

2110443 Human Computer Interaction Chate Patanothai



Human Variance (1)



Stature (Item 34) in inches

	1st	5th	50th	95th	99th
Men	63.1	64.8	69.1	73.5	75.2
women	58.4	60.2	64.1	68.4	70.1

Functiona	al Rea	<u>ch (It</u>	em 43) in inc	:hes	
	1st	5th	50th	95th	99th	
Men	28.4	29.1	31.5	34.1	35.3	
women	25.9	26.7	28.9	31.4	32.4	



Data from FAA Human Factors Design Guide



Human Variance (2)





Data from Department of Justice ADA Title III, Regulation 28 CFR Part 36



Human Variance (3)





Human Activity Cycle (1)



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Human Activity Cycle (2)



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Human Factors Model



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ประสาทสัมผัส



Human Cognitive Component

- >Attention (ความตั้งใจ)
- >Memory (ความทรงจำ)
- Information Processing (การประมวลผลข้อมูล)
- >Decision Making (การตัดสินใจ)
- >Action Initiation (การเริ่มต้นการกระทำ)

Human Musculoskeletal Component

>Motor Co-ordination (การเคลื่อนใหว)

>Action Performance (ประสิทธิภาพ)

>Object Manipulation (การจัดการกับวัตถ่)



Brain



http://www.hf.faa.gov/webtraining/Cognition/cognition_images/faces_houses.gif

Human Information Processing



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Human versus Machine

> ประสาทสัมผัส >ความสามารถในการรับรู้ stimulus generalization abstract concepts <u>ความยึดหยุ่น</u> การตัดสินใจ ความทรงจำ การให้เหตุผลแบบ induction

- > Alertness
- > speed and power
- sensor detection outside human
 - range
- routine work
- computation
- > short-term memory storage
- simultaneous activities



Human Information Processing (more detailed)



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PERCEPTION



Visible Spectrum



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Visual perception

การมองเห็นมี 2 ระยะ

- สายตารับรู้ต่อสิ่งกระตุ้น

 บางอย่างที่มองไม่เห็น
- ประมวลผลและแปล
 - 🔶 สร้างภาพจากข้อมูลที่ไม่สมบูรณ์ได้



The Eye - physical reception



The Eye - physical reception

- > รับแสงแล้วแปลงเป็นพลังงานไฟฟ้า
- > แสงสะท้อนจากวัตถ่
- >> ได้รูปกลับหัวที่จอตา (retina)
 - rods for low light vision and
 - cones for color vision, photoreceptors for RGB



Upside down image





Interpreting the signal

Size and depth

- visual angle indicates how much of view object OCCUPIES (relates to size and distance from eye)
- visual acuity is ability to perceive detail (limited)
- familiar objects perceived as constant size (law of size constancy)

(in spite of changes in visual angle when far away)

 cues like overlapping help perception of size and depth

Interpreting the signal (cont)

>Brightness

- subjective reaction to levels of light
- contrast a function of the luminance of an object and the luminance of its background

>Color

- made up of hue, intensity, saturation
 lightness light vs. dark
 - hue light's spectral wavelength; B -> G -> R
 - saturation amount of whiteness in the color



Color

<u>C</u> olors:			Cancel	Colors	:		
		⊲			÷		4
Color mo <u>d</u> el: <u>R</u> ed: <u>G</u> reen: <u>B</u> lue:	RGB		New	Color H <u>u</u> e: <u>S</u> at: Lum:	mo <u>d</u> el: HSL 108 - 123 - 119 -	•	

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Color perception

> Color

- cones sensitive to color wavelengths
- 8% males and 1% females color blind (red and green)
- red photopigments ~64%
- → green ~32%
- ✤ blue ~4%





Color Receptors - RODS

- >Rods provide "scotopic" or low intensity vision.
 - Provide our night vision ability for very low illumination,
 - Are a thousand times more sensitive to light than cones,
 - Are much slower to respond to light than cones,
 - Are distributed primarily in the periphery of the visual field.



