 4-1.



CODING OF INFORMATION

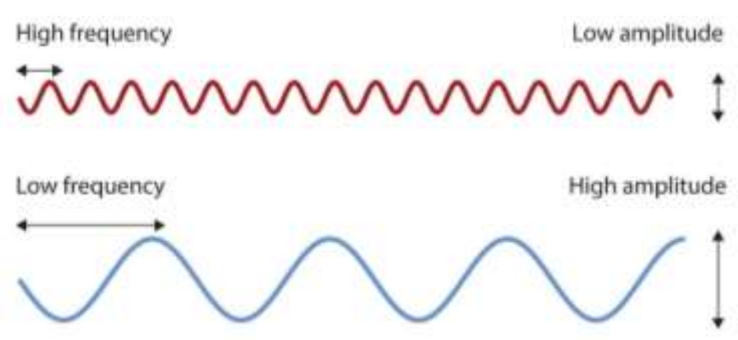
- **Coding** takes place when the original stimulus information is converted to a new form and displayed symbolically

- Examples are:
  - o radar screens where the aircrafts are converted and presented as dots on the screen
  - o maps displaying populations of different cities with different symbols.

CODING OF INFORMATION (Cont.)

- Information is coded along various dimensions

- Examples:
    - varying the size, brightness, color and shape of targets on a computer screen
    - varying the frequency, intensity, or on-off pattern of an audio warning signal



- Each of the above variations constitutes a dimension of the displayed stimulus, or a **stimulus dimension**

CODING OF INFORMATION (Cont.)

- The usefulness of any stimulus dimension in conveying information depends on the ability of people to:
  - identify a stimulus based on its position along the stimulus dimension (such as identifying a target as bright or dim, large or small)
    - This is an example of **absolute judgment**

  - distinguish between two or more stimuli which differ along the stimulus dimension (such as indicating which of the two stimuli is brighter or larger)
    - This is an example of **relative judgment**
    - Note, people are generally able to make fewer discriminations on an absolute basis than on a relative basis

CHARACTERISTICS OF A GOOD CODING SYSTEM

- **Detectability** of codes:
  - o stimulus must be detectable by human sensory mechanisms under expected environmental conditions
  - o e.g. is worker able to see the control knob in mine?

- **Discriminability** of codes:
  - o every code symbol must be discriminable (differentiable) from other symbols
  - o the number of coding levels is important

- **Meaningfulness** of codes:
  - o coding system should use codes meaningful to user
  - o Meaning could be
    - **inherent** in the code (e.g. bent arrow on traffic sign)
    - or **learned** (e.g. red color for danger)
  - o Meaningfulness: related to conceptual compatibility

CHARACTERISTICS OF A GOOD CODING SYSTEM (cont.)

- **Standardization** of codes:
    - when a coding system is to be used by different people in different situations, it is important that the codes be standardised, and kept the same for different situations
    - e.g. meaning of the red color in different parts of a factory

- Use of **multidimensional codes:**
    - this can increase the number and discriminability of coding stimuli used
    - e.g. using different size-color combinations greatly increases the number of stimuli that can be identified on an absolute basis*



COMPATIBILITY

- It is the relationship between the stimuli and the responses to human expectations

- A major goal in any design is to make it compatible with human expectations

- It is related to the process of **information transformation**
  - the *greater* the degree of compatibility, the *less* recording must be done to process information
  - this leads to faster learning and response time, less errors, and reduced mental workload
  - people like things that work as they expect them to work

