



# Cognition

9/11/18

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# Overview

- What is cognition?
- What are users good and bad at?
- Describe how cognition has been applied to HCI
- Explain what are Mental Models
- Cover relevant theories of cognition

# Why does cognition matter?

- Interacting with technology is cognitive
- Need to take into account cognitive processes involved and cognitive limitations of users
- Provides knowledge about what users can and cannot be expected to do
- Identifies and explains the nature and causes of problems users encounter
- Supply theories, modelling tools, guidance and methods that can lead to the design of better interactive products

# Cognitive processes

- Attention
- Perception
- Memory

# What is attention?

Attention is a cognitive process

- Concentrating on thinking about a specific thought or object
- Allows us to gather and process information
- Focus on what is important and avoid unnecessary noise
- More attention= increased mental effort

2 kinds of attention:

- Selective: ability to focus on specific information sources and ignore others
- Divided: ability to focus on multiple information sources at once, allows for doing more than one thing at once

# Modes of Attention

- Selective
- Divided
- Think of this as 1 vs Many

# Selective Attention

- Focusing on a specific task, object, thing and drowning out irrelevant environmental factors
- Consciously focusing our attention on something
- Example: Cocktail Party Effect
- Selective Attention can be impacted by
  - Visual
  - Auditory
  - Example: Reading a book
    - Visual disruption- lighting is sporadic
    - Auditory disruption- music is playing
- Multiple studies conducted to understand influence of visual and auditory cues on selective attention



# Too much selective attention?

- If we focus too much on a specific aspect of the environment, our attention on other aspects can be compromised
- <https://www.youtube.com/watch?v=vJG698U2Mvo>



# Divided Attention

- Must concentrate or focus on multiple information sources at once
- Often more difficult for people than selected attention
  - Less accurate perception
  - Slower response times
  - High threshold for detection and identification
  - Why?



# Divided Attention & Performance

- Performance depends on the task
  - Maintain attention of one target= good
  - 2 or more targets= incremental decrease in performance
- Divided attention generally decreases performance

# How is attention linked to awareness?

- Attention is one of the main cognitive processes that allows for awareness of a “thing” to be developed.
- Attention+Attention+Attention= Situational Awareness

## Activity: Find the price of a double room at the Holiday Inn in Columbia

Pennsylvania  
Bedford Motel/Hotel: Crinaline Courts  
(814) 623-9511 S: \$118 D: \$120  
Bedford Motel/Hotel: Holiday Inn  
(814) 623-9006 S: \$129 D: \$136  
Bedford Motel/Hotel: Midway  
(814) 623-8107 S: \$121 D: \$126  
Bedford Motel/Hotel: Penn Manor  
(814) 623-8177 S: \$119 D: \$125  
Bedford Motel/Hotel: Quality Inn  
(814) 623-5189 S: \$123 D: \$128  
Bedford Motel/Hotel: Terrace  
(814) 623-5111 S: \$122 D: \$124  
Bradley Motel/Hotel: De Soto  
(814) 362-3567 S: \$120 D: \$124  
Bradley Motel/Hotel: Holiday House  
(814) 362-4511 S: \$122 D: \$125  
Bradley Motel/Hotel: Holiday Inn  
(814) 362-4501 S: \$132 D: \$140  
Breezewood Motel/Hotel: Best Western Plaza  
(814) 735-4352 S: \$120 D: \$127  
Breezewood Motel/Hotel: Motel 70  
(814) 735-4385 S: \$116 D: \$118

# Activity: Find the price for a double room at the Quality Inn in Pennsylvania

South Carolina						
City	Motel/Hotel	Area code	Phone	Rates		
				Single	Double	
Charleston	Best Western	803	747-0961	\$126	\$130	
Charleston	Days Inn	803	881-1000	\$118	\$124	
Charleston	Holiday Inn N	803	744-1621	\$136	\$146	
Charleston	Holiday Inn SW	803	556-7100	\$133	\$147	
Charleston	Howard Johnsons	803	524-4148	\$131	\$136	
Charleston	Ramada Inn	803	774-8281	\$133	\$140	
Charleston	Sheraton Inn	803	744-2401	\$134	\$142	
Columbia	Best Western	803	796-9400	\$129	\$134	
Columbia	Carolina Inn	803	799-8200	\$142	\$148	
Columbia	Days Inn	803	736-0000	\$123	\$127	
Columbia	Holiday Inn NW	803	794-9440	\$132	\$139	
Columbia	Howard Johnsons	803	772-7200	\$125	\$127	
Columbia	Quality Inn	803	772-0270	\$134	\$141	
Columbia	Ramada Inn	803	796-2700	\$136	\$144	
Columbia	Vagabond Inn	803	796-6240	\$127	\$130	