Color Receptors - CONES

Cones - provide "photopic" or high acuity vision.

- Provide our day vision,
- Produce high resolution images,
- Determine overall brightness or darkness of images,
- Provide our color vision, by means of three types of cones:
 - "L" or red, long wavelength sensitive,
 - **•**"**M**" or green, medium wavelength sensitive,
 - **•**"S" or blue, short wavelength sensitive.



Color blind test





Cones





Cone response



Interpreting the signal (cont)

> The visual system compensates for:

- movement
- changes in luminance.

Context is used to resolve ambiguity

Optical illusions sometimes occur due to over compensation



Color Illusion







Optical Illusions



the Ponzo illusion



the Muller Lyer illusion



Optical Illusions









Wheel





Girl Spinning (clockwise?)



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Impossible Door



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Optical Illusions Is this text correct? The quick brown

fox jumps over the the lazy dog.



- Several stages:
 - visual pattern perceived
 - decoded using internal representation of language
 - interpreted using knowledge of syntax, semantics, pragmatics

eye movement

- Reading involves saccades and fixations
- Perception occurs during fixations
- > Word shape is important to recognition
- Negative contrast improves reading from computer screen



 Positive contrast
The speed at which text can be read is a measure of its legibility (easy to read)

 Negative contrast
The speed at which text can be read is a measure of its legibility (easy to read)



The pure red primary should never be used on a pure blue primary background

This generates chromostereopsis or depth through color perception. It also creates reading difficulties. The pure blue primary should never be used on a pure red primary background

This generates chromostereopsis or depth through color perception. It also creates reading difficulties.



Most individuals perceive the red text as being closer than the blue. Others perceive the blue text to be closer than the red. A few individuals perceive no difference



Can you read this?

"Aoccdrnig to rscheearch at Cmabridge Uinvervtisy, it deosn't mttaer in waht oredr the litteers in a wrod are, the olny iprmoetnt tihng is taht the frist and Isat Itteer be at the rghit pclae. The rset can be a ttoal mses and you can sitll raed it wouthit a porbelm. Tihs is besauae ocne we laren how to raed we bgien to aargnre the Iteerts in our mnid to see waht we epxcet to see. The huamn mnid deos not raed ervey Iteter by istlef, but preecsievs the wrod as a wlohe. We do tihs ucnsoniuscoly wuithot tuhoght."



Can you read this?

"AOCCDRNIG TO RSCHEEARCH AT CMABRIDGE UINVERVTISY, IT DEOSN'T MTTAER IN WAHT OREDR THE LITTEERS IN A WROD ARE, THE OLNY IPRMOETNT TIHNG IS TAHT THE FRIST AND LSAT LTTEER BE AT THE RGHIT PCLAE. THE RSET CAN BE A TTOAL MSES AND YOU CAN SITLL RAED IT WOUTHIT A PORBELM. TIHS IS BESAUAE OCNE WE LAREN HOW TO RAED WE BGIEN TO AARGNRE THE LTEERTS IN OUR MNID TO SEE WAHT WE EPXCET TO SEE. THE HUAMN MNID DEOS NOT RAED ERVEY LTETER BY ISTLEF, BUT PREECSIEVS THE WROD AS A WLOHE. WE DO TIHS UCNSONIUSCOLY WUITHOT TUHOGHT."



Different Perspective



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- Provides information about environment: distances, directions, objects et
- > Physical apparatus:
 - 🔸 outer ear
 - middle ear
- protects inner and amplities sound

Ear Flat

- transmits sound waves as vibrations to inner ear
- 🔸 inner ear
- chemical transmitters are released and cause impulses in auditory

- Sound
 - hertz
 - pitch
 - Ioudness
 - timbre

- unit of frequency
- sound frequency
- amplitude
- type or quality



Outer

Ear

Ear Canal

Hammer

Eardrum

Middle

Ear

Anvil

Inner

Ear

Eustachian Tube Auditory

Cochlea



Hearing (cont)

- >Humans can hear frequencies from 20Hz to 15kHz
 - less accurate distinguishing high frequencies than low.

