Lecture 5
chapter 1

the human
3 of 3

the human

- Lecture 3 Information i/o …
  - visual, auditory, haptic, movement
- Lecture 4 (today)
  - Information stored in memory
    - sensory, short-term, long-term
- Lecture 5
  - Information processed and applied
    - reasoning, problem solving, skill, error
  - Emotion influences human capabilities
  - Each person is different

Thinking

Reasoning

deduction, induction, abduction

Problem solving

Rats get the smarts from NZ gene research

24.07.2004 NZ Hearld By SIMON COLLINS science reporter

Researchers have opened the way to a "smart pill" by finding a chemical that generates new brain cells. A New Zealand-American team led by Auckland University's Professor Matthew During has made "super-smart" rats by injecting them with a gene that makes the chemical. He believes similar techniques may soon help children with Down syndrome, older people who are losing their memory and students trying to learn a foreign language or swotting for exams.

His study also found that rats which were given extra mental exercises generated more new brain cells than other rats, showing that environment as well as genes help to shape intelligence. "No longer can you say there is only nature or nurture," said Dr During. "It's nurture driving nature, nurture driving the genes. The environment is switching on these genes and working through a genetic mechanism. They work together."

The research, published in the journal Nature Genetics this week, put one group of rats in a water maze where they had to learn to find a platform near the surface or underwater. Another group was put in a stimulating environment with toys, a maze, a running wheel, nesting material and food treats. A third group was kept under standard laboratory conditions.

All rats were killed after the experiment and the scientists examined their hippocampus, the part of the brain that controls memory. The researchers found that the only chemical that increased in the hippocampus of both the first two groups was vascular endothelial growth factor (VEGF), one of more than 100 molecules called growth factors in the body. This one was already known to promote the growth of new blood vessels.

After identifying the chemical, the researchers then injected a virus that had been genetically modified to express VEGF into the hippocampuses of another group of rats, and tested them with the water maze and other tests. The rats injected with extra VEGF did better on all mental tests. They also produced both more blood vessels and more new brain cells.

Dr During emphasised that there was no proof that the extra brain cells caused the apparent increase in intelligence. "It is possible that the gene is acting on the brain cells that are already resident there," he said. Scientists still believed that people could learn new things with their existing brain cells. But circumstantial evidence suggested that injecting extra VEGF-expressing genes might generate new brain cells and boost intelligence in humans. "Knowing this, we can now think about not just educational ways, but potentially pharmacological ways in which we could direct improved brains, improved memories," Dr During said.

"We could genetically make a super-smart human by putting this gene into the hippocampus." Ironically, the research also suggested that people could boost their own brains by extra mental exercises. For example. studies had shown that London cabbies had bigger-than-average hippocampuses because of the effort in learning their way around the city's streets.

Another brain researcher at Auckland University, Professor Richard Faull, said Dr During's work showed that the brain was much more flexible than scientists had believed until a few years ago. "I wouldn't go out and make the claims he [Dr During] has, but I think it's no question it's an exciting development."

Deductive Reasoning

- Deduction:
  - derive 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

There is evidence that much of this is learnt

- The bears in the north are white
- Igor lives in the north
- What colour are the bears where Igor lives?
  - I don't know I haven't seen them you will have to ask Igor.

Deduction (cont.)

- When truth and logical validity clash …

    e.g. Some people are babies
    Some babies cry
    Inference - Some people cry

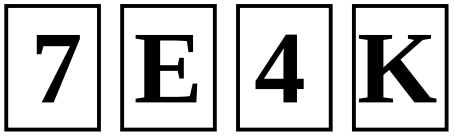
  Correct?
- People bring world knowledge to bear

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

  ... but useful!
- Humans not good at using negative evidence
  e.g. Wason's cards.

Wason's cards



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

- 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.
- Several theories.
- Gestalt
  - problem solving both productive and reproductive
  - productive draws on insight and restructuring of problem
  - attractive but not enough evidence to explain `insight' etc.
  - move away from behaviourism and led towards information processing theories

Problem solving (cont.)

Problem space theory

- problem space comprises problem states
- problem solving involves generating states using legal operators
- heuristics may be employed to select operators
  e.g. means-ends analysis
- operates within human information processing system
  e.g. STM limits etc.
- largely applied to problem solving in well-defined areas
  e.g. puzzles rather than knowledge intensive areas

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
    - lot 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
    humans create mental models to explain behaviour.
    if wrong (different from actual system) errors can occur

Emotion

- Various theories of how emotion works
  - James-Lange: emotion is our interpretation of a physiological response to a stimuli
  - Cannon: emotion is a psychological response to a stimuli
  - Schacter-Singer: emotion is the result of our evaluation of our physiological responses, in the light of the whole situation we are in
- Emotion clearly involves both cognitive and physical responses to stimuli

Emotion (cont.)

- The biological response to physical stimuli is called *affect*
- Affect influences how we respond to situations
  - positive → creative problem solving
  - negative → 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)

Emotion (cont.)

- Implications for interface design
  - stress will increase the difficulty of problem solving
  - relaxed users will be more forgiving of shortcomings in design
  - aesthetically pleasing and rewarding interfaces will increase positive affect

Social beings

- Humans are essentially social animals
- We like to work together
- We like to play together
- We like to learn together
- We like to help one-another

Collaborative systems

- PCs are 'personal computers'
- As are cell phones, pdas ……
- Increasingly systems are used to support collaboration
- Or exist to support communication
  - Email
  - Messaging
  - Online games
  - …..

Levels of knowing

- **Knowledge as facts**.
  - many people believe that knowledge is a collection of discrete facts that one simply acquires
- **Knowledge as opinion**.
  - People advance to Stage 2 when conflicting theories, points of view, and interpretations have convinced them that one cannot always know what is right
- **Knowledge as reason.**
  - By dint of teachers' and peers' assertions, most people eventually realize that there are indeed reasons why some opinions are better than others and that people use logic and evidence to support their points of view.
- **Knowledge as commitment.**
  - At this final stage, individuals recognize the complexity and uncertainty of knowledge while realizing their need to make commitments to reasoned positions. Perry's imaginary student sums up this stage: "I must be wholehearted while tentative, fight for my values yet respect others, believe my deepest values right yet be ready to learn"
- http://trc.virginia.edu/tc/2000/Promoting.htm
- Perry, William A. "Cognitive and Ethical Growth: The Making of Meaning." The American College: Responding to the New Realities of Diverse Students and a Changing Society. Ed. A.M. Chickering, et al. San Francisco: Jossey-Bass, 1981. 76-116.

Individual differences

- long 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?

Psychology and the Design of Interactive System

- Some direct applications
  - e.g. blue acuity is poor
    $\Rightarrow$ blue should not be used for important detail
- However, correct application generally requires understanding of context in psychology, and an understanding of particular experimental conditions
- A lot of knowledge has been distilled in
  - guidelines (chap 7)
  - cognitive models (chap 12)
  - experimental and analytic evaluation techniques (chap 9)