# Activity

Tullis (1987) found that the two screens produced quite different results

- 1st screen - took an average of 5.5 seconds to search
- 2nd screen - took 3.2 seconds to search

Why, since both displays have the same density of information (31%)?

## Spacing

- In the 1st screen the information is bunched up together, making it hard to search
- In the 2nd screen the characters are grouped into vertical categories of information making it easier

# Design implications for attention

Make information salient when it needs attending to

Use techniques that make things stand out like color, ordering, spacing, underlining, sequencing and animation

Avoid cluttering the interface with too much information

Search engines and form fill-ins that have simple and clean interfaces are easier to use

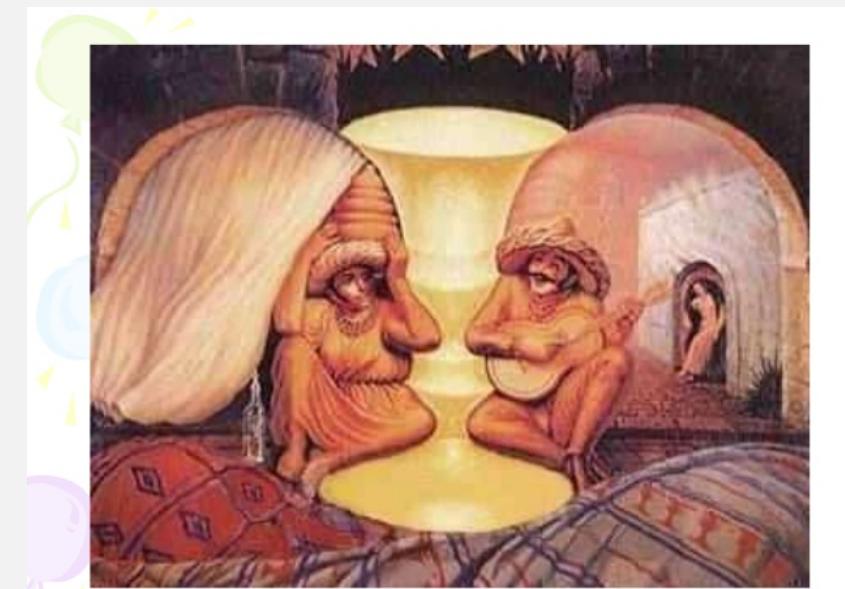
# A specific area that can cause human error...Perception

How we perceive objects is dependent on automatic neural signals

- Input
  - Information
- Processing
  - Making sense of information (neural signals)
- Output
  - Action- decision or interpretation

Things we perceive:

- Shapes
- Size
- Color
- Depth
- Dimension



# Why do we care about perception?

Directly effects how people complete work and interact with the world

- Driving
- Flying
- Running/Walking
- Making decisions

Must consider how people perceive their environment and information when considering how to design environments or technologies to support work

- Control Panels
- User Interfaces
- Workspaces

If we fail to consider how people perceive information- failure and harm may occur