> Auditory system filters sounds

- can attend to sounds over background noise.
- for example, the cocktail party phenomenon.



Hearing (cont)

Transduction

translation of sound vibration into neural impulses by the ear.

>Auditory grouping processes

sound elements are

segregate into separated streams

integrated into sound in coherent streams

Scene analysis

extraction of perceptual properties

Interpretation





Suggest different ways in which information belonging to a typical desktop could be displayed using sound.



Touch

- > Provides important feedback about environment.
- May be key sense for someone who is visually impaired.

> Stimulus received via receptors in the skin:

- thermoreceptors heat and cold
- nociceptors pain
- mechanoreceptors pressure (some instant, some continuous)

Some areas more sensitive than others e.g. fingers.

- Kinethesis awareness of body position
 - affects comfort and performance.



Multi-store Memory



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Memory Components



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Memory Component





sensory memory





Short-term memory (STM)

>Working memory Scratch-pad for temporary recall rapid access ~ 70 ms rapid decay ~ 30 sec Imited capacity - 7± 2 chunks



Examples

212348278493202

0121 414 2626

HEC ATR ANU PTH ETR EET



remember the shapes





remember the shapes











Memory Aids

Acronyms
first letter of every word: SOTUS
Acrostics/Sentences
first letter -> create new words

>Rhymes/Songs

🕈 กรุงเทพมหานคร...



Long-term memory (LTM)

> Repository for all our knowledge

- slow access ~ 1/10 second
- slow decay, if any
- huge or unlimited capacity



LTM Types

Declarative

 structured memory of facts, concepts, skills, information related to meaning

Episodic/autobiographical

- serial memory of events
- Procedure

stores our knowledge of how to do thing



LTM Types



http://www.hf.faa.gov/webtraining/Cognition/cognition_images/simple_LTM.gif

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LTM Types



http://projects.coe.uga.edu/epltt/images/8/8f/Information_2.jpg

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LTM - Storage of information

> rehearsal

information moves from STM to LTM

> total time hypothesis

amount retained proportional to rehearsal time

> distribution of practice effect

optimized by spreading learning over time

LTM – Retrieval

Recognition

- search memory and then decide whether the piece of information matches what you have in your memory store
- multiple choices

>Recall

 recognized and then specific, associated information found and retrieved from longterm memory.

Recall is more like a fill-in-the-blank test

LTM - Forgetting

>accessibility

whether or not we are able to retrieve information which has been stored in the memory

>availability

whether or not it was stored in memory

LTM - Forgetting

encoding failure

insufficient of time, lack of rehearsal

interference

- retroactive interference: new information replaces old
- proactive interference: old may interfere with new

retrieval failure

- trace decay: not access for long time
- Iost linkage: The memory is still in storage, but retrieval cues or links to find it have been lost

Multi-store memory

Movement

- Time taken to respond to stimulus: reaction time + movement time
- Movement time dependent on age, fitness etc.
- Reaction time dependent on stimulus type:

 - → auditory ~ 150 ms
 - ~ 700ms 🔶 pain

Increasing reaction time decreases accuracy in the unskilled operator but not in the skilled operator.

Movement (cont)

Fitts' Law describes the time taken to hit a screen target:

$$T = a + b \log_2 \left(\frac{D}{W} + 1\right)$$

where:

a and b are empirically determined constants T is movement time D is Distance $ID = \log_2\left(\frac{D}{W} + 1\right)$ W is the Width of target

 \Rightarrow targets as large as possible distances as small as possible

Reasoning deduction, induction, abduction Problem solving


Thinking



Problem solving



Deductive Reasoning

> Deduction:

- derives b as a consequence of a.
- the process of deriving the consequences of what is assumed.
- derives logically necessary conclusion from given premises.
 - e.g. If it is Friday then she will go to work It is Friday Therefore she will go to work.