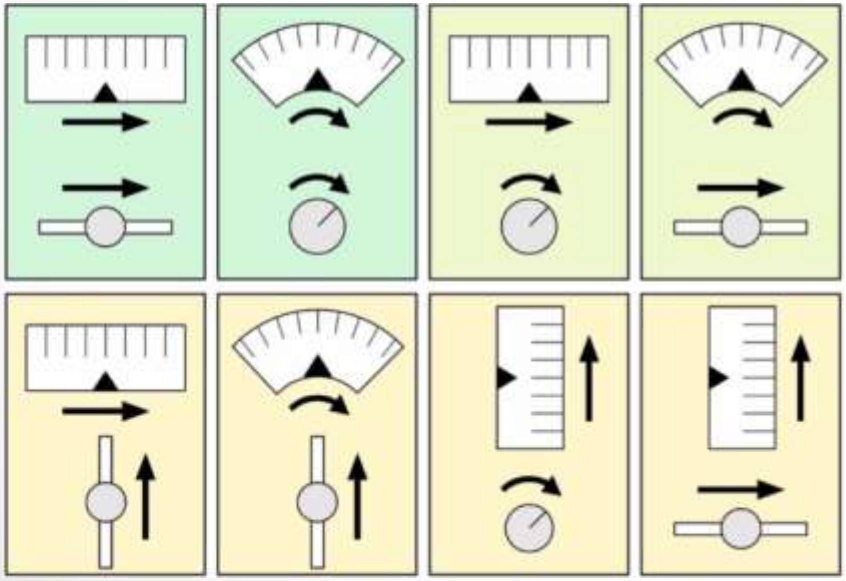
COMPATIBILITY (Cont.)

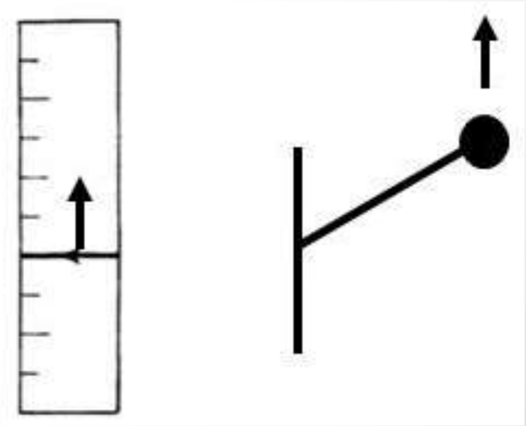
- Four types of compatibility:
  - **Conceptual**
  - **Movement**
  - **Spatial**
  - **Modality**

- **1. Conceptual compatibility:**
  - related to degree that codes, symbols correspond to conceptual associations people have
  - it relates to how meaningful codes and symbols are to people who use them
  - e.g.: airplane symbol to denote an airport on a map means much more than a square or circle
  - e.g.: creating meaningful abbreviations and names for computer applications

COMPATIBILITY (Cont.)

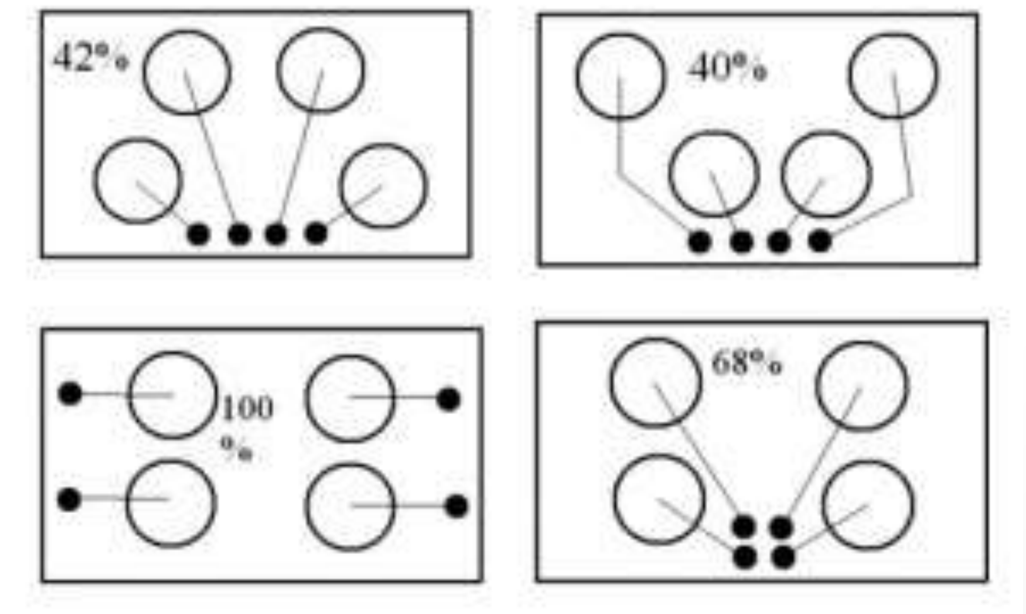
- **2. Movement compatibility**:
  - relates to the relationship between the movement of the displays and controls and the response of the system being displayed or controlled.
  - e.g.: to increase the volume on the radio, we expect to turn the knob clockwise.
  - e.g.: upward movement of a pointer is expected to correspond to an increase in a parameter





COMPATIBILITY (Cont.)