# Is color contrast good? Find Italian

Black Hills Forest	Peters Landing	Jefferson Farms	Devlin Hall
Cheyenne River	Public Health	Psychophysics	Positions
Social Science	San Bernardino	Political Science	Hubard Hall
South San Jose	Moreno Valley	Game Schedule	Fernadino Beach
Badlands Park	Altamonte Springs	South Addison	Council Bluffs
Juvenile Justice	Peach Tree City	Cherry Hills Village	Classical Lit
Results and Stats	Highland Park	Creative Writing	Sociology
Thousand Oaks	Manchesney Park	Lake Havasu City	Greek
Promotions	Vallecito Mts.	Engineering Bldg	Wallace Hall
North Palermo	Rock Falls	Sports Studies	Concert Tickets
Credit Union	Freeport	Lakewood Village	Public Radio FM
Wilner Hall	Slaughter Beach	Rock Island	Children's Museum
Performing Arts	Rocky Mountains	Deerfield Beach	Writing Center
Italian	Latin	Arlington Hill	Theater Auditions
Coaches	Pleasant Hills	Preview Game	Delaware City
McKees Rocks	Observatory	Richland Hills	Scholarships
Glenwood Springs	Public Affairs	Experts Guide	Hendricksville
Urban Affairs	Heskett Center	Neff Hall	Knights Landing
McLeansboro	Brunswick	Grand Wash Cliffs	Modern Literature
Experimental Links	East Millinocket	Indian Well Valley	Studio Arts
Graduation	Women's Studies	Online Courses	Hughes Complex
Emory Lindquist	Vacant	Lindquist Hall	Cumberland Flats
Clinton Hall	News Theatre	Fisk Hall	Central Village
San Luis Obispo	Candlewood Isle	Los Padres Forest	Hoffman Estates

# Are borders and white space better? Find french

Webmaster  
Russian  
Athletics  
Go Shockers  
Degree Options  
Newsletter

Curriculum  
Emergency (EMS)  
Statistics  
Award Documents  
Language Center  
Future Shockers

Student Life  
Accountancy  
McKnight Center  
Council of Women  
Commute  
Small Business

Dance  
Gerontology  
Marketing  
College Bylaws  
Why Wichita?  
Tickets

Geology  
Manufacturing  
Management  
UCATS  
Alumni News  
Saso

Intercollegiate  
Bowling  
Wichita Gateway  
Transfer Day  
Job Openings  
Live Radio

Thinker & Movers  
Alumni  
Foundations  
Corbin Center  
Jardine Hall  
Hugo Wall School

Career Services  
Doers & Shockers  
Core Values  
Grace Wilkie Hall  
Strategic Plan  
Medical Tech

Educational Map  
Physical Plant  
Graphic Design  
Non Credit Class  
Media Relations  
Advertising

Beta Alpha Psi  
Liberal Arts  
Counseling  
Biological Science  
Duerksen Fine Art  
EMT Program

Staff  
Aerospace  
Choral Dept.  
Alberg Hall  
French  
Spanish

Softball, Men's  
McKinley Hall  
Email  
Dental Hygiene  
Tenure  
Personnel Policies

English  
Graduate Complex  
Music Education  
Advising Center  
Medical School  
Levitt Arena

Religion  
Art Composition  
Physics  
Entrepreneurship  
Koch Arena  
Roster

Parents  
Wrestling  
Philosophy  
Wichita Lyceum  
Fairmount Center  
Women's Museum

Instrumental  
Nursing  
Opera  
Sports History  
Athletic Dept.  
Health Plan

# Activity

Weller (2004) found people took less time to locate items for information that was grouped

- using a border (2nd screen) compared with using color contrast (1st screen)

Some argue that too much white space on web pages is detrimental to search

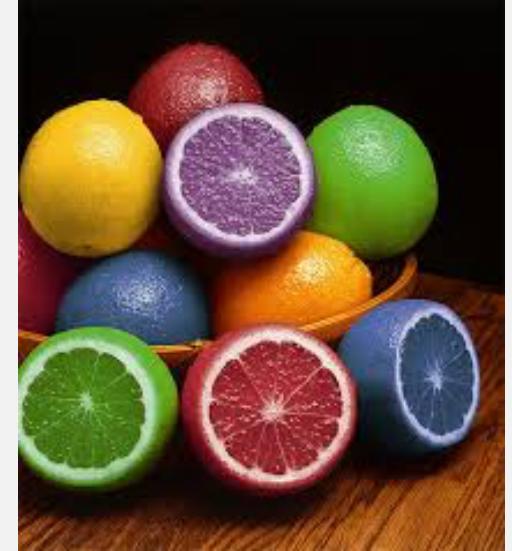
- Makes it hard to find information

Do you agree?

# Color Perception

Why is color so important?