> Logical conclusion not necessarily true:

e.g. If it is raining then the ground is dry It is raining Therefore the ground is dry



Deduction (cont.)

When truth and logical validity clash ... e.g. Some people are babies Some babies cry Inference - Some people cry Correct?

People bring world knowledge to support reasoning process



Inductive Reasoning

Induction:

generalize from cases seen to cases unseen

e.g. all elephants we have seen have trunks therefore all elephants have trunks.

> Unreliable:

can only prove false not true

Humans not good at using negative evidence e.g. Wason's cards



Wason's cards

The cards have a letter on one side and a number on the other side.



If a card has a vowel on one side it has an even number on the other.

Is this true?

How many cards do you need to turn over to find out?

.... and which cards?



Abductive reasoning

uses deductive + inductive
 reasoning from event to cause

 e.g. Sam drives fast when drunk.
 If I see Sam driving fast, assume drunk.

Unreliable:
can lead to false explanations



Problem solving

Process of finding solution to unfamiliar task using knowledge.



> Gestalt

- problem solving both productive and reproductive
- productive draws on insight and restructuring of problem
- reproductive uses previous experience and what is already known



Gestalt laws of perception

- Proximity
- Continuity
- Closure
- Similarity
- >Pragnanz









Continuity





Law of Continuity:

Lines are seen as following the smoothest path.

In the image above, the top branch is seen as continuing the first segment of the line. This allows us to see things as flowing smoothly without breaking lines up into multiple parts.



Closure



Law of Closure:

Objects grouped together are seen as a whole.

We tend to ignore gaps and complete contour lines. In the image above, there are no triangles or circles, but our minds fill in the missing information to create familiar shapes and images.





Similarity



Law of Similarity:

Items that are similar tend to be grouped together.

In the image above, most people see vertical columns of circles and squares.



Pragnanz (figure-ground)



Law of Pragnanz:

Reality is organized or reduced to the simplest form possible.

For example, we see the image above as a series of circles rather than as many much more complicated shapes.



🧟 Computer Engineering - Engineering - Chulalongkorn University





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Pre-attentive features



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Interference Effects

conjunction search



pre-attentive processing







Other interference effects

GREEN BLUE RED PURPLE YELLOW RED YELLOW BLACK PINK WHITE BLUE GREEN YELLOW BLACK FUSCHIA PINK GREEN YELLOW BLACK RED GREEN RED WHITE PURPLE GREEN RED BLUE BROWN RED





Problem solving (cont.)

>Root cause analysis (RCA)

aims at identifying the root causes of problems or events.



Problem solving (cont.)

> Analogy

- analogical mapping:
 - novel problems in new domain?
 - use knowledge of similar problem from similar domain
- analogical mapping difficult if domains are semantically different

Skill acquisition

- skilled activity characterized by chunking
 - Iot of information is chunked to optimize STM
- conceptual rather than superficial grouping of problems
- information is structured more effectively

Errors and mental models

Types of error

> slips

- right intention, but failed to do it right
- causes: poor physical skill, inattention etc.
- change to aspect of skilled behaviour can cause slip

> mistakes

- wrong intention
- cause: incorrect understanding



Emotion (cont.)

- The biological response to physical stimuli is called affect
- > Affect influences how we respond to situations

 - \bullet negative \rightarrow narrow thinking

"Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks"

(Donald Norman)



Individual differences

Iong term sex, physical and intellectual abilities >short term effect of stress or fatigue > changing 🔶 age Ask yourself: will design decision exclude section of user

population?



Factors affecting perception

Perceptual set – our expectations of a situation





Model of Thought





Neural Representation

NEURAL REPRESENTATION OF REALITY



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References

>FAA Human Factors websites

http://www.hf.faa.gov/Webtraining/Intro/Intro1.htm