- **3. Spatial Compatibility**
  - Refers to the physical arrangement in space of controls and their associated displays
  - e.g. how displays are lined-up with respect to corresponding control knobs*



COMPATIBILITY (Cont.)

- **4. Modality compatibility**:
  - refers to the fact that certain stimuli-response modality combinations are more compatible with some tasks than with others
  - this is simply related to the how our brains are "wired"
  - e.g.: responding to a *verbal command* that needs *verbal action* is faster than responding to a *written or displayed command* requiring the *same verbal action** (another e.g. is shown below)

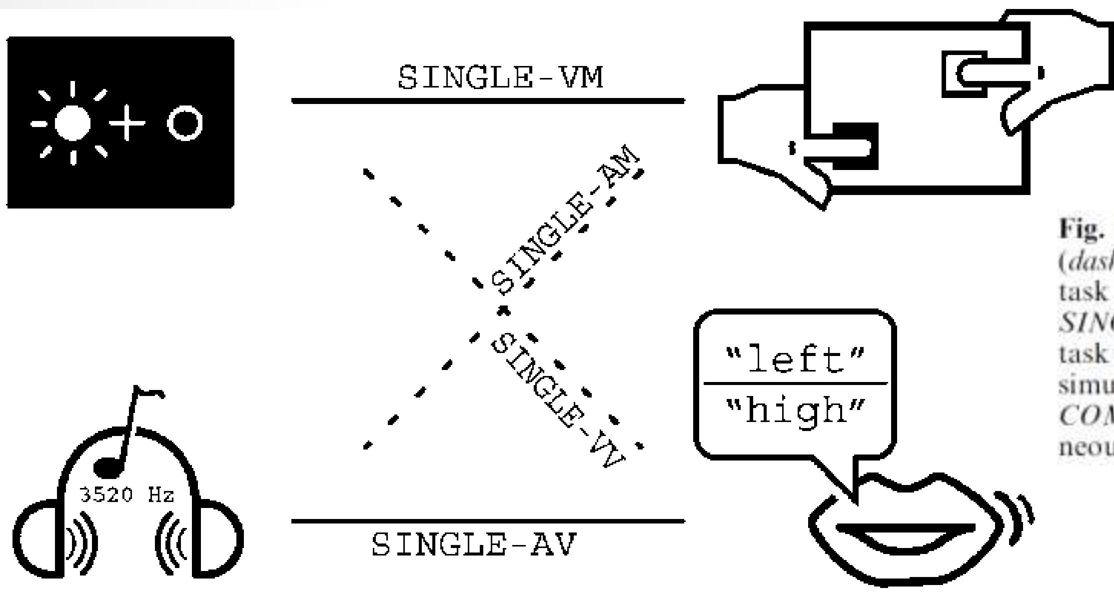


Fig. 1 Modality compatible (*solid lines*) and modality incompatible (*dashed lines*) stimulus–response pairs. *SINGLE-VM* single task visual–manual; *SINGLE-AV* single task auditory–vocal; *SINGLE-AM* single task auditory-manual; *SINGLE-VV* single task visual–vocal. SINGLE-VM and SINGLE-AV were performed simultaneously in the modality compatible dual task (*DUAL-COMP*), SINGLE-AM and SINGLE-VV were performed simultaneously in the modality incompatible dual task (*DUAL-INCOMP*)

References

- ***Human Factors in Engineering and Design***. Mark S. Sanders, Ernest J. McCormick. 7th Ed. McGraw: New York, 1993. ISBN: 0-07-112826-3.
- ***The neural effect of stimulus-response modality compatibility on dual-task performance: an fMRI study***. C Stelzel, et al, Psychological Research, 2006.