- Used to convey information and create knowledge
  - Good/ Bad
  - Healthy/ Sick
- Part of our socio-emotional framework
  - Happy/Angry
- Allows for localizing and identifying objects
- Used in UI design routinely



# Memory

- Involves first encoding and then retrieving knowledge.
- We don't remember everything - involves filtering and processing what is attended to
- Context is important in affecting our memory (i.e. where, when)
- We recognize things much better than being able to recall things
- we remember less about objects we have photographed than when we observe them with the naked eye (Henkel, 2014)

# Processing in memory

- Encoding is first stage of memory
  - determines which information is attended to in the environment and how it is interpreted
- The more attention paid to something...
- The more it is processed in terms of thinking about it and comparing it with other knowledge...
- The more likely it is to be remembered
  - e.g. when learning about HCI, it is much better to reflect upon it, carry out exercises, have discussions with others about it, and write notes than just passively read a book, listen to a lecture or watch a video about it

# Context is important

- Context affects the extent to which information can be subsequently retrieved
- Sometimes it can be difficult for people to recall information that was encoded in a different context:
  - “You are on a train and someone comes up to you and says hello. You don’t recognize him for a few moments but then realize it is one of your neighbors. You are only used to seeing your neighbor in the hallway of your apartment block and seeing him out of context makes him difficult to recognize initially”

# Activity

- Try to remember the dates of your grandparents' (or parents) birthday
- Try to remember the last 2 Instagram or Snapchat posts you posted
- Which was easiest? Why?

# Activity

People are very good at remembering visual cues about things

- e.g. the color of items, the location of objects and marks on an object

They find it more difficult to learn and remember arbitrary material

- e.g. birthdays and phone numbers

# Recognition versus recall

- Command-based interfaces require users to recall from memory a name from a possible set of 100s
- GUIs provide smart phones visually-based options that users need only browse
- Web browsers, etc., provide lists of visited URLs, song titles etc., that support recognition memory
- Recognition is better than recall for design

# Design implications for Memory

Don't overload users' memories with complicated procedures for carrying out tasks

Design interfaces that promote recognition rather than recall

Provide users with various ways of encoding information to help them remember

- e.g. categories, color, flagging, time stamping

# Mental models

Users develop an understanding of a system through learning about and using it

Knowledge is sometimes described as a mental model:

- How to use the system (what to do next)
- What to do with unfamiliar systems or unexpected situations (how the system works)

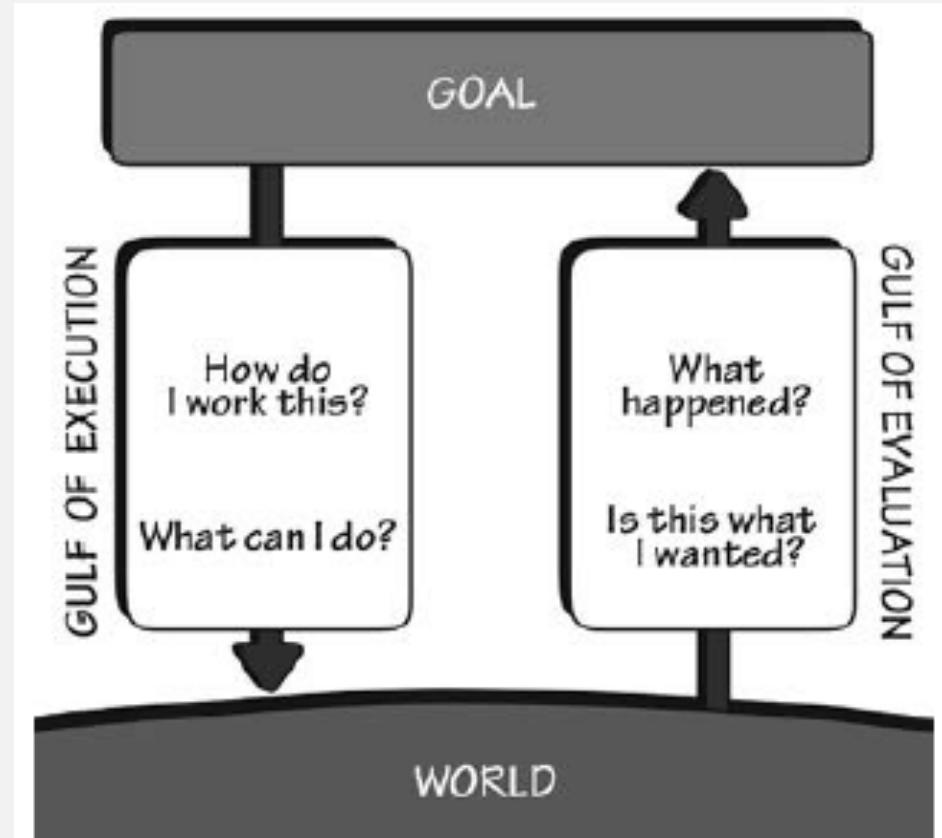
People make inferences using mental models of how to carry out tasks

# Mental models

- Craik (1943) described mental models as:
  - internal constructions of some aspect of the external world enabling predictions to be made
- Involves unconscious and conscious processes
  - images and analogies are activated
- Deep versus shallow models
  - e.g. how to drive a car and how it works

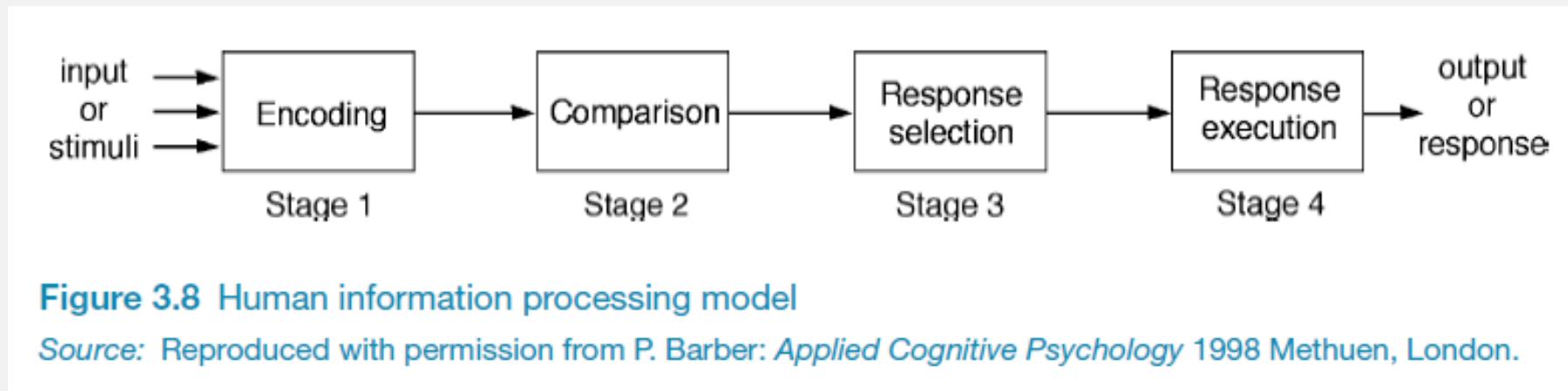
# Gulfs of execution and evaluation

- The ‘gulfs’ explicate the gaps that exist between the user and the interface
- The gulf of execution
  - the distance from the user to the physical system (user intention to what system allows)
- The gulf of evaluation
  - the distance from the physical system to the user
- Bridging the gulfs can reduce cognitive effort required to perform tasks



# Information processing

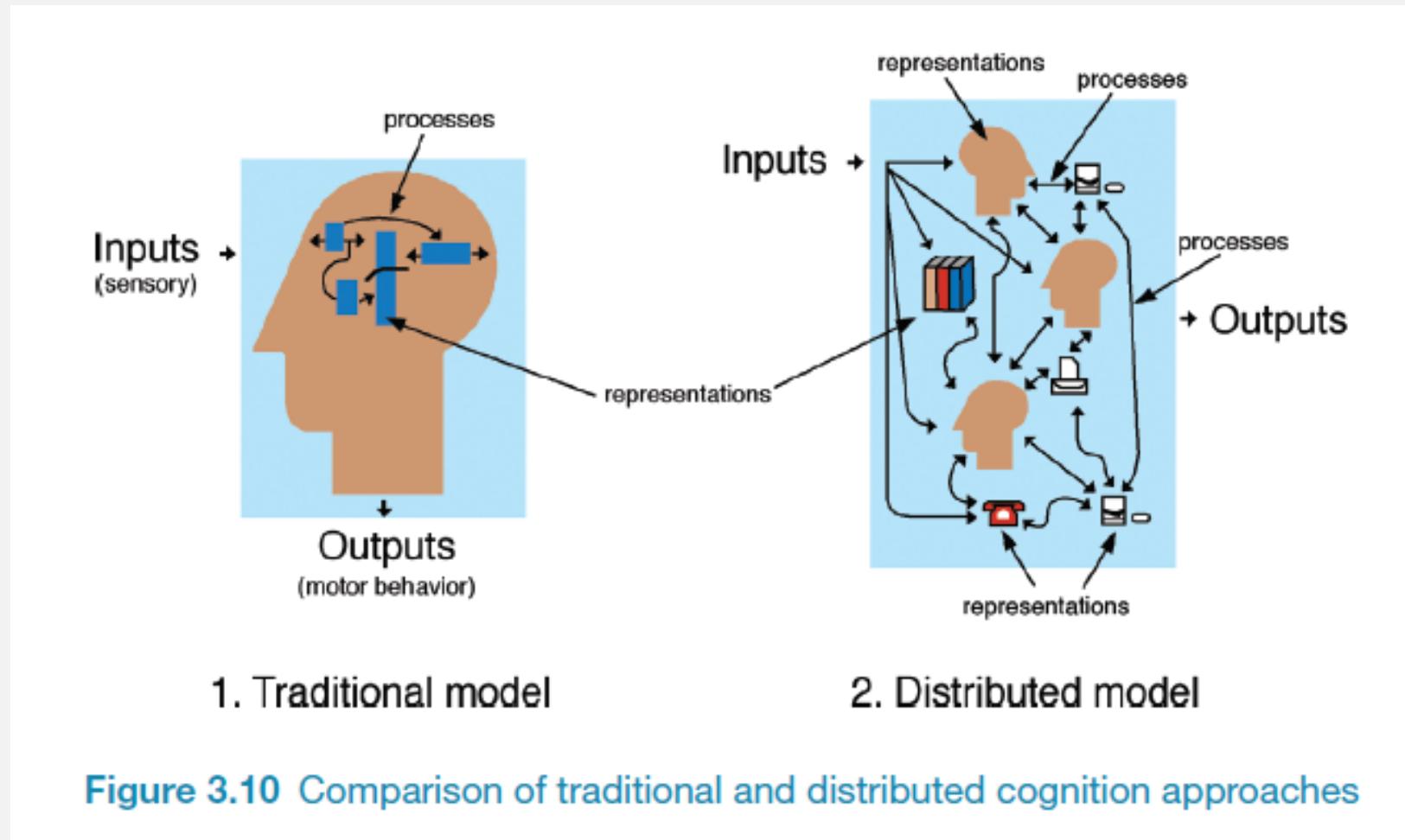
Conceptualizes human performance in metaphorical terms of information processing stages



# Distributed cognition

- Concerned with the nature of cognitive phenomena across individuals, artefacts, and internal and external representations (Hutchins, 1995)
- Describes these in terms of propagation across representational state
- Information is transformed through different media (computers, displays, paper, heads)

# How it differs from information processing



# External cognition

- Concerned with explaining how we interact with external representations (e.g. maps, notes, diagrams)
- What are the cognitive benefits and what processes involved
- How they extend our cognition
- What computer-based representations can we develop to help even more?

# Computational offloading

- When a tool is used in conjunction with an external representation to carry out a computation (e.g. pen and paper)
- Try doing the two sums below (a) in your head, (b) on a piece of paper and c) with a calculator.
  - $234 \times 456 = ??$
  - $\text{CCXXXIIII} \times \text{CCCCXXXXXXVI} = ???$
- Which is easiest and why? Both are identical sums

# Summary

- Cognition involves several processes including attention, memory, perception and learning
- The way an interface is designed can greatly affect how well users can perceive, attend, learn and remember how to do their tasks
- Theoretical frameworks, such as mental models and external cognition, provide ways of understanding how and why people interact with products
- This can lead to thinking about how to design better products

# Reading for next class...

pg. 100-115